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International (Non-U.S.) Industrial Pollution Prevention:

A Case Study Compendium

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KEYWORDS INDEX

ACRONYMS

AD	air dry
AOX	Adsorbable Organohalogens
APU	Acid Purification Unit
AQ	anthraquinone
ASAM	alkaline sulfite anthraquinone methanol
BL	black liquor
BOD	Biochemical Oxygen Demand
BOD_5	Biochemical Oxygen Demand (5-day)
BSH	Blanc Stabilise Humide
BSS	Blanc Stabilise Se
BTRA	Bombay Textile Research Association
$CA	Central American dollars
CAD	Canadian dollars
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIS	Commonwealth of Independent States
CMP	chemimechanical pulp(ing)
COD	Chemical Oxygen Demand
CTRL	Cotton Textile Research Laboratory
CTMP	chemithermomechanical pulp(ing)
Dfl	guilder (currency of the Netherlands)
DK	Danish Kroner (currency)
DP	degree of polymerisation
DTMPA	metal-(diethylenetrinitrilo) penta acetic acid
DTPA	(diethylenetrinitrilo) penta acetic acid
EDTA	ethlylenediamine tetra-acetic acid
e.g.	for example
EtOH	ethanol or ethyl alcohol
EPA	Environmental Protection Agency
FF	French francs
FPPRI	Finnish Pulp and Paper Research Institute
FRG	Ministry of Research and Technology
HNL	Hindustan Newsprint Ltd.
ICAITI	Instituto Centroamericano de Investigacion y Tecnologia Industrial or the Central American Research Institute for Industry
ICPIC	International Cleaner Production Information Clearinghouse
i.e.	that is
ISIC	International Standard Industrial Classification

IPPP	International Pollution Prevention Project
LRP	Lignon Removal Process
MCC	modified continuous cooking
N/A	Not Available
NCC	no chlorine compounds
NS	thionitrosyl
NS/AQ	neutral sulfite-anthraquinone
NTP	normal temperature and pressure
OD	oven-dry
OECD	Organization for Economic Cooperation and Development
O&M	Operation and Maintenance
PAA	Polyacrylates
PGW	pressurized groundwood
PGW-S	super pressurized groundwood
PH	Poly-hydrolysate
PIES	Pollution Prevention Information Exchange System
PPIC	Pollution Prevention Information Clearinghouse
ppm	parts per million
PUR	Polyurethane
PVA	Polyvinyl alcohol
PVC	Polyvinyl chloride
QTY	quantity
RCRA	Resource Conservation and Recovery Act
R&D	Research and Development
RDH	Rapid Displacement Heating
RF	Radio Frequency
SCMP	Sulfonated chemi-mechanical pulp
SEK	Swedish crowns
SEP	Steam Explosion Pulping
SIC	Standard Industrial Classification
SIDA	Swedish Industrial Development Authority
SRP	sulfite reducing peroxyde
SS	Suspended Solids
SYTYKE	The Environmental Research and Development Programme for Finnish Forest Industry
T	ton
TL	Thin Layer
TMP	thermomechanical pulp(ing)

TRS	total reduced sulfur
TS	total solids
TSS	Total Suspended Solids
UF	Ultrafiltration
UK	United Kingdom
UNEP	United Nations Environmental Programme
US	United States
USD or US$	United States dollars
UV	Ultraviolet
V.I.E.	volumetric isothermal expansivity
YTD	Yellow Telephone Directory (in Japan)

CHEMICAL SYMBOLS ABBREVIATION LIST

Chemical Symbol	Chemical Name
$Al_2(SO_4)_3$	aluminum sulfate
$CaCO_3$	calcium carbonate
CaHPO	calcium hypophosphate
CaO	calcium oxide
CaOH	calcium hydroxide
CCl_3F	trichlorofluormethane or CFC-11
CH_4	methane
Cl_2	elemental or diatomic chlorine
ClO_2	chlorine dioxide
CN	cyanide
CO-gas	carbon monoxide
CO_2	carbon dioxide
$Cr(OH)_3$	chromium hydroxide
Cr_2O_3	chromium oxide
DTMPA	metal-(diethylenetrinitrilo) penta acetic acid
DTPA	(diethylenetrinitrilo) penta acetic acid
EDTA	ethlylenediamine tetra-acetic acid
EtOH	ethyl alcohol
HCl	hydrochloric acid
H_2	elemental or diatomic hydrogen
HNO_2	nitrous acid
HNO_3	nitric acid
H_2O	water
H_2O_2	hydrogen peroxide (molecular formula)
H_2S	hydrogen sulfide
H_2SiF_6	hydrogen hexafluorophosphate or hexafluorophosphoric acid
H_2SO_4	sulfuric acid
H_3PO_4	(ortho) phosphoric acid
K_2O	potassium (mon)oxide
MgO	magnesium oxide
$MnSO_4$	manganese sulfate
$NaBH_4$	sodium borohydride
NaCl	sodium chloride
$NaClO_3$	sodium chlorate

Na_2CO_3	sodium carbonate
$NaHCO_3$	sodium bicarbonate
NaOH	sodium hydroxide
Na_2SO_3	sodium sulfite
Na_2SO_4	sodium sulfate
NH_3	ammonia
NH_4NO_3	ammonium nitrate
NO	nitrogen (mon)oxide or nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides (various)
NP	nitrogen-phosphorus
NPK	nitrogen-phosphorus-potassium
PH_3	phosphine
P_2O_5	phosphorus pentoxide
S^-	sulfide ion
SiF_4	silicon tetrafluoride
SiO_2	silicon dioxide
SO_x	sulfur oxides (various)
ZnO	zinc oxide

UNIT ABBREVIATIONS

ADMT/d (or ADMTPD)	air dry metric ton per day
ADt	air dry ton
ADt/a	air dry ton per annum
ADt/d	air dry ton per day
A or amps	amperes
ac	acres
amp/dm^2	amperes per square decimeter
Btu	British thermal unit
°C (or deg C)	degrees Celsius
cm	centimeters
cP	centipoise
dB	decibels
Dfl	guilders
Dfl/kg	guilders per kilogram
g	grams
g/l	grams per liter
g/m^3	grams per cubic meter
GJ	gigajoule
GJ/admt	gigajoule per air dry metric ton
GJ/ton (or GJ/t or GJ/tonne)	gigajoule per ton
h	hour
hp	horsepower
hr	hour
kg	kilograms
kg/AD	kilogram per air dry (pulp)
kg/day (or kg/d)	kilograms per day
kg/hr	kilograms per hour
kg/m^2	kilograms per square meter
kg/m^3	kilogram per cubic meter
kg/ton (or kg/tonne)	kilograms per ton
kt/a	kiloton per annum
kWh/ADt	kilowatt-hour per air dry ton
kWh/admt	kilowatt-hour per air dry metric ton
kWh/m^3	kilowatt-hour per cubic meter

kWh/ton (or KWh/t)	kilowatt-hours per ton
l	liters (also spelled litres)
l/kg	liters per kilogram
l/kg AD	liter per kilogram of air dry (pulp)
l/m^2	liters per square meter
l/ton	liters per ton
lakhs	100,000 rupees
lbs	pounds
lbs/year	pounds per year
m	meters
m^3	cubic meters
m^3/d (or m^3/day)	cubic meters per day
m^3/ton (or m^3/t or m^3/tonne)	cubic meters per ton
m^3/year	cubic meters per year
mg	milligrams
mg/l	milligrams per liter
mg/m^3	milligrams per cubic meter
min	minute
MJ	megajoule
mm	millimeters
MPa	megapascal
m sq ft	million square feet
m^2	square meter
MT	metric tons
MWh/t	megawatt-hour per ton
MWh/year	megawatt-hour per year
$Nm^3/hr/m^3$	Newton cubic meters per hour per cubic meter
Nm^3/kWh	Newton cubic meter per kilowatt-hour
Pa.S	pascal second
ppm	parts per million
psig	pounds per square inch, gauge
rpm	revolutions per minute
s	second
t/a	tons per annum
T/day (or t/day or tpd or t/d)	tons per day

tpy (or t/y)	tons per year
ug/m^3	micrograms per cubic meter
um	micrometer
V	volts
V/A	volts per ampere
v/v	volume per volume

INTERNATIONAL POLLUTION PREVENTION CASE STUDY COMPENDIUM

INTRODUCTION TO THE COMPENDIUM PROJECT

The U.S. Environmental Protection Agency (EPA) has joined with industry, States, and local regulatory agencies, as well as pollution prevention experts, to implement the EPA's Industrial Pollution Prevention Project (IP_3). The IP_3 is an agency-wide, multimedia project focusing on industrial pollution prevention. The objectives of the IP_3 are twofold: (1) to incorporate pollution prevention into the industrial effluent guidelines process, and (2) to extend information to industries and to the consuming public to better establish and spread the pollution prevention ethic.

The IP_3 includes 13 tasks, one of which is to gather together all readily available information on the pollution prevention measures implemented by industries in other countries, to put all that information into electronic files so that it is accessible to all interested parties, and to compile all the case studies into a hard-copy compendium.

This compendium has been prepared by the IP_3 to provide EPA, States, industries, and other interested parties with access to non-U.S. pollution prevention case studies. The compendium includes many countries' experiences related to a variety of pollution prevention concepts and technologies. It is hoped that this compendium will be helpful to plant designers, managers, and regulators who are searching for creative ways to accomplish further pollution prevention.

As indicated above, the information compiled for this hard-copy compendium is also being put into the Pollution Prevention Information Clearinghouse (PPIC) and into the International Cleaner Production Information Clearinghouse (ICPIC) so that it will be available electronically to all interested parties. (Although this hard-copy compendium does not include case studies from U.S. industries, U.S. case studies may be obtained through the PPIC.) Appendix A provides a reference guide to both the PPIC and the ICPIC, and Appendix B contains information on the content and format of the case studies.

APPROACH IN SELECTING THE CASE STUDIES

The case studies in this compendium have been compiled from a variety of sources, including the following:

- United Nations Environment Programme (UNEP)
- Organization for Economic Cooperation and Development (OECD)
- Embassies and government environmental offices
- Proceedings from various international conferences on pollution prevention

- Trade journals
- Contacts in the United States and abroad.

Over 200 case studies from more than 20 countries are included in this compendium. Before being included, all the international case studies obtained were reviewed to ensure conformity with the concept of pollution prevention. Pollution prevention, generally, is the multimedia approach to protecting the environment that involves the use of processes, practices, or products that reduce or eliminate the generation of pollutants—before recycling, treatment, or disposal. (For further discussion, see the next section—"BACKGROUND ON POLLUTION PREVENTION.") For this compendium, only source reduction or "closed-loop" recycling was considered to be pollution prevention.

All information obtained was reviewed to ensure that case studies included in this compendium (and added to electronic files) would be of interest and would provide sufficient detail to be useful to intended audiences. In some cases, materials had to be translated into English before being included.

Typically, each case study summarizes the technology used, its application, the status of the technology's development, commercial availability, investment and operating costs, payback periods, cost savings, feedstocks utilized, wastes produced, pollution reductions achieved, regulatory issues, and any startup or implementation problems encountered. Whenever possible, contact names, addresses, and telephone numbers have been provided.

It should be noted that much of the economic data included in the compendium is provided in the currency of the country from which the case study originated. To assist readers, a table of foreign currency rates and a table of common chemical elements and their symbols have been provided in Appendices C and D, respectively. (Readers should keep in mind that the economic figures included in the case studies represent the costs and savings incurred at the time each industry's activities were documented and may not reflect present values.)

This compendium contains over 200 pollution prevention case studies within 20 broad industrial categories, such as electroplating, chemical manufacturing, pulp and paper, petroleum refining, and textiles. Several additional case studies have also been included in this compendium, even though they are not truly pollution prevention as we have defined it. These additional case studies do reduce or eliminate pollutants, go beyond traditional end-of-pipe approaches, and therefore were judged to be valuable additions to the compendium. They have been included in the body of the compendium—but they are marked with a special <x> symbol to distinguish them from the truly pollution prevention case studies. Also, several case studies of successful post-consumer recycling technologies have been included as a separate section of the compendium.

Finally, the compendium provides a very helpful keyword index that lists the keywords included in the case study abstracts with citations indicating the pages on which each keyword appears.

While most of the case studies demonstrate success stories, examples of failed efforts (and the reasons for their failure) have also been included, because there is something to be learned from failures as well as successes.

BACKGROUND ON POLLUTION PREVENTION

Historically, the U.S. EPA has relied primarily on pollution abatement programs and policies that impose controls after the point of waste generation. This approach, commonly known as "end-of-pipe" management, is based largely on regulations intended to treat a waste or otherwise deal with pollution prevention after it has been generated.

In October 1990, the U.S. Congress passed the Pollution Prevention Act of 1990 (Public Law No. 101-508, Title 6, 104 Stat. 1388). The Act encourages the prevention of pollution at the source whenever feasible. By implementing such pollution prevention, industries may realize the following advantages:

- Lower facility operation and maintenance costs
- Savings in raw material, feedstock, and manufacturing costs
- Increased production rates and improved product quality
- More consistent compliance with Federal, State, and local wastewater discharge requirements
- Decreased treatment, storage, transportation, and waste disposal costs
- Decreased employee risk from exposure to chemicals
- Potential reduction in short- and long-term liability associated with handling and disposing of dangerous materials
- Potential reduction in environmental impairment insurance costs
- Improved public image and employee morale from waste reduction efforts
- Significant contributions to a cleaner environment due to reduced pollutant generation.

In order for an industry to identify appropriate pollution prevention and waste reduction opportunities (Figure 1), a facility should conduct an assessment that includes characterizing its waste stream, identifying viable options for reducing wastes, and determining which options are technically and economically feasible. The assessments usually include the following four phases: planning and organization, assessment, feasibility analysis, and implementation and performance evaluation. The opportunities that should be considered are discussed below:

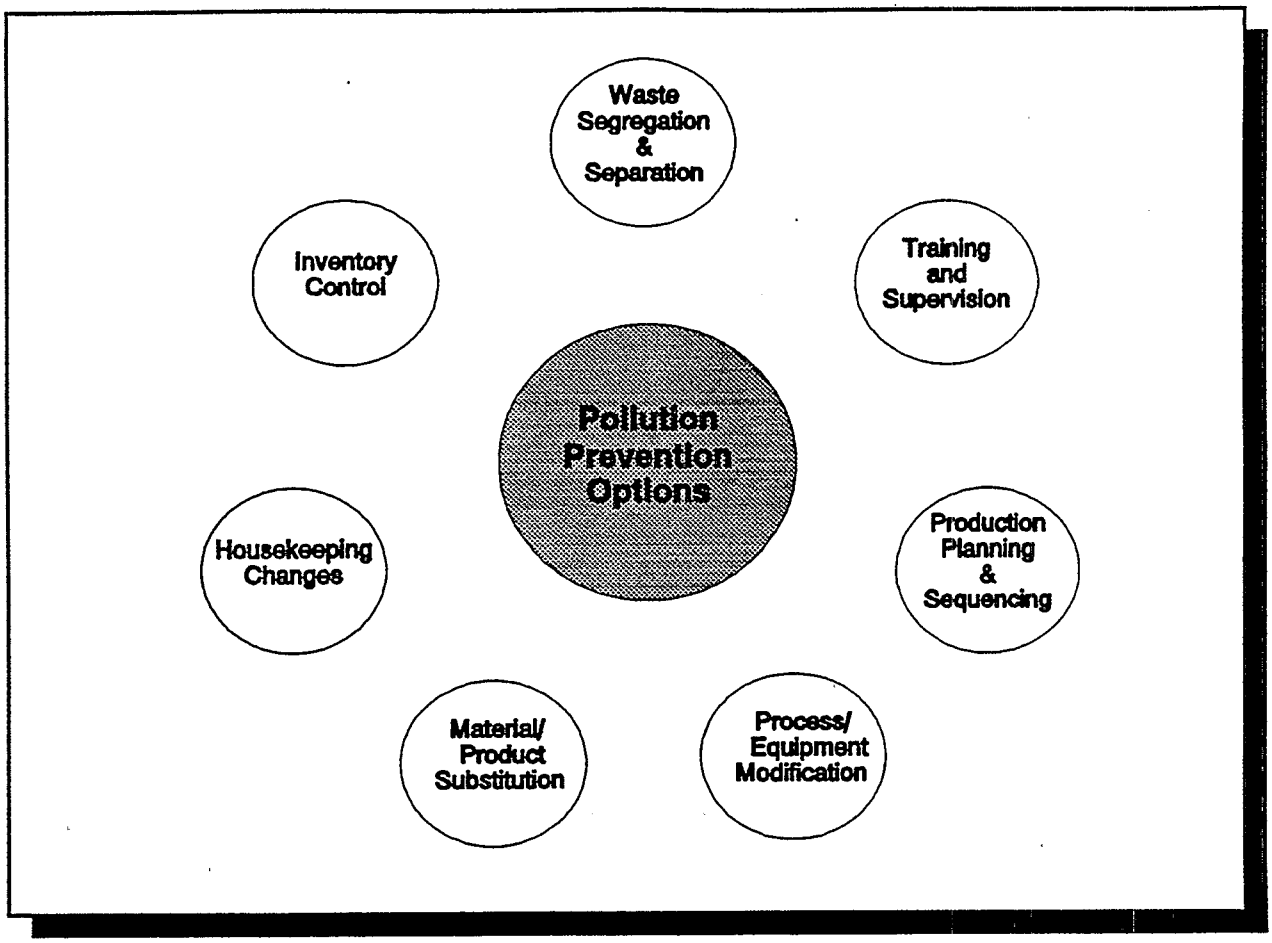

Figure 1. Pollution Prevention Opportunities

- Training and Supervision—Improved training and supervision of employees to help reduce or eliminate waste generation caused by improper equipment use and maintenance. Employees directly involved with processes and activities that generate wastes should have an understanding of why and how the wastes are generated, how they are managed, and the costs and liabilities incurred by the mismanagement of wastes.

- Production Planning and Sequencing—Planning and sequencing production processes such that no step in the production process is needlessly "undone" by a later operation. Examples of such sequencing include the sorting and rejection of parts prior to painting or electroplating or the scheduling of batch processes to allow wastes or residues from one batch to be used as input to the next. Improved scheduling of batch production runs reduces the frequency of equipment and tank cleaning, which can result in less generation of waste.

- Process/Equipment Modification—Changes in a process or in the equipment used to reduce the amount of waste generated. For example, paint overspray may be reduced by decreasing the atomizing air pressure to paint spray equipment; the dragout of pollutants may by reduced in metal finishing operations by reducing the withdrawal speed of parts from plating tanks. Further, redesigning or replacing equipment may generate less waste.

- Material/Product Substitution—Substituting or replacing a hazardous or toxic substance used in a production process with a nonhazardous or less hazardous toxic substance. Examples might include

replacing solvent degreasers with alkali washes or substituting cyanide dip and chromium dip/passivation lines with sulfuric acid and hydrogen peroxide bright pickle dips. Pollution prevention steps may also mean changing a facility's intermediate or final product to generate less waste during the production process.

- Housekeeping Changes—A variety of materials handling and equipment maintenance activities that can lead to reduced waste generation. For example, performing preventive maintenance of equipment can improve operating efficiency and reduce the likelihood or occurrence of product rejection or of off-specification products. Improved recordkeeping and documentation of operating procedures promotes consistency, reducing the manufacture of unacceptable products that must be discarded. Maintaining operating manuals may assist operators monitoring waste generation in identifying unplanned waste releases and in responding to equipment failures. Spill and leak prevention and control include operational procedures and precautionary modifications to equipment and containment areas to minimize leaks and spills.

- Inventory Control—Improved material tracking which can reduce the waste resulting from overstocking and identify the need for disposal of material with an expired shelf life. Improved material usage, handling, and storage can reduce loss of raw or intermediate materials due to mishandling and improper storage.

- Waste Segregation and Separation—Management of wastes so as to segregate hazardous and non-hazardous wastes, liquid wastes from solids, and wastestreams containing recoverable metals from those containing chelating agents. Waste segregation and separation promotes recycling and recovery of wastes and improves their treatability. For example, separating hazardous wastes from non-hazardous wastes eliminates the need to treat or dispose of an entire mixture as if it were all hazardous, thus saving treatment, disposal, and possible liability costs.

In order for an industry to optimize its use of pollution prevention measures, it should adopt a "product life cycle management" or holistic approach to identifying and evaluating opportunities to reduce the environmental impacts associated with a specific product, process, or activity by analyzing its entire life cycle. Such an approach encompasses the extracting and processing of raw materials; the manufacture, transport, and distribution of a product; use/reuse/maintenance of that product; possible recycling and composting; and final disposal. A life cycle assessment may consist of three components:

- Inventory analysis—The identification and quantification of energy and resource use and waste emissions

- Impact analysis—The assessment of the consequences of those wastes on the environment

- Improvement analysis—The evaluation and implementation of opportunities to effect environmental improvements.

The results of such an assessment may lead to the redesign of an existing product or to the creation of a new product.

While there are many potential benefits to be realized from implementation of pollution prevention techniques, industries should be aware that they may encounter short-term obstacles that should be overcome

during the process. For example, facilities may experience changes in production rates and/or product quality control during equipment or procedural transition periods. Industry officials may observe changes in client relations and product marketing as changes in product characteristics affect customer acceptance. Industries may encounter employee resistance to onsite changes and to lack of training or experience in new equipment or new operating processes. Onsite waste treatment systems may experience temporary adverse impacts during transitions to different, less hazardous raw or intermediate materials. Further, if an industry has chosen to accept another plant's waste as a feedstock for its operations (an environmentally efficient and often cost saving practice), the industry may first need to resolve possible regulatory and liability issues as well as any potential effects on product quality. However, if industry officials commit to establishing a pollution prevention program, each of these potential problems can be effectively resolved. This compendium provides examples of how industries from more than 20 categories from a variety of foreign countries have effectively overcome similar obstacles.

ADDITIONAL HELP AND INFORMATION

Appendix E of this compendium contains a comprehensive bibliography listing by industrial category the sources of all case studies included in this compendium. Compendium users may find this bibliography useful.

Also, EPA established the Pollution Prevention Information Clearinghouse (PPIC) in 1988 to improve and encourage the transfer of pollution prevention and recycling information. As mentioned earlier, all of the case studies in this compendium have been put into the PPIC (and the ICPIC, see below). The PPIC, however, is also a free clearinghouse service containing technical, policy, programmatic, legislative, and financial information relating to pollution prevention and recycling. The Clearinghouse is available to the public and attracts a varied group of users, including pollution prevention professionals from industry; Federal, State and local governments; trade associations; research institutions; academia; public interest groups; and international organizations. EPA encourages and welcomes industry to use the PPIC to obtain and exchange pollution prevention information. The PPIC can be reached through the EPA Clearinghouse Hotline at (202) 260-1023.

As part of the PPIC, EPA has established an electronic component known as the Pollution Prevention Information Exchange System (PIES). PIES is a computerized information dissemination and exchange service containing both technical and policy information accessible without user fees (except the cost of a telephone call). The system includes an interactive message center, announcements, a calendar of events, case studies, program summaries, a directory of contacts, a subject-specific mini-exchange, an environmental education bibliography, and an electronic bibliography of documents in PPIC. Assistance with PIES can be obtained through the PIES Technical Support Hotline at (703) 821-4800.

Through a cooperative agreement with the United Nations Environment Programme (UNEP), EPA has helped establish the International Cleaner Production Information Clearinghouse (ICPIC) in Paris, France. Similar in scope and content to the PPIC, the ICPIC works in close cooperation with its U.S. counterpart. The two clearinghouses are electronically linked and regularly share information. Together, these two programs (as described in more detail in Appendix A) form a truly international pollution prevention network.

For more information on pollution prevention, interested persons should contact PPIC, a free nonregulatory service of EPA, by mail, telephone hotline, or personal computer using the addresses, phone numbers, and guidance provided in Appendix A. EPA encourages any organization or person with access to case studies that do not appear in this compendium to submit this information to the address listed in Appendix A. The procedures for submitting pollution prevention case studies are provided in Appendix B.

CASE STUDIES

BATTERY

***** DOCNO: 400-070-A-307*****

HEADLINE:	Automation of battery plate manufacturing process reduces lead oxide dust by 85% and wastewater by 98%.
INDUSTRY/SIC CODE:	Metallurgical Industry/ISIC 38
POLLUTION PREVENTION OPTIONS SUMMARY:	This audit of a manufacturer of battery plates suggests that the automation of the mold filling stage, reduces waste generation. Battery plates are placed manually in a fixed mold which is located in a sound-proof cabinet. When the cabinet is closed, the mold is automatically filled with lead powder. This process is quite different from the standard technology where the battery plates are placed in mobile molds which are manually handled and filled with lead oxide powder. These operations are conducted under water spraying in order to reduce dust. Polluted air is extracted.
FEEDSTOCKS:	Lead oxide powder, water
WASTES:	Lead oxide dust; water containing lead dust
MEDIUM:	Aqueous, air
COST:	Calculated based on 230,000 battery plates produced per year
CAPITAL COST:	FF 1,500,000 (1979 figures)
OPERATION/MAINTENANCE:	FF 7,730,000 (1979 figures)
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	FF 565,000 (1979 figures)
FEEDSTOCK REDUCTION:	Material consumption is 2.4 tons of lead oxide and 2 m^3 of water per 1,000 battery plates (versus 2.6 tons of lead oxide and 80 m^3 of water per 1,000 battery plates with the standard technology).
WASTE PRODUCTION:	Manufacture of 1,000 battery plates generates 110 g of lead oxide dust (including 16 g of lead) and 2 m^3 of water containing lead dust (versus 830 g of lead dust, 380 g of lead and 80 m^3 of water in the standard technology).
IMPACT:	The quantity of water used is substantially reduced, improving reliability and efficiency. Substantial improvement of working conditions: elimination of one night shift; reduction of operator fatigue, and the noise level goes down from 95 dB (standard technology) to 85 dB (low-waste technology).
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Production of Lead Battery Plates by Automatic Filling of Fixed Molds", Monograph ENV/WP.2/5/Add.70.
KEYWORDS:	Metallurgical Industry, Battery Plates, Mold Filling, ISIC 3800, Lead Oxide, Dust Recovery, Wastewater

CEMENT PRODUCTS

***** DOCNO: 400-031-A-220 *****

HEADLINE:	Wastewater and residue recyucling by an asbestos-cement processer.
INDUSTRY/SIC CODE:	Manufacturing of non-metallic mineral products with the exception of petroleum and coal derivatives/ISIC 3699
NAME/CONTACT:	Ministere de l'Environment et due Cadre de Vie Direction de la Prevention des Pollutions 14, Boulevard de General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	The company manufactures asbestos-cement panels and pipes and recycles the water used in the process. The asbestos and the cement are mixed in water. The resulting mixture is placed on a cloth rolling at high speed, is drained and forms a thin layer that serves as a base for the panels and pipes. The water drained in both processes is decanted twice. The residue from the first decanting is recycled; that from the second is also recycled in the low pollution process, while it is discharged in the standard process.
FEEDSTOCKS:	Wastewater from asbestos-cement panels.
WASTES:	Pollution is mainly due to water that is discharged.
MEDIUM:	Water
COST:	(1980 Francs)
CAPITAL COST:	F 5,500,000
OPERATION/MAINTENANCE:	F 2.6/ton asbestos-cement
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Residue discharge is reduced by 57%; wastewater production is nearly eliminated.
IMPACT:	Reduces volume of disposed residue, and reduces wastewater discharge.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Recycling of Water from Manufacturing of Asbestos/Cement Panels and Pipes", Monograph ENV/WP.2/5/Add.31.
KEYWORDS:	Cement, Asbestos, ISIC 3699, Wastewater, Recycling

1.0 Headline: Cement kiln NOx and SOx emissions reduced by improved process control

2.0 SIC Code: SIC 3241, Cement, Hydraulic

3.0 Name and Location of Company:

Blue Circle Industries pic, Hope Works facility

4.0 Clean Technology Category

The technology was improved process control using a computer expert-system to run the cement kiln at its optimum operating conditions to reduced SOx and NOx emissions and conserve energy.

5.0 Case Study Summary

5.1 Process and Waste Information: Blue Circle Industries manufactures Portland cement by blending fuel, limestone, and clay to produce a clinker and then grinding with gypsum. The process must be operated within a certain temperature range to generate a usable product, avoid coal wastage, and minimize air pollution.

The LINKman expert-system continuously monitors all the appropriate process variables, such as the flue gas temperature, oxygen, NOx level and the power used to turn the two cement kilns. It then adjusts the coal, air and feed rates on the basis of a model of the plant's behavior derived from operational experience. This allows the plant to run much closer to its optimum conditions than is possible under manual control. One significant novel feature of the instrumentation is the measurement of the NOx level in the flue gas which gives valuable information on the temperature in the firing zone.

5.2 Scale of Operation: No information provided.

5.3 Stage of Development: The technology is fully operational.

5.4 Level of Commercialization: The technology is commercially available.

5.5 Material/Energy Balances and Substitutions: The NOx level of around 500 ppm is typically reduced to 200 ppm.

6.0 Economics*

All economic data is based on 1987 prices. It is assumed that the economic figures are based on purchase and operation of two cement kilns.

6.1 Investment Costs: 203,000 English Pounds.

6.2 Operational and Maintenance Costs: Annual savings in coal is 500,000 English Pounds and annual savings in grinding clinker is 430,000 English Pounds.

6.3 Payback Time: Payback time is 3 months.

7.0 Cleaner Production Benefits

NOx and SOx emissions are reduced. The wastage of coal at high temperatures is avoided. Higher quality clinker is produced. The clinker requires less energy to grind. The lining of the kilns has a longer life. Economic savings in energy costs are realized.

8.0 Obstacles, Problems and/or Known Constraints

None identified.

9.0 Date Case Study Was Performed: 1987

10.0 Contacts and Citation

10.1 Type of Source Material: Government publication.

10.2 Citation: Clean Technology, Environmental Protection Technology Scheme, Department of the Environment, 2 Marsham Street, London SW1P 3EB, 1989, p23.

10.3 Level of Detail of the Source Material: A simplified process flow diagram is provided. Equipment suppliers and contact are provided.

10.4 Industry/Program Contact and Address: Mr. W. Henerson, Chief Electrical and Process Control Engineer, Blue Circle Industries pic, Technical Services Centre, 305 London Road, Greenhithe, Kent DA99JQ, England, telephone (0322) 843011.

10.5 Abstractor Name and Address: John Houlahan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Cement kiln emissions, nitric oxides, sulfur oxides, NOx, SOx

11.2 Process type/waste source: Portland cement manufacture

11.3 Waste reduction technique: Process efficiency, expert system, continuous monitoring

11.4 Other keywords: expert system, United Kingdom, Portland cement, SIC 3241

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Cement Kiln Emissions, Nitric Oxides, Sulfur Oxides, NOx, SOx, Portland Cement Manufacture, Process Efficiency, Expert System, Continuous Monitoring, United Kingdom, Portland Cement, SIC 3241

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Pollution and Waste Reduction by Improved Process Control in Cement Production

2.0 SIC/ISIC Code: 3241

3.0 Name and Location of Company:

PT Semen Cibinong, Indonesia

4.0 Clean Technology Category:

5.0 Case Study Summary:

5.1 Process and Waste Information: Cement is made by burning a fuel together with limestone, clay, and shale, yielding a clinker that is then ground with gypsum to produce cement. The process is carried out in large rotating kilns and is highly sensitive to operational fluctuations. The use of coal as fuel increases the dust content of the exhaust gases which is removed with electrostatic precipitators. Off-specification product or increased pollutant content in the exhaust is generated as a result of improper process control.

5.2 Scale of Operation: The facility operates two 2,000 ton per day dry process kilns using a low sulfur coal.

5.3 Stage of Development: PT Semen Cibinong is currently implementing its process control system at its facility in Jakarta, Indonesia.

5.4 Level of Commercialization: The LINKman System for process control is currently available from ABB LINKman Systems Ltd in Beckenham, Kent.

5.5 Material/Energy Balances and Substitutions: No quantitative figures are given, but the system increases capacity by 9 percent. Also, the clinker produced requires less energy to grind, and there is a 40 percent reduction in off-specification material and a 3 percent fuel savings.

6.0 Economics*

6.1 Investment Costs: The capital investment of this system is about US$375,000.

6.2 Operational and Maintenance Costs: The system provides a power and fuel savings of approximately US$350,000.

6.3 Payback Time: Less than one year.

7.0 Pollution Prevention Benefits

The advantages of the system are that the wastage of coal at high temperatures is avoided, a higher quality clinker is produced, the lining of the kiln has a longer operational life, and there are some reductions in NO_x and SO_x emissions.

8.0 Obstacles, Problems, and/or Known Constraints

None Identified.

9.0 Date Case Study Was Performed: Not Identified.

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "Pollution and Waste Reduction by Improved Process Control," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: Ir Sugiharto, P T Semen Cibinong, Jl Let Jen M T Ilaryono, Jakarta, Indonesia, Tel: +62 21 819 0808

Mr Robert Harrison, ABB LINKman Systems Ltd, County House, 221-241 Beckenham Road, Beckenham, Kent, BR3 4UF, Tel: +44 81 778 1200

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Off-specification cement

11.2 Process Type/Waste Source: Cement manufacturing

11.3 Waste Reduction Techniques: Process control

11.4 Other Keywords:

11.5 Country Code:

12.0 Assumptions

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Off-specification Cement, Cement Manufacturing, Process Control

CHEMICAL MANUFACTURING

Adhesive and Sealants Manufacturing
Inorganic Chemical Manufacturing
Organic Chemical Manufacturing
Miscellaneous Chemical

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Water-Based Adhesives Replaces Organic-Solvents and Reduces Emissions to Atmosphere

2.0 SIC/ISIC Code:

3.0 Name and Location of Company:

Blueminster Ltd, Kent, United Kingdom

4.0 Clean Technology Category: This technology uses water-based adhesives, replacing the more common organic solvent-based adhesives, for possible application in a wide variety of industries.

5.0 Case Study Summary:

5.1 Process and Waste Information: This technology is designed to replace organic-solvent based adhesives with water-based adhesives. When solvent based adhesives are used, the solvent is volatile and evaporates to the atmosphere contributing to air pollution or the solvent is removed by high-energy drying and is recovered. Hot-melt organic adhesives do not use solvents, but are also high energy consumers.

5.2 Scale of Operation: Not Provided.

5.3 Stage of Development: Various trials have been carried out and small scale production has commenced.

5.4 Level of Commercialization: Not Discussed.

5.5 Material/Energy Balances and Substitutions: Not identified.

6.0 Economics*

6.1 Investment Costs: Not identified.

6.2 Operational and Maintenance Costs: Not identified.

6.3 Payback Time: Not identified.

7.0 Pollution Prevention Benefits

Water-based adhesives are non-toxic, do not pollute the atmosphere or water systems, do not require special handling, and are not a fire hazard. Also, solvent-based adhesives need three to five times the drying energy of water-based adhesives. Water-based adhesives need no special solvent recovery system or explosion proof equipment. Water-based adhesives can generate higher levels of adhesion through penetration of absorbent substrates, such as cellulose, and will allow more time for the precise positioning of adherents. Water-based adhesives are particularly suitable for food packaging.

8.0 Obstacles, Problems, and/or Known Constraints

None Identified.

9.0 Date Case Study Was Performed: Not Identified

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "New Product: Water-Based Adhesives," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: Trevor Jones, Managing Director, Blueminster Ltd, Unit 17 Chaucer Business Park, Kemsing Sevenoaks, Kent TN15 6PJ, Tel: +44 732 61858

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Air emissions

11.2 Process Type/Waste Source: Water-based adhesives

11.3 Waste Reduction Techniques: Material substitution

11.4 Other Keywords:

11.5 Country Code:

12.0 Assumptions

None.

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Air Emissions, Water-based Adhesives, Material Substitution

***** DOCNO: 400-074-A-248 *****

HEADLINE:	Agitator reactor used to recover phosphorous and reduce energy consumption.
INDUSTRY/SIC CODE:	Industrial Chemical Manufacturing/ISIC 3511
TECHNOLOGY DESCRIPTION:	Phosphorous contained in the by-product sludge from phosphorous production is converted to sodium phosphinate via alkaline digestion in an agitator reactor. The digestion suspension product contains contaminants from the sludge and is, therefore, filtered prior to further processing. Subsequent processing includes neutralization, evaporation, crystallization, centrifugation, and drying. This yields the sodium phosphinate final product, along with some CaHPO. The liquid resulting from the centrifugation is recycled to the process. Phosphine and hydrogen off-gases from the reaction are utilized in the production of phosphoric acid (combustion to H_3PO_4, mist absorption in circulating phosphoric acid).
FEEDSTOCKS:	Phosphorous sludge, acetylene-lime hydrate, sodium hydroxide, hydrochloric acid, nitrogen, steam, electric power, water.
WASTES:	With the low pollution technique there is a discharge of 340 kg PH_3 (intermediate product), 77 kg NaCl, 2 kg sodium-phosphinate dust and 5 kg filter cake.
MEDIUM:	Water, air, solid
COST:	
CAPITAL COST:	Low, relative to conventional technology, due to the use of common steel over stainless steel.
OPERATION/MAINTENANCE:	50% reduction in energy consumption over conventional technology. Elimination of heavy corrosion costs.
MONTHS TO RECOVER:	Installation can be amortized over less than three years.
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Not reported
FEEDSTOCK REDUCTION:	Phosphine gas emitted from reactor is utilized in phosphorous acid plant.
WASTE PRODUCTION:	Not reported
IMPACT:	Currently, 30% of the applied phosphorous is emitted into waste water in an elementary form. 10% is emitted into waste water in the form of P_2O_5. Low-waste technology recovers nearly all the applied phosphorous, yielding sodium phosphinate for use in electrolytic nickeling, and a non-toxic filter cake.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Sodium Phosphate Made From Phosphorous Sludge", Monograph ENV/WP.2/5/Add74.
KEYWORDS:	Phosphorous, Sludge, ISIC 3511

***** DOCNO: 400-040-A-229 *****

HEADLINE:	Debubbler used to extract nitrates from water vapor.
INDUSTRY/SIC CODE:	Chemical Industry and Manufacturing of Chemical Products, Petroleum and Coal Derivatives and Rubber and Plastic Products/ISIC 3512
NAME/CONTACT:	Ministere de l'Environnement et du Cadre de Vie Direction de la Prevention des Pollutions 14, Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	The company produces ammonium nitrate with direct verification of the reaction and debubbling of the water vapor extracted. In the low pollution technique, the verification of the reaction of the two basic elements (concentrated nitric acid and ammonia) is carried out through the pH analysis of the residual water collected at the end of the process. This water was originally contained in the nitric acid and was obtained by evaporation of the ammonium nitrate solution followed by condensation. In the low pollution technique, the ammonium nitrate laden water vapor passes through a debubbler before condensation which limits the nitrate bubbles carried by the vapor.
FEEDSTOCKS:	Ammonium nitrate, nitric acid
WASTES:	Wastewater containing ammonium, nitrogen, and nitric acid
MEDIUM:	Aqueous
COST: CAPITAL COST: OPERATION/MAINTENANCE: MONTHS TO RECOVER:	 F 300,000 Not reported 84
SAVINGS: DIRECT COST: FEEDSTOCK REDUCTION: WASTE PRODUCTION:	 Not reported Ammonium nitrate waste reduced by 93%.
IMPACT:	Material consumption is reduced in the low pollution technique by just under 2 per cent. Energy consumption, generally low, is more or less the same in both techniques. This technique allows closer verification of the chemical reactions that take place during production and thus gives a better material yield and less pollution. This principle should be extended to other procedures in the chemical sector.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Production of Ammonium Nitrate with Continuous Control of the Reaction and Degassing of the Resulting Water Vapors", Monograph ENV/WP.2/5/Add.40.
KEYWORDS:	Ammonium Nitrate, Reaction Verification, Debubbling, ISIC 3512

***** DOCNO: 400-112-A-271*****

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HEADLINE: Waste silica recovered during aluminum fluoride production is marketable product.

INDUSTRY/SIC CODE: Manufacture of Basic Industrial Chemicals Except Fertilizer/SIC 28

TECHNOLOGY DESCRIPTION: The low waste technology is for the production of aluminum fluoride with utilization of waste silica. There are no significant changes in the production of the aluminum fluoride. The use of waste silica permits the manufacture of a marketable product to be used as a filler in rubber compounds. The steps of the process include:

- Dissolution of the waste inactive silica by treating it with an ammonium fluoride solution.
- Separation of ammonium cryolite by filtration, to be used in ammonium fluoride production.
- Precipitation of active silica by treating the ammonium fluosilicate solution with ammonia (gas) or ammonia water.
- Separation and washing of active silica on the press filter.
- Evaporation of ammonium fluoride solution.
- Drying and packaging of active silica.

FEEDSTOCKS: Silicon (inactive) from aluminum fluoride production (23% SiO_2) - 4,384 kg/metric ton output; H_2SiF_6 (100 %) - 269 kg; NH_3 - 327 kg; process water - 2,330 kg; industrial water - 150 m^3.

WASTES: Residual gases (50 m^3/ton) from the calcination of active silica, containing less than 10 mg/m^3 F, are washed and passed into the atmosphere. Process waters and waste water from equipment washing are recycled to the process for washing active silica cake.

MEDIUM: Gaseous, liquid

COST: (Rubles per metric ton)
CAPITAL COST: 9,500 thousand rubles
OPERATION/MAINTENANCE: 330 rubles/metric ton
MONTHS TO RECOVER: Not reported

SAVINGS:
DISPOSAL & FEEDSTOCK: 120 rubles/metric ton gross profit on active silica filler.
FEEDSTOCK REDUCTION: Not reported
WASTE PRODUCTION: Five percent savings from depreciation charges on pollution control measures attributed to the elimination of the waste silica disposal, in addition to disposal costs.

IMPACT: Elimination of silica disposal in a landfill site or storage pond, by creating a profitable use for this waste by-product.

CITATION/PAGE: Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Production of Aluminum Fluoride with the Utilization of Waste Silica" Monograph ENV/WP.2/5/Add112.

KEYWORDS: Silica, Precipitation, Solid Waste Recovery, Fillers, Aluminum Fluoride, SIC 28

***** DOCNO: 400-092-A-318*****

HEADLINE:	Titanium anodes and crystallization are used to recover chlorate, reduce energy needs, and eliminate graphite sludge.
INDUSTRY/SIC CODE:	Manufacture of Basic Industrial Chemicals Except Fertilizer/ISIC 3511
POLLUTION PREVENTION OPTIONS SUMMARY:	Liquors containing soda chlorate and sodium chloride are injected into electrolyzers which transform chloride into chlorate with titanium anodes. The resulting liquors are then sent to a crystallizing pond where part of the chlorate is recovered. The remaining part is returned to the electrolyzers after addition of sodium chloride.
FEEDSTOCKS:	Sodium chloride, electrical energy, titanium anodes
WASTES:	None
MEDIUM:	Not applicable
COST:	
CAPITAL COST:	9,000,000 francs (1978)
OPERATION/MAINTENANCE:	601 francs/ton of product (1980)
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	191 francs/ton in electrical energy, which is offset by increased cost of 100 francs/ton for titanium anodes.
FEEDSTOCK REDUCTION:	Reduced energy requirements.
WASTE PRODUCTION:	Conventional technology uses graphite anodes which requires recovery and rejection of graphite powder sludge
IMPACT:	The standard technique involves filtration of the liquors prior to crystallization because the graphite anodes are gradually consumed (at a rate of 6 kg/ton). Consequently, waste disposal of graphite sludge is required. Additionally, energy consumption is reduced with the low waste technology. Titanium anodes may be used wherever alkaline chlorates are produced via electrolysis.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Manufacturing of Soda Chlorate by Electrolysis of Sodium Chloride with Graphite Anodes", Monograph ENV/WP.2/5/Add.92.
KEYWORDS:	Electrolytic Recovery, Chlorate, ISIC 3511

***** DOCNO: 400-123-A-330***** <x>

HEADLINE:	Low waste technology process used in producing hydrogen fluoride acid reduces volume of synthetic anhydrite produced by 85%.
INDUSTRY/SIC CODE:	Manufacture of Basic Industrial Chemicals Except Fertilizers/ISIC 3511
POLLUTION PREVENTION OPTIONS SUMMARY:	Synthetic anhydrite (calcium sulphate), produced from the production of hydrogen fluoride acid, is prepared to form a standardized anhydrite binder for use in floor construction in buildings. Part of the anhydrite produced is applied in the cement industry as a setting regulator. Conventional method is to dispose of the anhydrite. The low waste technology process involves an additional step of milling to reduce the grain size, requiring additional classifiers, mills, and bagging apparatus.
FEEDSTOCKS:	$Ca(OH)_2$ - 50 kg/ton anhydrite, ventilated paper sacks - 6.25 kg, activator-15 kg, electricity - 97.2 MJ, compressed air (0.3 MPa) - 220 m^3
WASTES:	Anhydrite waste
MEDIUM:	Solid
COSTS:	
CAPITAL COST:	4,000,000 Marks
OPERATING/MAINTENANCE:	80% of capital investment
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Investment costs are increased by 1,700,000 Marks, operating costs are reduced by 20%. Savings are realized through reduced disposal costs and sales of anhydrite.
FEEDSTOCK REDUCTION:	None
WASTE PRODUCTION:	To-date, 60% of the anhydrite has been produced as anhydrite binder, 25% as setting regulator, and 15% was disposed of as a waste (6 kt/a per 10 kt/a HF).
IMPACT:	The volume of solid waste requiring disposal from production of HF is reduced by 85%. Operating costs are reduced by 20% due to transportation and disposal costs, and a profitable product is produced that offers advantages in the construction of floors over other binding agents used for the same purpose.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, Monograph "Use of Anhydrite Formed in the Hydrogen Fluoride Production Process" ENV/WP.2/5/Add.123.
KEYWORDS:	Solid Waste Recovery, Hydrofluoric Acid, Anhydrite, ISIC 3511

***** DOCNO: 450-011-A-001*****

1.0 Headline: New sodium chlorate factory triples production and employs source reduction techniques to avoid treatment costs

2.0 SIC: 2812

3.0 Name and Location of Company

La Societe Quenord, Magog, Quebec, Canada

4.0 Clean Technology Category

5.0 Case Study Summary

5.1 Process and Waste Information: Quenord is the largest manufacturer of sodium chlorate in the world. Their product is principally used in the fabrication of chlorine for use in the pulp and paper industry. In 1985, Quenord built a new factory that tripled its production and because of reduction techniques, its effluent was reduced to almost nothing. The company decided the most effective modifications could be made regarding the refrigeration waters which cool the liquor before their return to electrolytic cells. They used a closed circuit and an open circuit to recover calorific energy (about 22 megawatts), to reduce the amount of water used as much as possible, and to avoid contaminating the waters to eliminate the need for treatment.

The company also used other preventative measures to reduce the amount of pollutants they generate. To reduce the volume of sludge to be disposed, they used table salt and a filter press. To eliminate the separation of their existing anodes, they used metallic anodes. To eliminate the contamination of condensation waters, the company used a surface condenser rather than a barometric condenser. The company used a demisting device that allowed condensate to be recycled. To limit losses of primary material and finished products, a series of pits and pumps returned the material to production and any dust generated was sprayed to wet it. To capture runoff or accidental releases of primary materials, the company used angled barriers and drainage channels around the reservoir and also used good insulation around the buildings and equipment. To eliminate hot purge waters, the company employed an electric heating system. To reduce the risk of chromium release to the environment, the company produced chlorate crystals that were already washed and dried.

By using source reduction, the company saved the $600,000 cost of installing a treatment system. They were able to completely recycle refrigeration waters through closed circuit instead of treating them, they were able to recover energy that normally would have been lost by using an open circuit. This measure saved the company $500,000/year in production costs. Using metallic anodes, eliminating graphite sludge and increasing the output of electricity at a more efficient rate allows the company to save $2,000,000/year.

5.2 Scale of Operation: The company produces approximately 95,000 tons of sodium chlorate/year.

5.3 Stage of Development: This technology was fully implemented at the time of the case study.

5.4 Level of Commercialization: This technology was commercially available at the time of this case study.

5.5 Material/Energy Balances and Substitutions

Effluent		Standards
Total Flow [m^3/d]	715	---
Free Chlorine [g/m^3]	0.05	---
NaClO(3) [g/m^3]	5.5	---
[kg/d]	4.0	---
Total Chrome [g/m^3]	0.01	1.0
*S.S. [g/m^3]	6.0	30
S.D. [g/m^3]	200-351	3000
DCO [g/m^3]	26	30
pH - 7-8.5		5.5-9.5

* Suspended Solids

6.0 Economics*

6.1 Investment Costs: The company spent $900,000 total. Use of the techniques saved $600,000 in the cost of a treatment system.

6.2 Operational and Maintenance Costs: Operational and maintenance costs of the program were not provided. However, $500,000/year were saved in production costs and $2,000,000/year were saved in energy costs.

6.3 Payback Time: The payback time of this operation was approximately 4 months.

It is assumed that costs were reported in Canadian dollars.

7.0 Cleaner Production Benefits: As a result of using source reduction techniques, the company virtually eliminated all effluents except for the release of disinfection waters from the refrigeration process. They periodically sell condensate from their crystallization system and they save $600,000/year in treatment costs, $500,000/year in production costs, and $2,000,000/year in energy costs.

8.0 Obstacles, Problems and/or Known Constraints: Not Available

9.0 Date Case Study Was Performed: The pollution prevention measure were initiated in 1985.

10.0 Contacts and Citations

10.1 Type of Source Material: Report

10.2 Citation: Secteur Chimie Inorganique, Technologies Propres, Production du Chlorate de Sodium, Gouvernement du Quebec, Ministere de l'Environnement, Gestion et Assainissement des Eaux, Revised June 1988. Source document is in French.

10.3 Level of Detail of the Source Material: Additional detail is available regarding the actual refrigeration process and the open and closed circuits. Greater explanation is also given regarding other preventative measures.

10.4 Industry/Program Contact and Address: Regional offices, addresses and phone numbers are given on the back of the report.

10.5 Abstractor Name and Address: Blair M. Raber, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA, 22043.

11.0 Keywords

11.1 Waste Type: Wastewater, refrigeration waters.

11.2 Process Type/Waste Source: Basic Wastewaters, Chlorine, Industrial Inorganic Chemical, Inorganic Chemicals, Refrigerant, Sodium Chlorate.

11.3 Waste Reduction Technique: Source Reduction, Crystallization, Energy Recovery, Equipment Modification, Insulation, Process Redesign, Refrigeration and Heating Equipment, Volume Reduction, Wastewater Reduction.

11.4 Other Keywords: Canada, Dust, Increased Productivity, Increased Efficiency.

(*) Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wastewater, Refrigeration Waters, Basic Wastewaters, Chlorine, Industrial Inorganic Chemical, Inorganic Chemicals, Refrigerant, Sodium Chlorate, Source Reduction, Crystallization, Energy Recovery, Equipment Modification, Insulation, Process Redesign, Refrigeration and Heating Equipment, Volume Reduction, Wastewater Reduction, Canada, Dust, Increased Productivity, Increased Efficiency

***** DOCNO: 400-033-A-222 *****

HEADLINE:	Use of water to neutralize alkylates is eliminated during the manufacture of ethylbenzene.
INDUSTRY/SIC CODE:	Chemical Industry and Manufacturing of Chemical Products, Petroleum and Coal Derivatives and Plastic and Rubber Products/ISIC 3540
NAME/CONTACT:	Ministere de l'Environnement et du Cadre de Vie Direction de la Prevention des Pollutions 14, Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	Dry neutralization of the alkylates resulting from the manufacturing of ethylbenzene is used instead of wet neutralization. In the low pollution technique, elimination of the salts and impurities from the ethylbenzene solution obtained by an ethylene reaction with benzene is carried out without water. The solution is neutralized in ammonia, then flocculated and decanted. The sediment is centrifuged and vacuum dried. The solid residue obtained can be used to manufacture mixed fertilizers.
FEEDSTOCKS:	Raw ethylbenzene product containing salts and impurities.
WASTES:	The low pollution technique does not produce wastes because solid residues are used in other applications (fertilizer manufacturing). Wastes produced in the standard technique are salts (ammonium and aluminum chloride), aluminum hydroxide, and hydrocarbons dissolved in water.
MEDIUM:	Liquid (ethylbenzene)
COST: CAPITAL COST: OPERATION/MAINTENANCE: MONTHS TO RECOVER:	(1978 Francs) F 5.25 million Not reported Not reported
SAVINGS: DIRECT COST: FEEDSTOCK REDUCTION: WASTE PRODUCTION:	 Not reported Not reported Wastes discharged to the environment are eliminated.
IMPACT:	The low pollution technique does not require water (as opposed to the standard technique, which requires 1.5 m^3 per ton of ethylbenzene). The amount of other raw materials used is identical (0.27 ton of ethylene, 0.745 ton of benzene, 7 kg of catalysts, 3.5 kg of ammonia per ton ethylbenzene). The output should however, be improved by 1 to 2 per cent in the low pollution process.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Dry-Phase Neutralization of Alkylates Generated in the Production of Styrene", Monograph ENV/WP.2/5/Add.33.
KEYWORDS:	Ethylbenzene, Neutralization, Purification, ISIC 3540

***** DOCNO: 400-093-A-319*****

HEADLINE:	Recycling of desalination water in hydrazine production process reduces wastewater generation by over 90%.
INDUSTRY/SIC CODE:	Manufacture of Basic Industrial Chemicals Except Fertilizer/ISIC 3511
POLLUTION PREVENTION OPTIONS SUMMARY:	Produce hydrazine hydrate by oxidizing ammonia with hydrogen peroxide, in the presence of other chemicals. After several processes, these chemicals are recovered and recycled upstream. In addition to hydrazine hydrate, other mineral residues are recovered for use in cement works, and heavy tars are burned away.
FEEDSTOCKS:	Ammonia, hydrogen peroxide, water, energy
WASTES:	Mineral residues (6.7 kg/ton), tar (13.3 kg/ton)
MEDIUM:	Wastewater
COST:	
CAPITAL COST:	52,000,000 francs (15 tons of hydrazine hydrate produced per day)
OPERATION/MAINTENANCE:	40% lower than standard technique
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	7,000,000 francs savings in original investment, 40% lower operating costs.
FEEDSTOCK REDUCTION:	14 m^3 water required for standard techniques compared to 1.6 m^3 for low-waste technique, energy requirements are reduced from 570 MG to 220 MG.
WASTE PRODUCTION:	27 m^3/ton of desalination water are rejected in standard techniques (containing 2.4 tons of chloride ions for one ton of product) compared to negligible waste production in low waste technology.
IMPACT:	The oxidation of ammonia with hydrogen peroxide reduces wastewater generation and investment and operating costs. Mineral residues and other chemicals are also recovered.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Production of Hydrazine Hydrate through Oxidizing Ammonia with Bleach", Monograph ENV/WP.2/5/Add.93.
KEYWORDS:	Inorganic Chemicals, Wastewater, Oxidation, Desalination, Hydrazine Hydrate, Raw Material Substitution, Recovery, ISIC 3511

***** DOCNO: 400-034-A-223 *****

HEADLINE:

INDUSTRY/SIC CODE: Chemical Industry and Manufacturing of Chemical Products, Petroleum and Coal Derivatives and Plastic and Rubber Products/ISIC 3511

NAME/CONTACT: Ministere de l'Environnement et du Cadre de Vie
Direction de al Prevention des Pollutions
14, Boulevard du General Leclerc
92521 Neuilly-sur-Seine Cedex, France

TECHNOLOGY DESCRIPTION: Cracked hydrogen containing 20 to 22 per cent of carbon dioxide is washed in a solution of potassium carbonate. The solution containing carbon dioxide is heated in an exchanger where the input cracked gas yields heat. It is then treated in a column containing nitrogen and it is regenerated. Wastes are made up of carbon dioxide and nitrogen.

FEEDSTOCKS: Cracked hydrogen and nitrogen

WASTES: The wastes produced by the low pollution processes (including washing and ammonia synthesis) contain 0.03 kg of ammonia in solution per ton of ammonia produced.

MEDIUM: Hydrogen gas

COST:
CAPITAL COST: Not reported
OPERATION/MAINTENANCE: Not reported
MONTHS TO RECOVER: Not reported

SAVINGS:
DIRECT COST: Not reported
FEEDSTOCK REDUCTION:
WASTE PRODUCTION: Eliminates ammonia discharge.

IMPACT: The low pollution technique allows substantial energy saving through steam saving.

CITATION/PAGE: Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Hydrogen Washing by Potassium Carbonate in Ammonia Production", Monograph ENV/WP.2/5/Add.34.

KEYWORDS: Ammonia, Hydrogen, ISIC 3511

***** DOCNO: 400-116-A-329******

HEADLINE:	Recycling and sorption of CCl_3F and TDI generated during the production of polyurethane (PUR) block soft foam.
INDUSTRY/SIC CODE:	Manufacture of Synthetic Resins, Plastic Materials and Man-made Fibers Except Glass/ISIC 3513
POLLUTION PREVENTION OPTIONS SUMMARY:	The technology involves the sorption and recycling of harmful materials in process gases generated during the production of polyurethane (PUR) block soft foam. Activated charcoal is used for removing CCl_3F and TDI which are emitted with the exhaust air during the conventional production process. Adsorption of TDI is an irreversible process, which eliminates the option of recovering the TDI. The CCl_3F, however, is recovered through regeneration of the charcoal bed with hot steam.
FEEDSTOCKS:	Steam, electric power, cooling water, activated charcoal, exhaust stream
WASTES:	CCl_3F in purified exhaust air (<20 mg/m^3), CCl_3F in condensed aqueous phase ($<0.01\%$ by weight), TDI converted to innocuous polyurea on activated charcoal (no longer detectable).
MEDIUM:	Gaseous, water, solid
COST:	
CAPITAL COST:	700,000 DM (1983 for plant capacity of 30,000 m^3 exhaust air per hour)
OPERATING/MAINTENANCE:	557 DM/ton of recovered CCl_3F
MONTHS TO RECOVER:	30
SAVINGS:	
DISPOSAL & FEEDSTOCK:	The recovery process is an addition to the process.
FEEDSTOCK REDUCTION:	1443 DM/ton of recovered CCl_3F
WASTE PRODUCTION:	CCl_3F emitted is <20 mg/m^3 compared to 0-50 g/m^3 without the recovery process (regulatory level is 300 mg/m^3), and TDI is now captured in the charcoal bed compared to emissions of 0-20 mg/m^3 without recovery (regulatory level is 20 mg/m^3).
IMPACT:	This sorption and recovery process achieves extremely low CCl_3F emissions from the polyurethane foam manufacturing process and TDI emissions below the detection limit. Additionally, CCl_3F resources are recovered with this process.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Sorption and Recycling of Harmful Materials During the Production of Polyurethane (PUR) Block Soft Foam", Monograph ENV/WP.2/5/Add.117.
KEYWORDS:	Gas Collection, Carbon Adsorption, Polyurethane, ISIC 3513

***** DOCNO: 400-081-A-313*****

HEADLINE:	Modification to the dehydration stage of chloral manufacturing reduces wastewater generation by 60%.
INDUSTRY/SIC CODE:	Manufacture of Industrial Chemicals/ISIC 351.
POLLUTION PREVENTION OPTIONS SUMMARY:	This audit presents the modification to the dehydration stage of the chloral manufacturing. Chloral synthesis is achieved by ethanol and chlorine reaction. The resulting product which is approximately 80% chloral is then dehydrated using a solvent. The conventional process uses concentrated sulfuric acid (oleum) for dehydration. The sulfuric acid in the conventional process is separated after the distillation step and then rejected. The solvent in the low-pollution process is recycled after distillation. The chloral is separated from chlorinated by-products which are used by the plant, and from water which is slightly acidic.
FEEDSTOCKS:	Solvent, chloral, ethanol, chlorine
WASTES:	Polluting wastes resulting from the low-pollution technique consist of slightly acidic water. In the case of the conventional technique, sulfuric acid is rejected after dehydration.
MEDIUM:	Aqueous
COST:	
CAPITAL COST:	FF 8,500,000 (1974 figures)
OPERATION/MAINTENANCE:	FF 3,270 per ton of product (1979 figures)
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	FF 90 per ton of product (1979 figures)
FEEDSTOCK REDUCTION:	Both techniques require 445 kg of ethanol and 2,100 kg of chlorine for the production of one ton of chloral. In addition, dehydration requires 6 kg of solvent (versus 600 kg of oleum for the conventional technique).
WASTE PRODUCTION:	The low-pollution process generates 140 liters (versus 360 liters) of slightly acidic water which is neutralized and discharged.
IMPACT:	Because it does not use sulfuric acid, the low-pollution technology enhances safety conditions in manufacturing plants.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Manufacturing of Chloral: Dehydration by Means of a Solvent", Monograph ENV/WP.2/5/Add.81.
KEYWORDS:	Chlorine, Solvent, Organic Chemical, Ethanol, Chloral, ISIC 351

***** Doc # 501-016-A-000 *****

1.0 Headline: Pollutants from discharge waters eliminated by new separation step in making caprolactam from toluene.

2.0 SIC Code: SIC 2869, Industrial organic chemicals, not elsewhere classified

3.0 Name and Location of Company:

Societa Chimica Dauna
Manfredonia, Italy

4.0 Clean Technology Category:

A new separation step meshed into an established process for making caprolactam from toluene forms no ammonium sulfate byproduct and eliminates pollutants from discharge waters.

5.0 Case Study Summary

5.1 Process and Waste Information: In the conventional process, ammonia neutralizes the caprolactam-sulfuric acid composite to produce crystals of ammonium sulfate. Caprolactam oil floating on top of the mother liquor is decanted, and extracted first by toluene and then by water. The water raffinate draws off the impurities formed during nitrosation and is discarded.

The technology involves a new separation step. Caprolactam is separated from the sulfuric acid in which it is dissolved during reaction by extraction with an alkylphenol solvent. No ammonia is used, and thus no ammonium sulfate forms. The remaining sulfuric acid is thermally cracked, destroying impurities while forming sulfur dioxide for recycle.

5.2 Scale of Operation: Plant capacity is 80,000 metric ton/year.

5.3 Stage of Development: The technology is implemented.

5.4 Level of Commercialization: The technology is commercially available.

5.5 Material/Energy Balances and Substitutions:

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Not reported

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

This technology eliminates the generation of ammonium sulfate byproduct and eliminates an aqueous wastestream. The composition of the aqueous wastestream was not identified.

8.0 Obstacles, Problems and/or Known Constraints

Increased energy is used in this new process because of the cracking step.

9.0 Date Case Study Was Performed

July 1974

10.0 Contacts and Citation

10.1 Type of Source Material: Book

10.2 Citation: Process Technology and Flowsheets, articles which appeared in Chemical Engineering over the last five years. V. Cavaseno and Staff of Chemical Engineering eds., McGraw-Hill, NY, NY, 1979. Caprolactam from Toluene Without Ammonium Sulfate, Andrew Heath. Pg. 137.

10.3 Level of Detail of the Source Material: Detail of each process step and a process flowsheet are available in the source document.

10.4 Industry/Program Contact and Address: Unknown

10.5 Abstractor Name and Address: John Houlahan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Ammonium sulfate, wastewater

11.2 Process type/waste source: Caprolactam manufacture

11.3 Waste reduction technique: Process modification

11.4 Other keywords: Industrial organic chemicals, solvent extraction, SIC 2869

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Ammonium Sulfate, Wastewater, Caprolactam Manufacture, Process Modification, Industrial Organic Chemicals, Solvent Extraction, SIC 2869

ELECTRICAL EQUIPMENT

***** DOCNO: 450-003-A-345*****

HEADLINE:	Powder-coating painting process used for appliances allows for recycling of paint powder and hot air thereby reducing hazardous waste generated.
INDUSTRY/SIC CODE:	Electric and Electronic Machinery/SIC 36
NAME/CONTACT:	W. C. Woods Company, Ltd. Guelph, Ontario
POLLUTION PREVENTION OPTIONS SUMMARY:	A powder-coating process for painting freezers uses a specially formulated fusible paint powder which is applied to the appliance in an enclosed spray booth. The appliance is then heat-cured in an oven to fuse the paint to the surface of the appliance. This technique eliminates solvent emissions, and the paint can be easily recycled compared to conventional liquid paints. No paint sludge is produced and no large volumes of wastewater are generated.
FEEDSTOCKS:	Powder coatings, hot air
WASTES:	Powder coatings
MEDIUM:	Solid
COST:	
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Lower than a conventional paint line because less material and labor is required.
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Quantities not reported.
FEEDSTOCK REDUCTION:	Hot air from the oven is recycled since it does not contain solvent emissions. As a result, overall energy required is lower.
WASTE PRODUCTION:	Eliminated paint sludge and wastewater
IMPACT:	The powder-coating spray booth allows for a more efficient process, requiring less materials and labor, and generating less hazardous waste. The paint powder and the hot air can be recycled.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects", Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 35.
KEYWORDS:	Paint, Recycle, Heat Recovery, Process Change, SIC 36

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Substitution of metalworking fluid promotes less need for organic solvent degreasing. Substitution of solvent-based paint with powdered paints further minimizes organic solvent emissions.

2.0 SIC/ISIC Code: SIC 3648, Lighting Equipment, NEC

3.0 Name & Location of Company: Garnkonst AB, P.O. Box 305, S-261, 23 Landskrona, Sweden.

4.0 Clean Technology Category: This clean technology scheme involves the substitution of mineral oil-based metalworking fluids with a vegetable-oil replacement, the switch from trichloroethylene degreasing to an alkaline, water-based detergent system, and the utilization of powdered paints instead of solvent-based liquid paints. Program reduced trichloroethylene and mineral solvent emissions.

5.0 Case Study Summary:

5.1 Process and Waste Information: Fixture manufacturing facility utilized a mineral oil-based cutting fluid for metalworking. Manufactured components were then degreased using trichloroethylene solvent. Solvent-based paints were utilized in the final finishing of parts.

The new program relies upon the use of a vegetable oil-based cutting fluid for metalworking operations. Substitution with this material allows parts degreasing with an alkaline detergent solution. Use of powdered paints results in reduced organic solvent vapor emissions and reduced operating costs.

5.2 Scale of Operation: 400,000 pieces/year

5.3 Stage of Development: Clean technology is fully implemented.

5.4 Level of Commercialization: Clean technologies are fully commercialized.

5.5 Material Balances:

Material Category	Quantity Before	Quantity After
Waste Generation:		
Trichloroethylene vapor	N/A	5 tons/year less than before
Mineral Solvent vapor	N/A	30 tons/year less than before

6.0 Economics*:

6.1 Investment Costs: Investment for system for powdered painting was $383,000. No other investment costs provided.

6.2 Operational & Maintenance Costs: Vegetable oil use saves $5,000/year over mineral oil.

Trichloroethylene: trichloroethylene use would have required investment of $50,000 for recycling unit plus additional $9,000/year operating expenses. Previous cost was $10,000/year with $500,000/year operating costs.

Operating costs for powder painting is $415,800/year less than for solvent-based painting. Initial investment for painting system was $383,000.

6.3 Payback Time: Payback for painting system changeover investment was less than 1 year. Payback period calculation for new powder painting system is based upon provided annual cost savings estimate.

7.0 Cleaner Production Benefits: New processes do away with the need for trichloroethylene degreasing; organic solvent emissions are minimized and costs associated with solvent purchases and waste disposal are greatly reduced. Cutting fluid costs are reduced. Workplace exposure to solvents is prevented. In addition, the new system facilitates compliance with air pollution standards.

8.0 Obstacles, Problems & Constraints: Not reported

9.0 Date Study Performed: Clean technology process changeover started in 1987 and was completed in July, 1989.

10.0 Contacts & Citation:

10.1 Type of Source Material: Not specified

10.2 Citation: Siljebratt, Lars et al; Förebyggande miljöskyddsstrategi och miljöanpassad teknik i Landskrona, etapp 2. ISSN 0281-5753

10.3 Level of Detail: Not reported

10.4 Industry/Program Contact: Egon Konradis

10.5 Abstractor Name: UNEP Working Group On (Halogenated) Solvents. Reformatted by Douglas Martin, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords:

11.1 Waste Type: Organic vapors, trichloroethylene, mineral oil

11.2 Process Type: SIC 3648, lighting fixtures, painting, degreasing

11.3 Waste Reduction Technique: Material substitution, powder process

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Organic Vapor, Trichloroethylene, Mineral Oil, SIC 3648, Lighting Fixtures, Painting, Degreasing, Material Substitution, Powder Process

ELECTROPLATING

***** DOCNO: 400-100-A-323*****

HEADLINE:	Copper-plating rinse water is recycled via electrodialysis allowing for recovery of copper ions for reuse while significantly reducing volume of wastes produced.
INDUSTRY/SIC CODE:	Manufacture of Fabricated Metal Products, Machinery and Equipment/ ISIC 38
POLLUTION PREVENTION OPTIONS SUMMARY:	Rinse water from the copper-plating of parts is recycled via electrodialysis. This allows for recovery of the copper ions for reuse in the copper plating process, and recycling of purified rinse water. Conventional technology involves recycling of rinse water by removal of the ions with ion-exchange resins, resulting in the production of toxic effluents from the resin regeneration.
FEEDSTOCKS:	Electrical energy, copper
WASTES:	Metal hydroxide mud resulting from detoxication of rinse waters containing copper and sodium cyanide
MEDIUM:	Sludge
COSTS:	
CAPITAL COST:	463,000 francs (1980 franc)
OPERATION/MAINTENANCE:	110,000 franc reduction in detoxication cost
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	110,000 franc reduction in detoxication cost
FEEDSTOCK REDUCTION:	Reduction in copper and energy requirements
WASTE PRODUCTION:	Volume of metal hydroxide mud is reduced by 90%. Waste waters contained 340 kg of copper compared to 3400 kg in standard technique, and 375 kg of sodium cyanide compared to 3750 kg
IMPACT:	This low waste technology significantly reduces the volume of wastes produced from copper-plating while reducing the raw material and energy requirements for the process. The technique may be applied to the electroplating of other metals.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Copper-plating of Parts Followed by Electrodialysis: Recovery of Copper Contained in Rinsing Water", Monograph ENV/WP.2/5/Add.100
KEYWORDS:	Metal, Electroplating, Recovery, Rinsewater, Recycling, Electrodialysis, ISIC 38

1.0 Headline: Copper recovery from printed circuit board etchant using electrolysis improves product quality and eliminates copper waste disposal costs and handling of hazardous chemicals.

2.0 SIC Code: 3672, Printed Circuit Boards

3.0 Name and Location of Company:

Finishing Services Ltd.
Woburn Road Industrial Estate
Kempston,
Bedfordshire MK42-7BU, England

4.0 Clean Technology Category

The technology involves reclamation of copper using electrolytic recovery of a PVC-based membrane.

5.0 Case Study Summary

5.1 Process and Waste Information: Finishing Services Ltd. manufactures printed circuit boards. In making printed circuits, unwanted copper foil is etched away by an acid solution of cupric chloride. Dissolved copper reduces the effectiveness of the solution. The solution is typically regenerated by oxidizing the cuprous ion with acidified hydrogen peroxide. The volume of solution, however, increases steadily and the surplus liquor must be stored. The copper in the surplus liquor is precipitated as copper oxide and landfilled. The new technology uses electrolytic recovery with a PVC-based membrane which allows the passage of hydrogen and chloride ions but not the copper. The copper is transferred to the cathode and recovered as pure flakes.

5.2 Scale of Operation: A staff of 55 people are employed in England.

5.3 Stage of Development: The technology is fully implemented.

5.4 Level of Commercialization: The technology is commercially available from Finishing Services Ltd.

5.5 Material/Energy Balances and Substitutions: Copper Recovery is 11 te/year.

6.0 Economics*

6.1 Investment Costs: Investment costs are 55,000 English Pounds.

6.2 Operational and Maintenance Costs: Annual cost savings (in English Pounds)reported as:

Cost Savings

Materials	22,000
Savings in disposal costs	6,000
Less extra costs	1,000
Total	27,000

6.3 Payback Time: 2 years

7.0 Cleaner Production Benefits

The quality of the printed circuit boards is improved. Disposal costs for copper are virtually eliminated. The etching solution is maintained at its optimum composition. Copper is recovered in a high value form, and there are no hazardous chemicals to be handled.

8.0 Obstacles, Problems and/or Known Constraints

None identified.

9.0 Date Case Study Was Performed: Unknown

10.0 Contacts and Citation

10.1 Type of Source Material: Government Publication

10.2 Citation: Clean Technology, Environmental Protection Technology Scheme, Department of the Environment, 2 Marsham Street, London SW1P 3EB, 1989, p2.

10.3 Level of Detail of the Source Material: Simple diagram of process provided.

10.4 Industry/Program Contact and Address: Mr. Gareth Weed, Technical Manager, Finishing Services Ltd., Woburn Road Industrial Estate, Kempston, Bedfordshire MK42 7BU, Telephone (0234) 857004

10.5 Abstractor Name and Address: John Houlahan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Etchant liquors

11.2 Process type/waste source: Electronic equipment, United Kingdom

11.3 Waste reduction technique: Copper recovery, solid waste recovery, electrolytic recovery

11.4 Other keywords: SIC 3672

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Etchant Liquors, Electronic Equipment, United Kingdom, Copper Recovery, Solid Waste Recovery, Electrolytic Recovery, SIC 3672

1.0 Headline: An experimental project using an electrowinning cell and ion exchange unit minimizes water usage and hazardous waste

2.0 SIC Code: SIC 3471, Electroplating, Plating, Polishing, Anodizing, and Coloring

3.0 Name & Location of Company

Kinetico Engineering Systems, Inc.
Newbury, Ohio

4.0 Clean Technology Category

Technology Principle: This experimental technology uses an electrowinning cell and ion exchange system to recover copper and reduce water usage.

5.0 Case Study Summary

5.1 Process and Waste Information: The line on which the experiment was undertaken is composed of a bath for bright acid copper plating, followed by a "dead" rinse and two rinses in counterflow. Nothing about pretreatment is mentioned in the source document. The dead rinse consists of a tank of 1500 gallons used to replenish the volume lost from the plating bath. The first running rinse, also 1500 gallons, overflowed to the waste treatment facility. The second running of 3000 gallons, was fed with 4 gallons of city water per minute. In the first stage of the project, an electrowinning system was introduced in a circulating loop with the dead rinse resulting in reduction in the copper content and in drag-out of copper into the running tanks. The electrowinning cell design consisted of a tank using up to 50 square feet of cathode material and 48 square feet of insoluble anode. A 300 Amp, six volt rectifier powered the cell. Current densities could be varied throughout the study. An air sparger was used to agitate the bath liquid, although no heating was used.

After successful reduction of copper in the dead rinse, and thus in the running rinses, an ion exchage unit was installed to remove copper from the drag-out tank. The deionized water was returned to the last rinse bath. The ion exchange system consisted of a pump which supplied four gallons of water per minute to the system. Two ion exchange tanks containing 1.4 cubic feet of a strong acid resin were used. The dual system allowed one tank to be in service while the second tank automatically regenerated or was in standby position. The technology resulted in reduction of the copper concentration from 15 to 6 g/l in the static rinse tank. In seven months of operation, 360 pounds of salvageable copper have been recovered by the electrowinner. As a consequence, the concentration in the first counterflow rinse dropped from over 200 to below 50 mg/l.

The water coming from the ion exchanger has copper levels well below 0.01 mg/l and is reintroduced into the second counterflow tank. It was necessary to change from city water to softened water at the inlet. Regeneration is necessary every second day and takes about 20 minutes.

The run-off water from the first counterflow rinse contains 6 mg/l of copper. It is transformed into sludge in the waste treatment system.

5.2 Scale of Operation: Information not provided.

5.3 Stage of Development: Implemented, but tests are continuing.

5.4 Level of Commercialization: Information not provided.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation: Sludge, 60% dry, lbs/day	18.5	2.5
Water Use (gpm):	4	2
Energy Use:	N/A	current density 8 ASF, surface area of 20 sq.ft., 6V, 950 W

Assumptions: No absolute figures on sludge production are given. It is assumed all wastes of the company are sent to the same facility.

As copper concentrations in the runoff water decreased by over 75% (from over 200 to below 50 mg/l) and the runoff was reduced from 4 to 2 gpm, it is assumed that the amount of copper entering the waste treatment facility from the experimental line decreased 87.5%. In the source document, a 75% reduction was claimed. The sludge production decreased by 16 lbs/day. From these figures, the before and after sludge production were computed.

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational & Maintenance Costs: Not reported

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Use of this technology was prompted by tightening control on discharge limits and waste production in the U.S.

Sludge production and water usage are reduced and salvageable copper are recovered.

8.0 Obstacles, Problems and/or Known Constraints

Copper at low concentrations in the electrowinner burned while plating. Lowering current densities also lowers plating to a rate at which the cell cannot keep pace with the drag-out rate. The running rinses had to be fed with demi water.

9.0 Date Case Study Was Performed: November 1990 (date of source document)

10.0 Contacts and Citation

10.1 Type of Source Material: Magazine article

10.2 Citation: Reduce Water Consumption and Hazardous Waste. Jerome Kovach, Kinetico Engineering Systems, Inc., Newbury, Ohio.

10.3 Level of Detail of the Source Material: Additional information is available on the processes in the source document.

10.4 Industry/Program Contact and Address:

Jerome Kovach, Kinetico Engineering Systems, Inc., Newbury, Ohio.

10.5 Abstractor Name and Address: M. Stein, RIVM, Dept. LAE, Anthonie van Leeuwenhoeklaan 1, postbus 1, Bilthoven Netherlands. Reformatted: Barbara M. Scharman, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords

11.1 Waste type: Copper plating bath

11.2 Process type/waste source: Electroplating, copper plating

11.3 Waste reduction technique: Electrowinning, ion exchange, drag-out reduction, copper recovery

11.4 Other keywords: Wastewater reduction

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Copper Plating Bath, Electroplating, Copper Plating, Electrowinning, Ion Exchange, Drag-Out Reduction, Copper Recovery, Wastewater Reduction, SIC 3471

***** DOCNO: 450-003-A-350*****

HEADLINE:	Electrolytic recovery unit reduces loss of nickel through dragout in the first standing rinse, allowing rinsewater to meet regulatory limits and reuse of nickel.
INDUSTRY/SIC CODE:	Fabricated Metal Products/SIC 34
NAME/CONTACT:	Sun Polishing & Plating, Ltd. Toronto, Ontario
POLLUTION PREVENTION OPTIONS SUMMARY:	A nickel plating line for lighting fixtures addressed loss of nickel through dragout in the first standing rinse with an electrolytic recovery unit. The electrolytic chamber contains expanded steel mesh electrodes in a bed of inert glass beads. The rinsewaters are pumped through the bed in successive rinses until a nickel concentration of 3 ppm is achieved. The scouring action of the beads on the surface of the electrodes ensures that the ion concentration is maintained. The electrodes are periodically removed when the deposits reach sufficient thickness, and the nickel is returned to the plating tanks.
FEEDSTOCKS:	Rinsewaters from nickel plating
WASTES:	Rinsewaters, nickel
MEDIUM:	Water, solid
COST:	
CAPITAL COST:	Not reported.
OPERATION/MAINTENANCE:	Requires less than 1/2 hour/day to maintain.
MONTHS TO RECOVER:	60
SAVINGS:	
DISPOSAL & FEEDSTOCK:	18 kg/week nickel recovered at about $7/kg, waste treatment costs eliminated.
FEEDSTOCK REDUCTION:	18 kg/week nickel.
WASTE PRODUCTION:	Eliminates discharge of nickel containing rinsewaters.
IMPACT:	The electrolytic recovery unit reduces the concentration of nickel in rinsewater from 300 ppm to 3 ppm, which meets the regulatory limit of 5 ppm for nickel. Thus, waste treatment costs are greatly reduced, and 18 kg/week of nickel can be reused.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects", Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 42.
KEYWORDS:	Recovery, Rinsewater, Electroplating, Electrolytic Recovery, SIC 34

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Use of a fluid bed reactor in an electroplating plant recovers nickel and reduces sludge generation

2.0 SIC Code: 3471, Electroplating, Plating, Polishing, Anodizing, and Coloring

3.0 Name & Location of Company:

Chroomwerk
Kerkrade

4.0 Clean Technology Category: This technology uses a fluid bed reactor to recover nickel from plating wastewater. The reactor is half filled with a special sand. Wastewater from the plating lines is mixed with soda (Na_2CO_3) and enters from below. The nickel crystallizes as carbonate on the sand grains which then sink to the bottom of the column and are removed. The sand, 10% of the weight of the material removed, is reused in the reactor. The sedimented nickel is very pure and can be reused after acidification. The effluent from the reactor is led over a filter, and partially reused.

5.0 Case Study Summary

5.1 Process and Waste Information: Wastewater from plating processes was originally treated in a DND device. Over 80% of the nickel from the static rinses in three plating lines was recovered. Use of the reactor and a filter removed over 99% of the nickel from the wastestream. Using the new technology results in a considerable reduction in both the amount of sludge produced from the DND device and the effluent produced.

5.2 Scale of Operation: Not provided.

5.3 Stage of Development: A test installation proved to work satisfactorily so a full scale installation was ordered in 1989. The new device will also be connected to four zinc plating automations for zinc recovery.

5.4 Level of Commercialization: The equipment was purchased from DHV at Amersfoort, the Netherlands.

5.5 Material/Energy Balances and Substitutions: No quantitive figures were given but the purchase of metal salts, the amount of sludge produced, and the final effluent is reduced.

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational & Maintenance: Not reported

6.3 Payback Time: Not provided and could not be calculated.

7.0 Cleaner Production Benefits: The installment of the fluid bed reactor was inspired by both economical and envionmental considerations, due to growth of the company and the concommitant increase in sludge production. The amounts of sludge and effluent produced are less. Savings result from reduced purchasing of metal salts.

8.0 Obstacles, Problems and/or Known Constraints: There were many start-up problems with the test equipment but these were not specified in the source document.

9.0 Date Case Study Was Performed: 1989

10.0 Contacts and Citation

10.1 Type of Source Material: Article

10.2 Citation: The fluid bed reactor in practice, advantages and disadvantages. W.L.J. Janssen. Tijdschriift voor oppervlaktetechnieken en corrosiebestrijding. Vol. 33, No. 12, December, 1989.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address:

H.W. du Mortier
VOM
Jan van Eycklaan 2
Postbus 120
3720 AC Bilthoven
Netherlands
Phone 030-287111
Fax 030-287674

10.5 Abstractor Name and Address: Barbara M. Scharman, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords

11.1 Waste type: Wastewater

11.2 Process type/waste source: Nickel plating

11.3 Waste reduction technique: Recovery, reuse

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Electroplating, Fluid Bed Reactor, Nickel Plating, Wastewater, Recovery, Reuse, SIC 3471

1.0 Headline: Membrane electrolysis results in almost complete recovery of nickel from electroplating wastewaters

2.0 SIC Code: 3471, Electroplating, Plating, Polishing, Anodizing, and Coloring

3.0 Name & Location of Company

Egidius Jansen
Witveldweg 14
5951 AV Belfeld
The Netherlands
Phone 04705-1444

4.0 Clean Technology Category

Technology Principle: This technology involves in-process modifications using membrane electrolysis to recover nickel and reduce rinse water flow from electroplating processes.

5.0 Case Study Summary

5.1 Process and Waste Information: Water purification was previously accomplished in a DND installation. For the new process, membrane electrolysis was selected because the high iron concentration in the solution can impair electrolysis operation. The wastewater is sent to ion exchangers where the stream of 4 m^3/hr with 0.5 g/l of nickel is concentrated to 10 m^3/week with a concentration of about 12 g/l. The wastestream is then passed to a membrane electrolysis cell where 99.8% or 5000 kg/year of nickel is reclaimed through batch treatment. The nickel content in the stream is reduced to less than 6 mg/l. The membrane in the cell is composed of perfluorinated PTFE. The cell operates at 7 V and with 900 A 4 days/week. The new technology reduces the rinse water flow, eliminates chlorine and sludge production, and recovers nickel for sale or reuse. There is no effect on the final product.

5.2 Scale of Operation: No information was provided.

5.3 Stage of Development: The technology is fully implemented.

5.4 Level of Commercialization: From the case study, it was not clear whether the equipment was purchased or developed in the plant itself. On further inquiry, it became apparent that the equipment comes from Esmil, Diemen in the Netherlands.

5.5 Material/Energy Balances and Substitutions

5000 kg/year of nickel are reclaimed from the rinsewater.

6.0 Economics

6.1 Investment Costs: Investment costs for the electrolysis system were reported as Dfl 715,000. Capital costs were reported as Dfl 100,000. No further breakdown was provided.

6.2 Operational & Maintenance Costs: Operating and maintenance costs were reported to be Dfl 5,000 for energy, Dfl 15,000 for labor, and Dfl 14,000 for maintenance.

6.3 Payback Time: Nickel savings can be estimated to be about Dfl 100,000 since 5000 kg/year of nickel are recovered at a rate of Dfl 20/kg. Savings on sludge hauling were not specified, however, the amount of sludge not produced was indicated as "tens of tons" and hauling rates are estimated at Dfl 300 to 500.

7.0 Cleaner Production Benefits

This process recovers nickel for sale or reuse, reduces the quantity of wastewater requiring further treatment, and eliminates chlorine and sludge production. Benefits from improved public relations, reduced liabilities, and changes in regulatory compliance were not discussed.

8.0 Obstacles, Problems and/or Known Constraints

One problem which arose during implementation of the technology was the plugging of anode compartments with iron sludge from steel anodes. This was solved by using activated titanium anodes with a layer or iridium oxide which also increased efficiency. At the end of the process, a basic mist was produced above the anode compartments. This problem was eliminated by placing mist filters above the anode compartments.

It was found that removal of nickel from the electrodes took about 5 to 6 hours. Using cathode cylinders treated with a contact oil before starting the process decreased the time to about 2 hours. The problem of the control of the voltage rectifier being destroyed frequently was corrected by using oil cooling instead of air cooling.

9.0 Date Case Study Was Performed: January 1990 (date of source document)

10.0 Contacts and Citations

10.1 Type of Source Material: Article

10.2 Citation: Membrane electrolysis in practice. J. Manders. Tijdschrift voor oppervlaktetechnieken en corrosiebestrijding. Vol. 34, No. 1, January 1990, p.14-16.

10.3 Level of Detail of the Source Material: Schematic diagrams of plating and membrane electrolysis processes, including additional efficiency and mass balance data, are available in source document.

10.4 Industry/Program Contact and Address

Jan Ros
RIVM, dept LAE
Anthonie van Leeuwenhoeklaan 1
Bilthoven
Netherlands

10.5 Abstractor Name and Address: M. Stein, RIVM, anthonie van Leeuwenhoeklaan 1, Bilthoven, Netherlands.

Reformatted: Barbara M. Scharman, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords

11.1 Waste type: Electroplating rinsewater, metal-bearing wastes

11.2 Process type/waste source: Electroplating, nickel plating, SIC 3471

11.3 Waste reduction technique: Electrolysis, ion exchange, nickel recovery, reclamation, drag-out tanks

11.4 Other keywords: Sludge reduction, chlorine reduction, Netherlands

Keywords: Electroplating Rinsewater, Metal-Bearing Waste, Electroplating, Nickel Plating, SIC 3471, Electrolysis, Ion Exchange, Nickel Recovery, Reclamation, Drag-Out Tanks, Sludge Reduction, Chlorine Reduction, Netherlands

***** DOCNO: 400-073-A-310*****

HEADLINE:	Ion exchange of chromium plating rinse tanks recovers chromium and reduces wastewater generation rate.
INDUSTRY/SIC CODE:	Manufacture of Metal Products, Machines and Equipment/ISIC 38
POLLUTION PREVENTION OPTIONS SUMMARY:	This audit presents a modification of the rinsing stages of the conventional chromium plating technology. After chromium plating, the parts are rinsed. The first rinsing bath which is high in chromic acid, is recycled and the last cold rinsing bath is regenerated on ion-exchange resins and recycled. In the conventional process, the last cold rinsing bath is discarded.
FEEDSTOCKS:	For 1,000 m^2 of treated surface: 18 kg chromic acid; 24 kg caustic soda and 60 kg sulfuric acid for resin regeneration; 2 kg barium carbonate for sulphate precipitation; 15 m^3 water.
WASTES:	The only polluting residuals generated by the low-waste technology are eluates from the regeneration process and the barium sulfate sludge. In the standard technology, the most polluting residual stream is the last cold rinsing bath.
MEDIUM:	Aqueous, solid
COST:	
CAPITAL COST:	FF 2,200,000 (1978 figures), additional
OPERATION/MAINTENANCE:	FF 92 per 1,000 m^2 of chromium plating surface (1979 figures), additional.
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	No savings due to additional labor expenses
FEEDSTOCK REDUCTION:	Not applicable
WASTE PRODUCTION:	Elutes and sludge from regeneration
IMPACT:	The low-waste technology can be applied to a large number of other surface treatment related operations.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Chromium Metal Plating Followed by Rinsing and by Regeneration of Rinse Water on Ion Exchange Resins with Recycling", Monograph ENV/WP.2/5/Add.73.
KEYWORDS:	Metal Finishing, ISIC 38, Ion Exchange, Resin Adsorption, Chrome Wastes, Electroplating, Rinsewater, Recycle, Regeneration

*****DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Replacement of hexavalent chromium with trivalent chromium in decorative chrome plating reduces sludge generation

2.0 SIC Code: ISIC 3471, Electroplating, Plating, Polishing, Anodizing, and Coloring

3.0 Name & Location of Company:

W. Canning Materials Ltd.
P.O. Box 288
Great Hampton Street
Birmingham B18 6AS
UK
Phone 021-236-8621
Fax 021-236-0444

4.0 Clean Technology Category: The cleaner production is achieved by plating with trivalent rather than hexavalent chromium. The tendency of trivalent chromium to be oxidized to hexavalent chromium was overcome by using a special membrane surrounding the anodes. This also allows use of anodes made of lead. The low deposition rates associated with trivalent chrome plating were grossly increased by using specially developed in-house organic additives to modify the reactions and give performances superior to the traditional process. This results in production which is 20-40% higher.

5.0 Case Study Summary

5.1 Process and Waste Information: Although the composition of the plating line was not clear from the source document, it is assumed that the sequence consists of bright nickel plating with drag-out recovery, two clean running rinses, chrome plate, two additional rinses, and a final hot rinse. In the traditional process, hexavalent concentrations are sometimes as high as 120 g/l. Trivalent chromium replaces hexavalent chromium in the new process and organic compounds are added. This results in a decrease in sludge generation of over 95%, energy consumption reduced by over 50%, lower current densities, no chloride in the electrolyte, and a 98% reduction in waste treatment costs. No reduction chemicals are needed with the new process. Product quality was greatly improved due to better coverage and more uniform plating.

5.2 Scale of Operation: Not provided.

5.3 Stage of Development: The technology has been fully implemented and in operation since about 1985.

5.4 Level of Commercialization: It appears the company has developed the procedure and sells it under the name "Envirochrome-90". The membranes were developed for mercury-free electrolysis of sodium chloride. Canning is a supplier of machineries to the electroplating industry.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before*	Quantity After*
Waste generation:	100%	95%
Energy use: Consumption	100%	50%
Current densities	10-15Amp/dm^2 8-12V	3.2-8Amp/dm^2

*Exact quantities were not supplied.

6.0 Economics*:

6.1 Investment Costs: Actual figures on investments are not given, and these estimates may be low. A comparison is made on the investment costs for a traditional plating line and the new plating process for a plant producing 3 million nickel and chrome plated water fittings per year.

	Traditional Technology	New Technology
Plating plant	175,000	135,000
Effluent plant	70,000	52,000

6.2 Operational & Maintenance: Only costs for water treatment were given for the traditional and new technologies as follows:

	Traditional Technology	New Technology
Chrome reduction	6,459	0
Hydroxide precip.	1,605	120
Sludge disposal	2,905	130
Labor and materials	2,050	50
Total	13,064	300

No costs were given for labor, maintenance of membranes, or energy consumption for other operations. Membrane life is assumed to be indefinite since no signs of wear occurred after five years of operation.

6.3 Payback Time: It is not possible to calculate a payback time due to lack of data but appears the technology is relatively cheap compared to the traditional technology.

7.0 Cleaner Production Benefits: Sludge production decreased by 95%, waste treatment costs decreased by 98%, and power consumption decreased by over 50%. Electrical current densities are lower and the electrolyte is less corrosive since no chloride is present. The technology appears to be cheaper than the traditional process and results in improved product quality. Benefits from improved public relations, reduced liabilities, and changes in regulatory compliance were not discussed.

8.0 Obstacles, Problems and/or Known Constraints: No problems were encountered although the brownish color of trivalent chrome may be a problem for some people.

9.0 Date Case Study Was Performed: 1985

10.0 Contacts and Citation:

10.1 Type of Source Material:

Document 1: UNEP report
Document 2: British government leaflet
Document 3: Plant leaflet

10.2 Citation:

Document 1: Title not given. B. Johnson, W. Canning Materials Ltd., P.O.Box 288, Great Hampton Street, Birmingham B18 6AS, UK. Phone 021-236-8621, Fax 021-236-0444.

Document 2: Clean Technology. EPT Office, Department of the Environment, Room B 357, Romney House, 43 Marsham Street, London SW1P 3PY, UK. Phone 01-276-8318.

Document 3: Envirochrome Process Operating Guide. W. Canning Materials Ltd., P.O. Box 288, Great Hampton Street, Birmingham B18 6AS, UK. Phone 021-236-8621, Fax 021-236-0444.

10.3 Level of Detail of the Source Material: Additional detail is available in the source documents on some aspects of the manufacturing process.

10.4 Industry/Program Contact and Address:

Mr. Brian Johnson
W. Canning Materials Ltd.
P.O. Box 288
Great Hampton Street
Birmingham B18 6AS
UK
Phone 021-236-8621
Fax 021-236-0444

10.5 Abstractor Name and Address:

Barbara M. Scharman, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords:

11.1 Waste type: Electroplating waste, metal-bearing waste

11.2 Process type/waste source: Chrome plating, membrane plating, SIC 3471

11.3 Waste reduction technique: Process modification, material substitution

11.4 Other keywords: Sludge reduction, chloride reduction, drag-out reduction, energy reduction, United Kingdom

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Electroplating Waste, Metal-Bearing Waste, Chrome Plating, Membrane Plating, SIC 3471, Process Modification, Material Substitution, Sludge Reduction, Chloride Reduction, Drag-Out Reduction, Energy Reduction, United Kingdom

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Removal of iron from a hardchrome plating bath by membrane extraction reduces energy needs, plating bath replacement, and waste disposal costs.

2.0 SIC Code: SIC 3471, Electroplating, Plating, Polishing, Anodizing, and Coloring

3.0 Name & Location of Company:

Twentsche Hardchroom
Slijpsteen 10
Enschede
Netherlands

4.0 Clean Technology Category

5.0 Case Study Summary

5.1 Process and Waste Information: In the original process, the plating baths were substituted about once every four years by a completely fresh bath solution. The old bath liquor originally was disposed of, later on it was stored.

A continuous flow of hard chrome plating bath liquor is separated from a continuous flow of oxalic acid by membranes selectively impermeable to iron ions (and possibly also other metallic ions). The metal ions are induced to cross the membranes by an electrical driving force. The equipment operates at 7 volts and 120 Amp. To prevent long pipelines running through the plant, a semi-batch approach was chosen. The company decided to handle a volume of 1,000 ($1m^3$) of bath liquor at the time. This volume is pumped into a container and moves close to the actual iron extraction device. Analysis of the bath liquor in the 1000 liter container over a ten day period confirms that 200 grams/day of iron are removed. Savings are achieved due to lower energy requirements, purchases of bath solution, and hauling and disposal of baths. There were no effects on products.

5.2 Scale of Operation: The company employs 15 people in two shifts of eight hours/day, five days/week. Several baths are in operation, the largest one has a content of 6,000 liters.

5.3 Stage of Development: The equipment, although commercially available, was still in the testing stage. The producer is not yet very experienced with this type of device.

5.4 Level of Commercialization: The equipment is commercially available.

5.5 Material/Energy Balances and Substitutions:

No wastes are produced.

6.0 Economics*:

6.1 Investment Costs: Precise figures were not available but approximate costs were 100,000 guilders (Dfl) (1990).

6.2 Operational & Maintenance Costs: These costs are estimated to be 1,000 Dfl/year. One man-hour is required per week to clean the membranes.

6.3 Payback Time: Savings are estimated at 55,000 Dfl/year since the bath liquor does not neet to be replaced at a rate of 4,000 liters/year. The payback time was estimated at between 2 and 3 years.

7.0 Cleaner Production Benefits

Use of this technology was inspired by the following motives:

When a 600 liter bath, due to high iron content, had to be substituted, the electricity bill of the company dropped Dfl 4,000 per month

The high costs of new bath liquor and haulage of the waste bath liquor

A stock of 20,000 liters (20 m^3) of bath liquor with an iron content of 10 g/l

The reluctancy of the plant manager to let the disposed liquor be transported

The dissatisfaction of DND water purification, where waste is transformed from one form to another but no waste prevention results.

Use of the technology resulted in decreased energy consumption, savings on bath solution purchases, and savings on bath hauling and disposal.

Economic benefits were estimated as follows:

Decreased energy consumption	24,000 Dfl/year
Purchase of bath solution	25,000
Bath haulage and disposal	6,000
Total	55,000

8.0 Obstacles, Problems and/or Known Constraints

No problems were encountered, although the equipment was in operation for only three weeks at the date of the case study.

9.0 Date Case Study Was Performed: December 1990

10.0 Contacts and Citation

10.1 Type of Source Material: Plant visit

10.2 Citation: Plant visit

10.3 Level of Detail of the Source Material:

10.4 Industry/Program Contact and Address:

H. W. du Mortier
VOM
Jan van Eycklaan 2
Postbus 120
3720 AC Bilthoven
Netherlands
Phone 030-287111 Fax 030-287674

10.5 Abstractor Name and Address: Submitted by UNEP Workgroup. M. Stein, RIVM, Dept. LAE, Postbus 1, Anthonie van Leeuwenhoeklaan 1, Bilthoven, Netherlands.

11.0 Keywords

11.1 Waste type: Electroplating baths

11.2 Process type/waste source: Electroplating, SIC 3471, hard chrome plating

11.3 Waste reduction technique: Membrane electrolysis, iron removal

11.4 Other keywords: Material conservation, energy conservation, Netherlands

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Electroplating Baths, Electroplating, SIC 3471, Hard Chrome Plating, Membrane Electrolysis, Iron Removal, Material Conservation, Energy Conservation, Netherlands

1.0 Headline: Electrolysis increases life of sulfuric acid bath and allows copper recovery.

2.0 SIC Code: ISIC 2085, Metal Plating

3.0 Name & Location of Company: Confidential

4.0 Clean Technology Category

Technology Principle: This process involves removing heavy metals from plating wastewaters by electrolysis and ultrafiltration.

5.0 Case Study Summary

5.1 Process and Waste Information: The facility has one lead plating line where workpieces are treated with sulfuric acid and copper is dissolved. A recirculating system is used for spray rinsing followed by staining in a zinc chloride bath. Thermal lead plating in a bath containing 6% tin is then followed by immersion in a cooling bath. A spray bath and a final immersion bath complete the process. Changes to the process included the addition of the cooling bath after the actual plating bath and the regeneration cell parallel to the acid bath. The wastewater has been separated from the sanitary wastewater at the plant. The remaining wastewater is first sent to a collection pit and a storage tank. It is then treated in a mixing tank with lye and after flocculation goes to an ultrafiltration system. The permeate is sewered and the concentrate thickened in a filter press.

The new measures involved constructing a regeneration cell parallel to the sulfuric acid bath to recover the dissolved copper. This has resulted in a considerable increase in the lifetime of this bath. The immersion bath cools the workpieces and removes copper oxides.

Water consumption at the facility is greatly reduced with the process modification. Wastewater flows of 18,000 m^3/year, containing 4,000 - 5,000 kg of heavy metals, has been reduced to 10,000 m^3/year, containing 700 kg of heavy metals. The new process requires small amounts of chemicals for neutralization and flocculation. Sludge is a new waste product resulting from the new process. No effects on product quality were experienced.

5.2 Scale of Operation: The facility employs one worker for 1800 hours/year and has a production capacity of 30 tons of lead per year, deposited in a layer less than 100μm thick.

5.3 Stage of Development: The measures are fully implemented.

5.4 Level of Commercialization: All equipment needed is widely available.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation (kg/year):		
Heavy metals	4,000-5,000	<2
Sludge, 23% dry matter	0	10,000
Copper	N/A	<1
Zinc	N/A	<1
Nickel, chrome, lead	N/A	immeasurable
Water Use (m^3/year): (including 2,000 m^3/year sanitary)	20,000	12,000

6.0 Economics*

6.1 Investment Costs: Investment costs (Dfl) for the new process are as follows:

Regeneraton cell at acid bath	36,000
Separation of wastewater streams	33,000
Wastewater treatment system	235,000

Capital costs reported separately in the source document were included here with investment costs.

6.2 Operational & Maintenance Costs: The following costs (Dfl) are required to operate the system:

Inline:	
Cooling bath	1,500
Regeneration cell maintenance	2,000
Regeneration cell operation	2,000
Wastewater treatment system:	
Chemicals (e.g. NaOH)	800
Sludge removal	4,000
Operation (6 manhours/week)	10,000
Energy	2,000
Analyses	1,000

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Installation of the equipment was promoted by water regulation demands. Water consumption, wastewater quantities, and the quantity of heavy metal contained in wastewaters are decreased.

8.0 Obstacles, Problems and/or Known Constraints

Some minor start-up difficulties were experienced but not specified.

9.0 Date Case Study Was Performed: August 1986

10.0 Contacts and Citation

10.1 Type of Source Material: Report on company interviews

10.2 Citation
Wastewater Problems in the Metal Industry. Results of interviews in 48 companies. Dr. W.H. Rulkens, TNO, Maatschappelijke Technologie, postbus 342, 7300 AH Apeldoorn, Netherlands, tel (055) 773-344.

10.3 Level of Detail of the Source Material: Not reported

10.4 Industry/Program Contact and Address:

H.W. du Mortier
VOM
Postbus 120
3720 AC Bilthoven
Netherlands
Phone 030-287111

10.5 Abstractor Name and Address: M. Stein, RIVM, Dept. LAE, Anthonie van Leeuwenhoeklaan 1, Postbus 1, Bilthoven, Netherlands. Reformatted: Barbara M. Scharman, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords

11.1 Waste type: Plating wastes, metal-bearing wastes

11.2 Process type/waste source: Lead plating, ISIC 2085

11.3 Waste reduction technique: Electrolysis, ultrafiltration, regeneration cell, cooling bath, reclamation, copper recovery

11.4 Other keywords: Wastewater reduction, Netherlands

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Plating Wastes, Metal-Bearing Waste, Lead Plating, ISIC 2085, Electrolysis, Ultrafiltration, Regeneration Cell, Cooling Bath, Reclamation, Copper Recovery, Wastewater Reduction, Netherlands

***** DOCNO: 400-124-A-331*****

HEADLINE:	Rotalyt-Alutop process for aluminum plating reduces discharge of cadmium into the environment while also reducing costs.
INDUSTRY/SIC CODE:	Corrosion Protection of Small Components/ISIC 3844
POLLUTION PREVENTION OPTIONS SUMMARY:	The Rotalyt-Alutop process for aluminum plating is based on the chemo-mechanical plating of pieces in a medium containing an impact body, and metal particles and catalysts, using relative movement. The pieces are loaded into a perforated drum, and lowered into a plating bath where glass balls are added as the impact body and the aluminum flakes are added. The drum passes through a separation tank where the glass balls are separated for reuse, to a centrifuge unit, and to an unloading station for drying. The cathodic corrosion protection properties are considerably improved by the use of zinc containing aluminum alloys, or preplating to add a zinc/tin layer.
FEEDSTOCKS:	Electric energy-140 kWh/ton, Al metal-14 kg/ton, rinse water-200 l/ton, catalyst-5 kg/ton, pre- and post-treatment-20 kg/ton
WASTES:	Wastewaters, chemical baths
MEDIUM:	Aqueous
COSTS:	
CAPITAL COST:	500,000 DM (1983)
OPERATION/MAINTENANCE:	294 DM/ton treated goods
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	100,000 DM reduction in capital cost,. 94 DM/ton of treated goods reduction on process costs.
FEEDSTOCK REDUCTION:	Electrical requirements reduced by 780 kWh/ton, rinsewater by 800 l/ton, 14 kg/ton Al required compared to 15 kg/ton Cadmium, treatment chemicals by 100 kg/ton.
WASTE PRODUCTION:	Wastewaters produced from conventional process contains cadmium, cyanide, and chromium compounds. The waters are neutralized, precipitated, and dumped. The low waste technology reduces the toxicity of the waste.
IMPACT:	Reduction of environmental pollution from the proven toxicity of cadmium while reducing costs.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, Monograph "Rotalyt-Alutop" ENV/WP.2/5/Add.124.
KEYWORDS:	Electroplating, Aluminum, Wastewater Treatment, Metal Treating, Corrosion, Rotalyt-Alutop, ISIC 3844

***** DOCNO: 400-125-A-332*****

HEADLINE:	Aluminum used instead of cadmium in conventional electroplating technology eliminates cadmium and cyanide-containing waters and hydroxide sludge, while reducing operating costs.
INDUSTRY/SIC CODE:	Manufacture of Structural Metal Products/ISIC 3813
POLLUTION PREVENTION OPTIONS SUMMARY:	Conventional electroplating technology using aluminum instead of cadmium as the plating metal. A thin layer of nickel is initially deposited on ferrous and aluminum die casting materials. The pieces are dried using fluorohydrocarbons, and passed to the aluminum plating cell. Using an electrolyte solution, an aluminum layer is applied to the nickel coating. A post-treatment process may be applied to improve corrosion protection or for decorative appearance.
FEEDSTOCKS:	Nickel-18 g/m^2, Al-27 g/m^2, electrolytic bath (recycled), electrical energy
WASTES:	No wastewaters (electrolyte is recycled), evaporation of toluene from the bath (1-2 kg/hr)
MEDIUM:	Vapor
COSTS:	
CAPITAL COST:	6 million Dfl - 40 m^2/hr plant
OPERATION/MAINTENANCE:	50 - 75 Dfl/m^2
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	10 - 15 Dfl/m^2 reduction in operating costs, elimination of wastewater treatment and disposal costs.
FEEDSTOCK REDUCTION:	18 g of Ni, and 27 g Al is require compared to 180 g Cd, and 5 g CN in conventional technology.
WASTE PRODUCTION:	Cd and CN containing wastewaters are eliminated. 1-2 kg/hr toluene vapor is produced.
IMPACT:	Elimination of Cd and CN containing waters and hydroxide sludge, with reduced operating costs. Discharge of the bath contents occurs after two years, and the materials are recycled.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, Monograph "A Low-waste Electroplating Process of Aluminum in Non-aqueous Solvent (Sigal-Process)" ENV/WP.2/5/Add.125.
KEYWORDS:	Electroplating, Aluminum, Wastewater Treatment, Metal Treating, Recycling, ISIC 3813

***** DOCNO: 400-126-A-333*****

HEADLINE:	Blue passivation process in the galvanic industry uses trivalent chromium (instead of hexavalent chromium) to allow for reuse of chemical bath, less aggressive rinsewaters and lower operating costs.
INDUSTRY/SIC CODE:	Manufacture of Structural Metal Products/ISIC 3813
POLLUTION PREVENTION OPTIONS SUMMARY:	The use of trivalent chromium for the Blue Passivation process in the Galvanic Industry instead of hexavalent chromium leads to a no-dump bath. The conventional technology for the chromating of zinc coatings utilizes hexavalent chromium and mineral acid, which reacts with the metal. In addition to the chemicals present in the bath, the wastewater also contains zinc that was dissolved from the metal surface. The low-waste technology utilizes Cr(III) and H_2O_2 which dissolves little zinc and the bath can be replenished with concentrate and reused.
FEEDSTOCKS:	Cr(III), H_2O_2 (30%), citric acid
WASTES:	Wastewater containing Cr(III) - 200 g, H_2O_2 - 8 ml, citric acid - 600 g, zinc - 750 g (treated by reduction and precipitation of hydroxide) per 1000 m^2 chromated.
MEDIUM:	Aqueous
COSTS:	
CAPITAL COSTS:	Only material and discharge costs involved.
OPERATING/MAINTENANCE:	40 Dutch guilders/1,000 m^2 of passivated metal surface.
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Operating costs are reduced by 190 Dutch guilders/1,000 m^2 of passivated metal.
FEEDSTOCK REDUCTION:	0.75 kg zinc dissolved in bath compared to 7.5 kg of lost zinc using conventional technique, allowing for reuse of the bath.
WASTE PRODUCTION:	Chemical baths are reused, rinsewaters contain less aggressive H_2O_2 and citric acid, compared to conventional method, resulting in savings of 171.50 Dutch guilders in discharge costs.
IMPACT:	The use of trivalent chromium over hexavalent chromium in passivating zinc metals allows for reuse of the chemical bath, less aggressive rinsewaters and lower operating costs.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, Monograph " A No-dump Bath Using Trivalent Chromium for the Blue Passivation Process in the Galvanic Industry" ENV/WP.2/5/Add.126.
KEYWORDS:	Metal Finishing, Recycling, Chrome, Chromating, ISIC 3813

*****DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Removal of cations from chromic acid and evaporation result in decreased sludge production and energy consumption

2.0 SIC Code: SIC 3471, Electroplating

3.0 Name & Location of Company:

Koni BV
Langeweg 1
Oud-Beyerland
Netherlands
Phone (01860)12500
H. van Zessen

4.0 Clean Technology Category: This technique involves use of a cation exchanger for continuous cleaning of drag-out baths and evaporation followed by water reuse.

5.0 Case Study Summary

5.1 Process and Waste Information: The plant operates a three step cascade rinse behind the plating baths and the water is used to replenish the water evaporating from the process baths. This is supplemented with demi water. In the original process, a final rinse with tap water occurred after the cascade.

Because of a build-up of undesired cations such as iron, copper, and nickel in the process baths, drag-out baths are now treated over a cation resin. The water of the final rinse has been substituted with demi water and is also treated over the resin. The process liquor is too aggressive to be treated. By using the waste heat of the cooling system and controlling the process bath temperature, an extra amount of water is evaporated. The resulting wastewater is still treated in a DND installation. Lifetime of the untreated baths was about five years with the original process.

In the original process, the starting power was 10 V and 15,000 Amp. The voltage increased at a rate of 1 V/A. Due to limitations in the transformers, this meant that after about five years the process baths had to be thrown away. In the current situation, the voltage increased two volts in five years of operation, and then remained stable.

Sludge production decreased from 10 tons to 0.4 tons in five years and 60 regenerations of the cation exchanger were performed using 1500 liters of hydrochloric acid. Tap water consumption decreased from 1330 to 15 m^3/year and demi water consumption went up 1320 m^3/year. Energy consumption decreased from 99 MWh/year to 59 MWh/year or more than 40%. The consumption of chromic acid decreased by 2,000 liters/year and chemicals for the DND installation decreased from 2,000 to 20 liters/year.

No effects on product quality were reported in the source document although quality should have improved since foreign elements have been removed.

5.2 Scale of Operation: Not reported

5.3 Stage of Development: The technology is fully implemented.

5.4 Level of Commercialization: All necessary parts are widely available.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:		
Sludge (tons)	10	0.4
Feedstock Use:		
New chromic acid (tons)	10	N/A
HCl (liters in 5 yrs.)	0	1500
Chemicals for DND (tons)	10	0.1
Water Use:		
Tap water (m^3/year)	1330	15
Demi water (m^3/year)	N/A	increased by 1320 m^3/year
Energy Use: (MWh/year)	99	59

6.0 Economics*:

6.1 Investment Costs: Not reported

6.2 Operational & Maintenance Costs: Costs for the five year period are as follows:

	Old Process (Dfl)	New Technology (Dfl)
New chromic acid	15,000	--
Waste disposal	3,500	140
Chemicals for DND	40,000	400
Power loss	74,250	44,550
Tap water	8,600	100
Extra demi water	--	33,000
Sewage costs	9,550	100

6.3 Payback Time: Costs over five years have decreased by Dfl 71,710. Since no investment costs were given, a payback period cannot be calculated. However, based on the cost information given and the cost of an ion exchanger, it can be estimated that the payback period would be less than one year.

7.0 Cleaner Production Benefits: The new technology resulted in decreases in power consumption, undesired metals in the deposited layer, sludge production, chromic acid, and chemicals needed for wastewater treatment. The following are savings realized using the new process:

Less chromic acid	3,000 Dfl/year
DND treatment chemicals	8000
Waste disposal	700
Power consumption 5340	
Tap water	1900

8.0 Obstacles, Problems and/or Known Constraints: No obstacles or problems were discussed.

9.0 Date Case Study Was Performed: Probably early 1990

10.0 Contacts and Citation

10.1 Type of Source Material: Example report

10.2 Citation: Removal of cations from chromic acid by continuous cleaning of drag-out baths through a cation resin and evaporation before reuse. Jan Ros, RIVm, Dept. LAE, anthonie van Leeuwenhoeklaan 1, Postbus 1, 3720 BA Bilthoven, Netherlands.

10.3 Level of Detail of the Source Material: More detailed information is available on the process.

10.4 Industry/Program Contact and Address:

H.W. du Mortier
VOM
Jan van Eycklaan 2
Postbus 120
3720 AC Bilthoven
Netherlands
Phone 030-287111
Fax 030-287674

10.5 Abstractor Name and Address: M. Stein, RIVM, Dept. LAE, Anthonie van Leeuwenhoeklaan 1, Postbus 1, 3720 BA Bilthoven, Netherlands. Reformatted: Barbara M. Scharman, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords:

11.1 Waste type: Plating baths

11.2 Process type/waste source: Electroplating, SIC 3471

11.3 Waste reduction technique: Ion exchange, evaporation

11.4 Other keywords: Sludge reduction, energy reduction, Netherlands

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Plating Baths, Electroplating, SIC 3471, Ion Exchange, Evaporation, Sludge Reduction, Energy Reduction, Netherlands

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Water and Waste Reduction in Electroplating Using Static Rinses and Ion Exchange Columns

2.0 SIC/ISIC Code:

3.0 Name and Location of Company:

FSM Sosnowiec, Poland

4.0 Clean Technology Category: The facility modified its plating system to replace overflow rinses with static rinses. In addition, the final rinse tank in each plating line is equipped with ion exchange columns to permit water recycling and raw materials recovery.

5.0 Case Study Summary:

5.1 Process and Waste Information: FSM Sosnowiec manufactures automobile parts using copper-nickel-chromium plating and zinc plating. The wastestreams contain cyanide, hexavalent chromium, copper, zinc, and nickel. After a pollution prevention audit, the facility reduced water usage by 93 percent through minor process/equipment modifications.

5.2 Scale of Operation: Not provided.

5.3 Stage of Development: The practices are currently being implemented at FSM Sosnowiec.

5.4 Level of Commercialization: The practices are operational modifications and are readily available.

5.5 Material/Energy Balances and Substitutions: The reduction in waste stream quantities include: chromic acid-80 percent, copper-95 percent, cyanide-80 percent, nickel-98 percent, zinc-96 percent, and wastewater 93 percent. Wastewater is treated to the following levels: chromium-0.1 mg/l, copper-0.1 mg/l, nickel-1.0 mg/l, cyanide-2.0 mg/l, and zinc-0.9 mg/l.

6.0 Economics*

6.1 Investment Costs: The capital investment is US$36,000.

6.2 Operational and Maintenance Costs: The modifications save the facility approximately US$193,000 a year.

6.3 Payback Time: Two months.

7.0 Pollution Prevention Benefits

The process modifications decrease both the water and raw materials consumption and reduces the amount of pollutants to be treated in the plant effluent.

8.0 Obstacles, Problems, and/or Known Constraints

None identified.

9.0 Date Case Study Was Performed: Not Provided.

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "Waste Reduction in Electroplating," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: Mrs Mirostawa Domino, Mr Zdzistaw Twardon, Environmental Protection Department, FSM Sosnowiec, Pekin Street 1, 41-200 Sosnowiec, Poland, Tel: +48 32 63 84 01 ext 210

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Wastewater

11.2 Process Type/Waste Source: Electroplating

11.3 Waste Reduction Techniques: Static rinsing

11.4 Other Keywords: Ion exchange

11.5 Country Code:

12.0 Assumptions

None.

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wastewater, Electroplating, Static rinsing, Ion exchange

***** DOCNO: 450-003-A-381*****

HEADLINE:	Use of ion-exchange metal recovery system meets space and waste reduction requirements.
INDUSTRY/SIC CODE:	Transportation Equipment/ISIC 32
NAME/CONTACT:	G. G. Buffing & Plating Longuevil, Quebec T. Nadeau
POLLUTION PREVENTION OPTIONS SUMMARY:	A chemical recovery system was built above a plating line of an electroplating plant that plates decorative copper, nickel and chromium on a variety of components and trim for automobiles and motorcycles. Short-bed ion exchange systems, designed and built by Eco-Tec of Ontario, were installed on the copper, nickel and chromium rinses. This system was chosen over a conventional waste treatment system, because limited space (20 x 15 feet) was available, and the payback was more attractive.
FEEDSTOCKS:	Copper, nickel, chromium rinsewaters
WASTES:	Rinsewaters, unrecovered metals
MEDIUM:	Water
COST:	
CAPITAL COST:	$125,000 (comparable to that of a destruction/precipitation treatment system)
OPERATION/MAINTENANCE:	The plating manager monitors and maintains the units for approximately 1-1/2 hrs/day.
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	$13,257 for first year, projected to be $60,222 when line reaches full capacity of 6,000 hrs/year.
FEEDSTOCK REDUCTION:	Recovered metals reduce quantities of raw material to be purchased.
WASTE PRODUCTION:	Recovered metals no longer require disposal.
IMPACT:	In addition to meeting the company's space requirements, this ion-exchange system recovers metal from plating baths, reducing the waste for disposal as well as raw material needs.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects", Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 96.
KEYWORDS:	Electroplating, Metal, Ion Exchange, Recovery, ISIC 32

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Clean technology measures result in minimal waste production in electroplating shop of a large company

2.0 SIC Code: SIC 3471, Electroplating, Plating, Polishing, Anodizing and Coloring

3.0 Name & Location of Company: Confidential

4.0 Clean Technology Category

Technology Principle: Processes were designed to minimize heavy metal concentrations in rinsewaters and continuous treatment of process bath liquid in order to result in minimal water usage and waste generation.

5.0 Case Study Summary

5.1 Process and Waste Information: The plant operates twelve lines for all kinds of electrolytical surface treatment. Not all lines contain static rinses and one line contains cascade rinsing. In order to minimize waste generation, the lines are operated manually and drip plates are used between baths. Long drip-off times are achieved with slow movements in the process and workpieces are hung carefully. Static rinses are used where possible and a complete return of static rinse water into the process baths is achieved. Continuous treatment of process bath liquid maintains a constant bath quality. This includes electrolytic recovery of silver, activated carbon treatment, and filtration. Intense monitoring of baths maintains a constant composition and the lowest concentration of process chemicals possible is used.

The rinsewater streams of all lines are collected into one stream and sent to a water treatment system. Wastewater and concentrates of outside dischargers are also treated in the system. The contaminated water (200,000 m^3/year) is treated in an ion exchanger then is returned to the plant. A small part of the processed water is first sent to an extra mixed bed ion exchange device for more purification, and then returned to the plant. The regenerate of the ion exchanger is treated in a DND device, the neutralized water is filtered by a filter press and, if necessary, led over a selective ion exchanger to remove cadmium. The pH is corrected and the water is sewered. The sludge is removed as chemical waste and transported to Western Germany.

The rinsewater leaving the electroplating plant (200,000 m^3/year) has an estimated concentration of 5 - 30 mg/l of heavy metals. The final water released to the local sewer system has heavy metal concentrations far below the regulatory limits. Due to treatment of water and concentrates from outside dischargers, 600 m^3/year - 1500 m^3/year are released to the sewer system. The process was installed, as described above, at the outset of operation. These measures are not changes to the process.

5.2 Scale of Operation: Five people work in the electroplating shop. The plant capacity was not provided. Three people are employed in the water treatment unit which has a capacity exceeding 200,000 m^3/year.

5.3 Stage of Development: The plant has been operative since 1968 and has undergone only slight modifications for process improvements since then.

5.4 Level of Commercialization: All necessary components are widely available.

5.5 Material/Energy Balances and Substitutions:

The measures were installed when the plant became operational so there is no "before" situation. The electroplating shop produces 200,000 m^3/year of contaminated liquids but this amount is

completely reused after purification. The sludge production is 150 tons/year of about 30% dry materials.

6.0 Economics*

6.1 Investment Costs: Investment costs include Dfl 1,700,000, of which Dfl 300,000 were from construction of buildings. Capital costs were Dfl 1,000,000. The costs of the in-process measures cannot be estimated since they were part of the original investment. These costs are from 1970. According to the company these costs would have tripled by 1986.

6.2 Operational & Maintenance Costs: Annual costs for the water purification system are as follows:

Maintenance and operation	200,000 Dfl
Energy	30,000
Chemicals, 100 tons/year	100,000
Sludge removal, 150 tons/year	50,000

6.3 Payback Time: Payback time could not be calculated.

7.0 Cleaner Production Benefits

Reusing the water saves the company about Dfl 200,000/year. Recovery of metals saves about 150,000/year based on estimates of interviewers.

8.0 Obstacles, Problems and/or Known Constraints

None were reported.

9.0 Date Case Study Was Performed: August 1986 (date of source document)

10.0 Contacts and Citation

10.1 Type of Source Material: Report based on interviews with 48 companies.

10.2 Citation: Wastewater problems in the Metal Industry: Results of Interviews with 48 Companies. Dr. Ir WH. Rulkens, TNO, Maatschappeliijke Technologie, Postbus 342, 7300 AH Apeldoorn, Netherlands. tel (055) 773 344.

10.3 Level of Detail of the Source Material:

10.4 Industry/Program Contact and Address

H. W. du Mortier
VOM
Jan van Eycklaan 2
Postbus 120
3720 AC Bilthoven
Netherlands
Phone 030-287111
Fax 030-287674

10.5 Abstractor Name and Address: M. Stein, RIVM, Dept. LAE, Anthonie van Leeuwenhoeklaan 1, Postbus 1, Bilthoven, Netherlands. Reformatted: Barbara M. Scharman, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords

11.1 Waste type: Electroplating rinsewater

11.2 Process type/waste source: Electroplating, SIC 3471

11.3 Waste reduction technique: In-process measures, cascade rinsing, electrolytic recovery, silver recovery, carbon adsorption, ion exchange, wastewater treatment

11.4 Other keywords: Germany

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Electroplating Rinsewater, Electroplating, SIC 3471, In-Process Measures, Cascade Rinsing, Electrolytic Recovery, Silver Recovery, Carbon Adsorption, Ion Exchange, Wastewater Treatment, Germany

***** DOCNO: 400-101-A-262 *****

HEADLINE:	Chemelec electrolytic cell recovers pure metal from static rinses for recycle to plating baths, reducing wastewater treatment sludge volume.
INDUSTRY/SIC CODE:	Manufacture of Fabricated Metal Products, Machinery and Equipment/ISIC 38
TECHNOLOGY DESCRIPTION:	The "Chemelec" electrolytic cell recovers pure metal from a moderately dilute static rinse. The metal is recycled directly to the plating bath as dissolving anodes. The "Chemelec" cell is an electrolytic device which economically deposits metal of high quality from solutions containing 100 to 1,000 mg/l of heavy metal. Expanded metal mesh electrodes immersed in a bed of 0.5 mm glass beads impinge on the electrodes, continually renewing the depleted boundary layer adjacent to them, and providing an enhanced rate of deposition. The cell is used to maintain an electroplating drag-out tank at a low concentration, so that metal losses into the drain or as hydroxide sludge are reduced by a factor of about 100. The recovered material is recycled directly to the plating bath as dissolving anode material.
FEEDSTOCKS:	Not reported
WASTES:	Aqueous metal-laden plating waste.
MEDIUM:	Aqueous
COST:	British Pounds
CAPITAL COST:	5,200 for a cell with steel anodes and cathodes for alkaline cyanide solution (i.e., zinc, cadmium); 8,100 for a cell with titanium cathodes and noble-metal-oxide-coated titanium anodes for acidic solution (i.e. nickel, copper)
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DISPOSAL & FEEDSTOCK:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	The amount of hydroxide treatment sludge is reduced. This development is of great relevance to the sewage sludge disposal problems encountered in public effluent treatment.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "The "Chemelec" cell for Recycling of Metal in the Electro-plating Industry", Monograph ENV/WP.2/5/Add101.
KEYWORDS:	ISIC 38, Chemelec, Electrolytic Recovery, Electroplating

***** DOCNO: 400-127-A-334*****

HEADLINE:	Use of providence method for rinsing electroplated parts reduces volume of metals in rinsewater and allows recovery of the dragout and reuse of rinsewaters.
INDUSTRY/SIC CODE:	Manufacturing of Fabricated Metal Products, Machinery, and Equipment/ISIC 3800
POLLUTION PREVENTION OPTIONS SUMMARY:	The "Providence Method" (PM) is a low-waste process for rinsing of electroplated parts. The method is designed to remove the majority of contaminating metals from rinsewater in a small volume before utilizing the conventional flowing rinse which flows at a fairly high rate to ensure good product quality. The PM tank is frequently set up as a counter-current tank in order to remove a sufficient quantity of dragout (metals). Some of the solution from this counter-current PM is used as make-up solution to raise the level in the plating tank following evaporation or excess dragout.
FEEDSTOCKS:	Rinsewaters, spent solutions from plating and cleaning operations
WASTES:	Contaminated wastewaters
MEDIUM:	Aqueous
COSTS:	
CAPITAL COSTS:	$24,000 - $89,000 (dependent on capacity of plant)
OPERATION/MAINTENANCE:	$9740 - $133,570
MONTHS TO RECOVER:	Total capital and operating costs are lower than conventional technology.
SAVINGS:	
DISPOSAL & FEEDSTOCK:	For conventional processes of equal capacities, ranges are $63,750 - $421,600 for capital costs and $26,960 - 180,430 for operating costs.
FEEDSTOCK REDUCTION:	Some make-up solution is recycled from the PM process.
WASTE PRODUCTION:	Total volume of waste requiring treatment is reduced as well as the concentration of the waste.
IMPACT:	The use of low-volume rinsing in surface finishing, and electroplating processes reduces the volume of metal containing wastewaters, and allows for recovery of the dragout. Additionally, investment and operating costs are reduced primarily due to reduced treatment costs.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, Monograph "Use of Low-volume Rinsing in surface Finishing, Electroplating Processes" ENV/WP.2/5/Add.127.
KEYWORDS:	Metal Finishing, Metal Recovery, Counter-Current Rinsing, Wastewater Treatment, Dragout, Electroplating, Providence Method, ISIC 3800

***** DOCNO: 450-012-A-001*****

1.0 Headline: Quebec electroplating company decreases effluent and saves money on chemical and treatment costs

2.0 SIC Code: 3471

3.0 Name and Location of Company

Galvano
Saint-Mathieu-de-Beloeil, Quebec

4.0 Clean Technology Category: This technology involves wastewater reduction, process/equipment modification, and waste segregation/separation.

5.0 Case Study Summary

5.1 Process and Waste Information

Because of elevated levels of zinc found in the groundwater surrounding Galvano's factory, the owners decided to implement a new system in 1981 to treat the wastewaters from this electroplating company. They decided to implement a system that would decrease the amount of effluent while incorporating a treatment system that would precipitate metals out of the effluent. In order to decrease the volume of the waters to be treated, the company separated refrigeration waters from the contaminated effluent. This action alone decreased the amount of waters to be treated from 810 to 270 liters/min. A system of counter-current rinsing was put in place to further decrease the volume of effluent. Also, deflectors were positioned between the acid and alkaline basins to recover drippings from metals pieces so that the liquids could be returned to their respective solutions. Using counter-current rinsing and the deflectors decreased water usage from 270 liters/min. to 100 liters/min. The decrease in water consumption resulted in savings of $20,000. Total reduction in the effluent volume was 87%. By eliminating and reorganizing the rinsebaths, the company was able to rearrange enough space to add more plating lines and increased production by 100%.

The company realized, however, that a reduction in the volume of effluents didn't necessarily mean that the contamination of these waters would be decreased. By centrifuging the basket where "hot zincing" takes place and by increasing the time between cleanings by 50%, the company was able to recover 1 ton of zinc/day and save $1,000/day. By using a special pump to adjust the levels of water in the rinsebaths, the concentration of contaminants was able to be controlled. This action conserved mineral salts necessary to the process and decreased the amount of zinc and potassium chloride and boric acid used. Also, the company's normal sand filtering system was replaced by another in which more filters were added to decrease the cumber of times the rinsebaths needed cleaning and decreased the number of chemicals needed to maintain the baths. The pumping system and the new filters enabled the company to save $28,000/year in chemical costs. This decrease in chemicals decreased the amount of residual sludge which saved $20,000/year in treatment costs. Total treatment cost savings were approximately $70,000/year due to a 10% reduction in sludge. Total cost savings were approximately $368,000/year due to the decrease in the amount of effluent and increase in the capture of metals. The company was also able to increase its production by 100%.

5.2 Scale of Operation: Galvano operates 24 hours/day and employs about 50 people. It is the most productive electroplating plant in Quebec, plating approximately 2,500 tons/year of bolts, screws, nails, and similar products.

5.3 Stage of Development: This technology was fully implemented at the time of this case study.

5.4 Level of commercialization: This technology was commercially available at the time of this case study.

5.5 Material/Energy Balances and Substitutions

Quality of Effluent

Chemicals	Before Treatment mg/l	After Treatment mg/l	Standards mg/l
Cr	.91	.1	1
Zn	500	.69	1
H and G	215	4.6	15
Fe	100	1.0	17
pH	1.0-8.0	7.5-8.5	5.5-9.5

6.0 Economics*

6.1 Investment Costs: Information not provided.

6.2 Operation and Maintenance Costs: Operation and maintenance costs were not provided.

6.3 Payback Time: With the system fully implemented, payback starts immediately.

7.0 Cleaner Production Benefits: Savings in chemical and treatment costs are as follows:

Technology	Savings
1) Decreasing consumption of water	$20,000
2) Decreasing consumption of chemical products	$28,000
3) Reduction of contaminated sludges	$20,000
4) Recovering zinc and increasing the period between cleanings of baskets	$300,000
Total	$368,000

It is assumed that costs were reported in Canadian dollars.

Production was increased by 100% after rinse baths were eliminated or reorganized. The company is now in compliance with the effluent standards of Quebec.

8.0 Obstacles, Problems and/or Known Constraints: Information not provided

9.0 Date Case Study Was Performed: The case study was performed in 1981.

10.0 Contacts and Citations

10.1 Type of Source Material: Report

10.2 Citation: Secteur Revetement de Surface, Technologies Propres, Electrogalvanization et zingage a chaud, Gouvernement de Quebec, Ministre de l'Environnement, Gestion et Assainissement des Eaux, revised June 1988. Source document is in French.

10.3 Level of Detail of the Source Material: More detail is provided about the general process of electroplating.

10.4 Industry/Program Contact and Address: Regional offices, addresses and phone numbers are given on the back of the report.

10.5 Abstractor Name and Address: Blair M. Raber, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA, 22043.

11.0 Keywords

11.1 Waste Type: Electroplating rinsewater, Acidic Wastewaters, Alkaline Solution, Zinc.

11.2 Process Type/Waste Source: Electroplating, Plating and Polishing, Rinsate, Sludge, Zinc Galvanization.

11.3 Waste Reduction Technique: Counter-Current Rinsing, Metal Recovery, New Equipment, Process Modification, Pumps and Pumping Equipment, Volume Reduction, Wastewater Reduction, Source Reduction, Drip Confinement, Sand Filter.

11.4 Other Keywords: Bolts, Nuts, Screws and Rivets; Increased Productivity, Metal Products.

(*) Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Electroplating Rinsewater; Acidic Wastewaters; Alkaline Solution; Zinc; Electroplating; Plating and Polishing; Rinsate; Sludge; Zinc Galvanization; Counter-Current Rinsing; Metal Recovery; New Equipment; Process Modification; Pumps and Pumping Equipment; Volume Reduction; Wastewater Reduction; Source Reduction; Drip Confinement; Sand Filter; Bolts, Nuts, Screws and Rivets; Increased Productivity; Metal Products

FERTILIZER

***** DOCNO: 400-010-A-201 *****

HEADLINE:	Reduced energy consumption and wastewater generation achieved in nitric acid production.
INDUSTRY/SIC CODE:	Fertilizer Industry, Nitric Acid Production/ISIC 3512
NAME/CONTACT:	National Authority for Environmental Protection and Nature Conservation - Veszprem University of Chemical Engineering -Nitrogen Works Pet, Hungary
TECHNOLOGY DESCRIPTION:	The company uses a pressurized process with catalytic end-gas reduction (GIAP). This includes: Oxidation ammonia - oxidation HO - absorption NO_x - catalytic end-gas reduction. End gas 3.300 m^3 with NO_x content (vol. %) 0.1 - 0.15 (The conventional process produces an end-gas with an NO_x content (vol. %) of 0.2 - 0.4) Acidic wastewater effluent of 1-3 m^3/day with NO_3 - content of 5g/1. (The wastewater volume from the conventional process is about 5-15 m^3/day.) End-gas amounting to 4.100 NH_3/ton of HNO_3 with an NO - content (vol %) of 0.005 per cent, CO-content of 0.1 per cent, and CO_2 - content of 2.5 percent.
FEEDSTOCKS:	Not reported
WASTES:	Not reported
MEDIUM:	Not reported
COST:	
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	Dramatically reduced energy consumption, but dramatically increased catalyst consumption. Stack gases and waste heat increase but wastewaters are decreased significantly.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Comparison Between Conventional and Low-Waste Nitric Acid Production Technologies", Monograph ENV/WP.2/5/ Add.10.
KEYWORDS:	Nitric Acid, ISIC 3512, Fertilizer, End Gas Reduction

HEADLINE: Continuous absorption of SiF_4 from waste gas reduces discharges of purified waste gas.

INDUSTRY/SIC CODE: Manufacture of Fertilizers and Pesticides/ISIC 3512

NAME/CONTACT:
Zentrum Fur Umweltgestaltung
Schnellerstrasse 140
DDR - 1190 Berlin
German Democratic Republic

TECHNOLOGY DESCRIPTION: The company performs continuous absorption of fluorine - containing waste gas. This low-waste technology is a continuous method for absorption of SiF_4 from waste gas of the phosphate-fertilizer industry. It works upon the principle of turbogrid absorption. In an absorption tower, the waste gas is cleaned of fluorine streams through several, specifically-designed turbogrid trays, one after the other.

These turbogrid trays are sprayed with aqueous hexafluorosilicic acid. In the turbogrid trays, stable dynamic bubbling layers develop which offer a big mass-transfer surface for the absorption.

FEEDSTOCKS: Waste gas of the phosphate fertilizer industry (especially superphosphate industry)

WASTES: Purified waste gas

MEDIUM: Not reported

COST:
CAPITAL COST: Not reported
OPERATION/MAINTENANCE: Not reported
MONTHS TO RECOVER: Not reported

SAVINGS:
DIRECT COST: Not reported
FEEDSTOCK REDUCTION: Not reported
WASTE PRODUCTION: The quantity of filter-wet sludge amounts to approximately 30 kg per 1 metric ton of P_2O_5 superphosphate (20 percent solids - SiO_2; 80 percent adhesive liquids - some 10 to 15 percent H_2SiF_6, remainder H_2O). With low-waste technology there is a discharge of 20 to 30 mg/m^3 purified waste gas, whereas the conventional technology had 1,000 mg f/m^3.

IMPACT: Prior to the introduction of turbogrid absorption of fluorine-containing waste gas, the superphosphate factories of the German Democratic Republic applied conventional spray-roll chambers for depositing SiF_4 from waste gas. These chambers had the disadvantages of discontinuous operation and of a maximum efficiency of 90 percent due to limited contact surface; thus up to 1,000 mg F/m^3 were emitted. In order to maintain even this inadequate efficiency, frequent and very high manual cleaning expenditures

were required for regularly removing the silicic acid deposited in the chambers which became extremely hard.

CITATION/PAGE: Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Continuous Absorption of Fluorine-Containing Waste Gas", Monograph ENV/WP.2/5/Add.48.

KEYWORDS: Fertilizer, Absorption, ISIC 3512

HEADLINE:	Nitrophosphate process conserves steam and oil and improves efficiency in fertilizer production.
INDUSTRY/SIC CODE:	Complex Fertilizer or NP/NPK industry/ISIC 3512
NAME/CONTACT:	Horsl: Hydro a.s, P.O. Box 2594 Solli, Oslo 2 - Norway
TECHNOLOGY DESCRIPTION:	The company uses the Nitrophosphate (ODDA) process with conversion of calcium nitrate and recirculation of nitrogen and phosphorous effluents. The nitrophosphate process includes nitric acid digestion of phosphate rock and deep cooling precipitation of calcium nitrate with subsequent conversion into fertilizer products. The nitrophosphate process includes the use of waste CO_2 from an NH_3 plant and avoids the use of sulfur. 1.1 tons of steam and 35 kg of oil is saved per ton of P_2O_5 by this process. A wide range of commercial phosphate rocks may be used in the process. The Norsk Hydro Nitrophosphate products are not subject to self-sustaining decomposition.
FEEDSTOCKS:	Not reported
WASTES:	Not reported
MEDIUM:	Not reported
COST:	
CAPITAL COST:	$1,000,000
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	The Nitrogen efficiency of the process is 98-99 per cent, the P_2O_5 efficiency better than 99 percent and the K_2O efficiency better than 99.8 percent.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Production of NPK Fertilizers Through the Nitro-Phosphate (ODDA) Process with Conversion of Calcium Nitrate and Recirculation of Nitrogen and Phosphorous Effluents", Monograph ENV/WP.2/5/Add.11.
KEYWORDS:	Fertilizer, ISIC 3512, Nitrophosphorous, Urea, Ammonia

***** DOCNO: 400-062-A-243 *****

HEADLINE:	Raw material needs and wastewater production decrease using evaporator system.
INDUSTRY/SIC CODE:	Fertilizer Industry/ISIC 3512, SIC 2873
TECHNOLOGY DESCRIPTION:	NPK fertilizers, a nitro-phosphate type fertilizer, is produced through the Norsk-Hydro-ODDA technology. This technology has been modified to incorporate an effective wastewater evaporator system which reduces the amount of contaminated cooling water discharge. The wastewater passes through a series of evaporation steps whereby the vapors are used as wash water in the calcium carbonate filters and the concentrated solution is pumped to the neutralizers where it is mixed with the acidic NP solution and used to regulate the N/P_2O_5 nutrient ratio of the fertilizer. Through this modified technology, steam and electric energy consumption increases somewhat but such increases are balanced by the more effective utilization of nitrogen and the reduction of the wastewater stream discharge.
FEEDSTOCKS:	Phosphate rock, Ammonia, Nitric Acid, Potassium Chloride
WASTES:	Wastes produced include wastewater, NH_4NO_3, SiF_4, NH_3 and flue gas.
MEDIUM:	Aqueous
COST:	
CAPITAL COST:	50 million forints
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	
FEEDSTOCK REDUCTION:	Savings in raw materials and water are five times grater than the added cost of steam and energy.
WASTE PRODUCTION:	Eliminates wastewater discharge
IMPACT:	The evaporator, used for the elimination of wastewater, can also be applied for the reduction of waste streams of low salt concentration in various sectors of the chemical industry.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Wastewater Evaporation Process For Fertilizer Production Technology", Monograph ENV/WP.2/5/Add62.
KEYWORDS:	Fertilizer, Ammonium Vent Gas, ISIC 3512, SIC 2873, Wastewater Evaporation

***** DOCNO: 400-029-A-218 *****

HEADLINE:	Recovery of ammonia reduces emissions and raw materials requirements in fertilizer production.
INDUSTRY/SIC CODE:	Fertilizer Industry/ISIC 3512
NAME/CONTACT:	Ministere de l' Environment et due Cadre de Vie Direction de la Prevention des Pollutions 14 Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France August 1980
TECHNOLOGY DESCRIPTION:	The company performs ammonium nitrate synthesis accompanied by recovery and recycling of the ammonia contained in the vapor. The synthesis of ammonium nitrate is carried out in both techniques through a nitric acid reaction on the ammonia. When the reaction takes place, vapor is formed, containing a small amount of ammonia. Whereas in the formerly used process the vapor was discharged, it is now washed in nitric acid, which permits recovery and recycling of the ammonia that it contains.
FEEDSTOCKS:	Ammonia
WASTES:	Vapor containing nitrate and ammonia.
MEDIUM:	Vapor
COST:	(1976 Francs)
CAPITAL COST:	F 350,000
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Reduced production of waste nitrogen by 75%.
IMPACT:	Reduced waste nitrogen production and reduced virgin ammonia requirements.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Recovery and Recycling of Ammonia Contained in Gases from Ammonium Nitrate Production", Monograph ENV/WP.2/5/Add 29).
KEYWORDS:	Ammonium Nitrate, ISIC 3512, Recovery

FOOD

Vegetable Processing
Animal and Poultry Processing
Dairy Products

***** DOCNO: 400-043-A-232 ***** <x>

HEADLINE:	Wastewater treatment results in recovery of methane.
INDUSTRY/SIC CODE:	Food and Fermentation Industries/ISIC 3111, 3112, 3113, 3114, 3118, 3131, 3132, and 3133
NAME/CONTACT:	AB Sorigona Box 139, S-24500 Staffenstorp, Sweden
TECHNOLOGY DESCRIPTION:	Wastewaters from the industry are treated with anaerobic microorganisms for recovery of methane. The water treated in this way is then treated with aerobic microorganisms for achieving a very good effluent quality. The aerobically-produced excess biosludge is recycled back to the anaerobic step. The recovery of methane is about 300 l/kg COD treated.
FEEDSTOCKS:	Industrial effluents containing large amounts of biodegradable organic material (e.g., wastewaters from food and fermentation industries).
WASTES:	Crude digestion gas, small amounts of excess sludge.
MEDIUM:	Aqueous
COST:	
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "The Ahamet Process for Wastewater Purification", Monograph ENV/WP.2/5/Add.43.
KEYWORDS:	Activated Sludge, Methane, Ahamet Process, ISIC 3111

1.0 Headline: Recovery and use of methane from sugar beet processing effluent

2.0 SIC Code: SIC 2063, Beet Sugar

3.0 Name and Location of Company:

British Sugar plc
Oundle Road
Peterborough PE2 9QU, England

4.0 Clean Technology Category:

This technology uses an anaerobic stage to recover methane from sugar beet effluent for use as a process fuel.

5.0 Case Study Summary

5.1 Process and Waste Information: The facility processes sugar beets generating a wastewater effluent with a high chemical oxygen demand. Traditionally, this effluent was dealt with aerobically by a water treatment plant and its organic content wasted. The clean technology was to add an anaerobic stage to the water treatment section to convert the organic content of the effluent to usable methane. The fermentation takes place in the digestion vessel, the off-gas consists largely of methane with some carbon dioxide. Key features of the process are the pre-heating of the incoming stream using low-grade heat, careful control of the pH and the recirculation of sludge. The methane provides process heat to dry the pulp for use as an animal feed.

5.2 Scale of Operation: British Sugar operates 12 beet factories and employs 3,000 people. The Peterborough facility produces 100,000 tons of sugar per year.

5.3 Stage of Development: The technology is fully implemented.

5.4 Level of Commercialization: No information provided.

5.5 Material/Energy Balances and Substitutions: No information provided.

6.0 Economics:* It is assumed that the economics cited in the source document are on a per plant basis and not the total of all 12 British Sugar plants.

6.1 Investment Costs: The capital cost of the technology is 750,000 English Pounds.

6.2 Operational and Maintenance Costs: Annual savings in lower sewage charges are 26,000 English Pounds and 8,000 English Pounds in electricity cost savings. The value of recovered gas is 25,000 English Pounds.

6.3 Payback Time: Payback time is 12 years.

7.0 Cleaner Production Benefits

The technology resulted in reduced chemical oxygen demand in the wastewater effluent. Recovery and use of methane from organic matter in the wastewater effluent were achieved. Lower operating costs and energy conservation were added benefits of the technology.

8.0 Obstacles, Problems and/or Known Constraints

None were identified.

9.0 Date Case Study Was Performed

Unknown

10.0 Contacts and Citation

10.1 Type of Source Material: Government Publication.

10.2 Citation: Clean Technology, Environmental Protection Technology Scheme, Department of the Environment, 2 Marsham Street, London SW1P 3EB, 1989, p. 21.

10.3 Level of Detail of the Source Material: No additional detail is provided.

10.4 Industry/Program Contact and Address: Mr. J.N. Smith, Chief Safety and Environment Officer, British Sugar plc, Oundle Road, Peterborough PE2 9QU, England, Telephone (0733) 63171.

10.5 Abstractor Name and Address: John Houlahan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Chemical oxygen demand, wastewater effluent, sugar beet processing effluent

11.2 Process type/waste source: Sugar products, agricultural processing

11.3 Waste reduction technique: Anaerobic digestion

11.4 Other keywords: Methane, United Kingdom, SIC 2063

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Chemical Oxygen Demand, Wastewater Effluent, Sugar Beet Processing Effluent, Sugar Products, Agricultural Processing, Anaerobic Digestion, Methane, United Kingdom, SIC 2063

HEADLINE:	Eluates from beet juice demineralization are recovered and sold as fertilizer and animal feed.
INDUSTRY/SIC CODE:	Food Industry/ISIC 3118
NAME/CONTACT:	Ministere de l'Environnement et du Cadre de Vie Direction de la Prevention des Pollutions 14 Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	The company demineralizes beet juice with valorization eluates. The demineralization eluates are separated from the other effluents. After having been homogenized, these eluates are concentrated by evaporation and then crystallized. Centrifugation permits the separation of salts that are marketed as fertilizer and the mother liquor, rich in proteins, that is marketed for animal feed.
FEEDSTOCKS:	Beet juice, salt
WASTES:	Not reported
MEDIUM:	Not reported
COST:	(1973 Francs)
CAPITAL COST:	F 3.0 million
OPERATION/MAINTENANCE:	12 Francs/ton demineralized beets
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	This process is more reliable than a standard purification process.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Demineralization of Beet Juice with Re-Use of Eluates", Monograph ENV/WP.2/5/Add.41.
KEYWORDS:	Foodstuff, Beets, Demineralization, ISIC 3118

***** DOCNO: 400-084-A-255*****

HEADLINE:	Potato starch extracted without water washing eliminates wastewater generation.
INDUSTRY/SIC CODE:	Food Manufacturing/ISIC 311
TECHNOLOGY DESCRIPTION:	Extraction of potato starch without water washing of the finely divided potatoes. The potatoes are separated into solid and liquid phases, which are then processed independently.
FEEDSTOCKS:	Five tons of potatoes, 0.2 GJ of electric power and 0.1 GJ in the form of steam, per ton of potato powder.
WASTES:	Wastewater
MEDIUM:	Aqueous
COST:	
CAPITAL COST:	0.2 million rubles for new process.
OPERATION/MAINTENANCE:	380 rubles per ton of potato powder.
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	0.4 million rubles in initial investment, due to need for water-treatment station in conventional process. 150 rubles savings per ton of starch produced due to reduced operating costs.
FEEDSTOCK REDUCTION:	None
WASTE PRODUCTION:	In the low-pollution technique, the water required is 3.5 m^3 per ton of end-product compared to 14.5 m^3 in the conventional process.
IMPACT:	Elimination of wastewater generated from wash water and internal vegetation water in the standard starch process. In the low-pollution process of potato powder production, one obtains undiluted potato cell fluid which undergoes direct processing.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Dry Extraction of Potato Starch Substitute", Monograph ENV/WP.2/5/Add84.
KEYWORDS:	Wastewater Treatment, Food Processing, Potato, Starch, ISIC 311

1.0 Headline: Recovery of Protein from Potato Starch Effluent Using Reverse Osmosis

2.0 SIC/ISIC Code: 2046

3.0 Name and Location of Company:

Avebe Foxhol, Foxhol, The Netherlands

4.0 Clean Technology Category: This technology uses reverse osmosis to concentrate potatofruitwater to a level that the protein can be recovered economically using coagulation. Reverse osmosis is a process that separates water from dissolved and suspended solids by forcing water through the membrane while dissolved substances are retained. The filtrate from the reverse osmosis process is recycled within the factory to further reduce process water intake. The plant also implemented a counter current extraction process that further reduced water usage.

The reverse osmosis process, aside from reducing water usage and wastewater discharge, also produces two saleable products. Following concentration of the potato water, protein is extracted from the concentrated reverse osmosis stream by steam coagulation and dried. The residual potato water is evaporated and used for the enrichment of the potato fibers and incorporated in cattle feed.

5.0 Case Study Summary:

5.1 Process and Waste Information: Potato starch production involves washing and grinding potatoes to produce a pulpy liquor of potatofruitwater, starch, and fibers. Starch is extracted, with fibers separated using centrifuges. The residual waters contain protein, sugar, and minerals at a concentration previously too dilute to recover. The new technology uses a reverse osmosis open-channeled tubular membranes to separate water from dissolved and suspended solids. The process generates two streams: a concentrated liquor and clean water.

5.2 Scale of Operation: The clean technology was implemented at a plant processing 180,000 tons of potatoes an hour and previously produced 2.2 million cubic meters per year of potato water.

5.3 Stage of Development: The process was implemented full scale at Avebe Foxhol.

5.4 Level of Commercialization: The reverse osmosis is available from PCI Membranes Systems Ltd., a specialist in membrane filtration equipment with 25 years experience.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Water Usage	7 m^3/ton potato	0.6 m^3/ton potato
Wastewater Generation	3.2 million m^3/yr	1.1 million m^3/yr

6.0 Economics*

6.1 Investment Costs: Not Specified.

6.2 Operational and Maintenance Costs: The overall cost to Avebe of concentrating the liquor with reverse osmosis was approximately US$0.54 per m^3 of potato water treated.

6.3 Payback Time: Not Specified.

7.0 Pollution Prevention Benefits

The reverse osmosis system provides for; major reductions in the volume of process water consumed, reduction in capital and energy as a result of the reduction in the quantity of water handled enabling the heat coagulation and evaporation plant to be half the size, and the production of two by-products from the effluent. This also solves an effluent treatment problem (including calming the public outcry about strong odors and killing water life) and avoids wastewater disposal costs.

8.0 Obstacles, Problems, and/or Known Constraints

None Identified.

9.0 Date Case Study Was Performed: Late 1970's early 1980's.

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "Recovery of Protein from Potato Starch Effluent," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: Mr Wijnholds, Avebe Foxhol, Avebeweg 1, 9607 PT Foxhol, The Netherlands, Tel: +31 5980 42136

Miss N J Randles, Business Development Manager, PCI Membrane Systems Ltd, Laverstoke Mill, Whitchurch, Hampshire RG28 7NR, United Kingdom, Tel: =44 256 896966

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Wastewater

11.2 Process Type/Waste Source: Potato Starch Manufacturing

11.3 Waste Reduction Techniques: Recycling

11.4 Other Keywords: Reverse Osmosis

11.5 Country Code:

12.0 Assumptions

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wastewater, Potato Starch Manufacturing, Recycling, Reverse Osmosis

***** DOCNO: 400-039-A-228 ***** <x>

HEADLINE:	Coagulation and centrifugation of vegetation water recovers proteins.
INDUSTRY/SIC CODE:	Food Industry/ISIC 3121
NAME/CONTACT:	Ministere de l'Environnement et du Cadre de Vie Direction de la Prevention des Pollutions 14, Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	The company performs extraction of potato starch with recovery and valorization of proteins in internal vegetation water. Coagulation followed by centrifugation of the proteins contained in the internal vegetation water permits them to be separated from the water whereas with the standard technique the vegetation water, still full of proteins, was discharged into the river after having been stored for a month.
FEEDSTOCKS:	Internal vegetation water
WASTES:	Wash water and manufacturing water.
MEDIUM:	Aqueous
COST:	
CAPITAL COST:	FF 8.6 million
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	The discharge flow, 17.5 m^3/ton of potato starch, remains the same, but the pollution is reduced by about 40 per cent. The biochemical oxygen demand is 70 kg/ton and the chemical oxygen demand is 145 kg/ton compared to 120 kg/ton and 205 kg/ton, respectively, in the standard process.
IMPACT:	Although this technique is already operational it may still undergo improvements that will permit an increase in the efficiency of the recovery and valorization of the products recovered.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Extraction of Potato Starch with Recovery and Use of Proteins in Internal Liquid", Monograph ENV/WP.2/5/Add.39.
KEYWORDS:	Foodstuff, ISIC 3121

***** DOCNO: 400-035-A-224 *****

HEADLINE:	Use of abrasive peeling machine reduces material requirements in processing tubers.
INDUSTRY/SIC CODE:	Manufacturing of Foodstuffs, Drinks and Tobacco/ISIC 3113
NAME/CONTACT:	Ministere de l'Environnement et du Cadre de Vie Direction de la Prevention des Pollutions 14, Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	In the low pollution technique the washed tubers are peeled in an peeling-machine composed of abrasive rolls, with water. The wastewater containing peelings is filtered and recycled at the peeling stage. The filter contains only peelings of less than 5 mm and it is periodically cleaned. In the standard technique the washed tubers are dipped into a soda solution, then peeled and dipped into a citric acid solution for neutralization. In the low pollution technique, material requirements are substantially reduced: water needs are down from 25 m^3 to 5 m^3 per ton of tubers treated, no soda is used (as opposed to 10 kg/ton) and citric acid use is down from 6 kg per ton in the standard technique to 1 kg per ton.
FEEDSTOCKS:	Fruits and vegetables
WASTES:	Fruit and vegetable peelings
MEDIUM:	Not reported
COST:	
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DIRECT COST:	Not required
FEEDSTOCK REDUCTION:	Water requirements reduced by 20 m^3/ton of tubers, reduced citric acid usage, and eliminates soda usage.
WASTE PRODUCTION:	The wastes produced by the low pollution technique are made of tuber wastes and citric acid which are contained in the water discharged. Peelings retained by the filter are sent for dumping. For each ton of tubers treated, 5 m^3 of wastes are produced, which contain 15 kg of tuber wastes and 1 kg of citric acid; 170 kg of peelings are sent for dumping.
IMPACT:	Apart from pollution reduction, the low pollution technique ensures an improved output, higher quality of products, and a reduction in raw materials.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Mechanical Peeling of Vegetables/Fruits", Monograph ENV/WP.2/5/Add.35.
KEYWORDS:	Foodstuff, Abrasives, ISIC 3113

***** DOCNO: 400-051-A-240 ***** <x>

HEADLINE: Centrifugation used to recover fats from paté production.

INDUSTRY/SIC CODE: Manufacturing of Food, Beverages and Tobacco/ISIC 31

NAME/CONTACT:
Ministere de l'Environnement
Direction de la Prevention des Pollutions
14 Boulevard du General Leclerc
92522 Neuilly-sur-Seine Cedex, France

TECHNOLOGY DESCRIPTION: The company manufactures preserved patés with recovery of fats by centrifugation. Pork fats are cooked in water circulating in a closed circuit. The cooking water which is normally rejected every day, is centrifuged. Other liquid effluents from washing equipment, floors, etc., go through a fat separator. In the standard technology there is no centrifuge. Polluted water is discharged from the fat separator.

FEEDSTOCKS: Not reported

WASTES: Wastewater from the fat separator.

MEDIUM: Aqueous

COST:
CAPITAL COST: Not reported
OPERATION/MAINTENANCE: Not reported
MONTHS TO RECOVER: Not reported

SAVINGS:
DIRECT COST: Not reported
FEEDSTOCK REDUCTION: Not reported
WASTE PRODUCTION: The water resulting from cooking is equal to 285 liters per ton of paté, containing: 2 kg of fats; biochemical oxygen demand, 3.5 kg; chemical oxygen demand, 8 kg (versus respectively, 285 liters, 10 kg, 10 kg, 20 kg with the standard technology).

IMPACT:

CITATION/PAGE: Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Manufacture of Preserved Patés with Recovery of Fats by Centrifugation", Monograph ENV/WP.2/5/Add.51.

KEYWORDS: Foodstuff, Fat Recovery, Centrifugation, ISIC 31

***** DOCNO: 400-078-A-311***** <x>

HEADLINE:	Recovery of animal fats reduces wastewater generation by 90% and reduces energy costs.
INDUSTRY/SIC CODE:	Manufacture of Food, Beverages and Tobacco/ISIC 31
POLLUTION PREVENTION OPTIONS SUMMARY:	Manufacture of fats by continuous melting process with recovery of fats and protein from wastewater. Tallow is ground and melted in a steam-fed melting pot. Extracted fats are refined. Process water is treated in a concentrator to further recover fats and proteins. Concentrates are dehydrated and together with the grease can be sold as animal feed. The evaporated process water is condensed before being reused. In the standard technology, the process wastewater is degreased, processed through a florentine flask, and discharged.
FEEDSTOCKS:	Water, steam, tallow
WASTES:	Wastewater
MEDIUM:	Aqueous
COST:	
CAPITAL COST:	FF 795,000 (1979 figures)
OPERATION/MAINTENANCE:	FF 14 per ton of tallow (1979 figures)
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Not reported
FEEDSTOCK REDUCTION:	200 liters of water per ton of tallow.
WASTE PRODUCTION:	For each ton of tallow processed, the wastewater generation is reduced from 500 l for the standard technology to 50 l for the modified technology. The energy required for processing wastewater with the modified process is 670 MJ versus 21 MJ with the standard process. Also, with the low-waste technology, it is possible to recover 5.7 kg of proteins per ton and 3 kg of animal fats per ton of tallow.
IMPACTS:	The volume and the quality of wastewaters in terms of BOD and COD concentrations are improved significantly by the modified process.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Manufacture of Fats by Continuous Melting with Recovery of Fats and Proteins from the Wastewater", Monograph ENV/WP.2/5/Add.78.
KEYWORDS:	Food Processing, Fat Recovery, Condensates, Wastewater, ISIC 31

***** DOCNO: 450-013-A-001 *****

1.0 Headline: Poultry slaughterhouse decreases effluent by using dry suction system for clean-up

2.0 SIC Code: 2015

3.0 Name and Location of Company

La Cooperative Federee de Quebec,
Saint-Felix-de-Valois, Quebec.

4.0 Clean Technology Category:

This technology involves wastewater reduction by installing a vacuum system to clean-up poultry organs from cutting tables.

5.0 Case Study Summary

5.1 Process and Waste Information: Water is an essential element for poultry slaughterhouses. It is used to clean poultry cages, to scald the poultry so that feathers may be removed, to wash feathers from poultry, to remove organs from cutting tables, to refrigerate poultry, and to wash equipment. The authorities at the municipal water treatment system of Quebec found that the efficiency of their purification machinery was being greatly compromised by the volume and high pollution levels of water from the poultry slaughterhouses. As a result, the water treatment company and La Cooperative Federee decided to treat the slaughterhouses's waters on site. The company elected to decrease the amount of water it was using and, therefore, avoid the $1,500,000 cost of a treatment system. The most obvious way to decrease the volume of water at the facility was to install a vacuum system that sucked organs and other inedible body parts from the visceration tables and collected them in a vat of other non-edible parts. The old system used a lot of water to hose the tables down with disinfectant. As a result of the new suctioning system, the company was able to reduce the pollutants in its effluent by 75%. The company also used the following source reduction techniques to decrease its wastewaters:

*Recovered blood instead of washing it away,

*Segregated process waters from rain waters so that only the volume of process waters needing treatment would be discharged to a pit,

*Installed automatic spray nozzles to concentrate water more directly when washing equipment,

*Installed high pressure cleaning systems to clean more efficiently.

5.2 Scale of Operation: La Cooperative Federee slaughters approximately 23,000 poultry per day. It used 500,000 liters/water/day and discharged 400 kg BOD(5)/day (demande biochimique en oxygen).

5.3 Stage of Development: This technology was fully implemented at the time of this case study.

5.4 Level of Commercialization: This technology was fully available at the time of this case study although the suction system needed to be specifically designed for this application.

5.5 Material/Energy Balances and Substitutions

Transportation of Visceral Organs

Parameters (kg/ton)	Traditional Transportation	Transportation at La Cooperative			
	Transportation by Water	Transport by Water		Suction System	
	without hens*	w/o hens*	with hens*	w/o hens*	with hens*
BOD(5)	15.5	17.1	39.5	8.2	11.0
Suspended Solids	10.9	9.7	25.8	7.8	9.4
Oils and Fats	5.1	3.7	7.0	2.1	2.5

* It is noted in the text that hens pollute more than other poultry due to the eggs located in the viscera.

6.0 Economics*

6.1 Investment Costs: In order to install the equipment for the suction system, the company invested $180,000 compared to the $1,500,000 the company would have had to spend to install a chemical and biological treatment system.

6.2 Operation and Maintenance Costs: With the dry suction system, the company must only spend $4,000/year for disinfection chemicals as opposed to spending $10,000/year on chemical and energy costs for the chemical/biological treatment system.

6.3 Payback time: The payback time of this operation was 7 months.

It is assumed that costs are reported in Canadian dollars.

7.0 Cleaner Production Benefits:

This process reduced the wastewaters of the slaughterhouse by 75%. The use of disinfection chemicals decreased by 75% and oils and fats in the effluent were reduced by 65%.

8.0 Obstacles, Problems and/or Known Constraints

One of the obstacles the company had to overcome was how to implement a suction system using existing pipes and equipment. The company was able to attach the system to existing conduits to transport the organs to an existing storage area for inedible parts.

9.0 Date Case Study Was Performed: This case study was performed in 1986.

10.0 Contacts and Citation

10.1 Type of Source Material: Report

10.2 Citation: Secteur Agro-Alimentaire, Technologies Propres, Abattage de Volailles, Gouvernement de Quebec, Ministre de l'Environnement, Gestion et Assainissement des Eaux, May 1989. Source document is in French.

10.3 Level of Detail of Source Material: More detail is provided about the slaughter industry in general in Quebec. More detail is also provided about the system before the changes and the system after the implementation of the suction system.

10.4 Industry/Program Contact and Address: Regional offices, addresses and phone numbers are given on the back of the report.

10.5 Abstractor Name and Address: Blair M. Raber, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA, 22043.

11.0 Keywords

11.1 Waste Type: Wastewater, Food Wastes, Animal and Marine Fats, Fats and Oils.

11.2 Process Type/Waste Source: Food Processing.

11.3 Waste Reduction Technique: Equipment Modification, Process Modification, Source Reduction, Wastewater Reduction, Jet Sprayers, Vacuum System.

11.4 Other Keywords: Agriculture, Annual Cost Savings, Canada, Environmental Impact Reduction, Food Products.

(*) Disclaimer - Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wastewater, Food Wastes, Animal and Marine Fats, Fats and Oils, Food Processing, Equipment Modification, Process Modification, Source Reduction, Wastewater Reduction, Jet Sprayers, Vacuum System, Agriculture, Annual Cost Savings, Canada, Environmental Impact Reduction, Food Products

***** DOCNO: 452-002-A-000 *****

1.0 Headline: Disposal of wastewaters and decreased water requirements are achieved through conservation, recycling and process modification in dairy operations

2.0 SIC Code: 2202 Cheese Manufacturing

3.0 Name & Location of Company: General information presented with no mention of specific companies or facilities.

4.0 Clean Technology Category

Technology Principle: This technology involves minimizing water consumption and subsequent wastewater production through onsite conservation and recycling while also increasing productivity.

5.0 Case Study Summary

5.1 Process and Waste Information: This new waste technology is concerned with water, which is a universal solvent in many processes and subsequently becomes an environmental problem. This technology focuses on eliminating the need for new water in a process by recycling water into the process and minimizing consumption. Cheese manufacturing was the example presented. Cheese manufacture produces two wastewater streams: the whey and the water from cleaning the plant. Whey can go to an ultrafiltration plant to produce protein and permeate powder and wastewater can be recycled. Total recycle begins with good preparation including initial treatment of water to remove any contaminants such as hardness, inorganic or organic substances through hyperfiltration, and a complete clean out of the plant to eliminate on-site contaminants (i.e., left-over bacteria).

The process water is conserved by installing better-built pumps, i.e., better glands and bearings independent of the motor, preventing release onto the floors. Discontinuous operation is replaced with continuous operation which serves to increase water economy with minimum storage capacity required. In addition, production increases with less investment. Plants must be set up or run to ensure that total shut-down is not required for clean-up, and a phased clean-up can be effectually conducted with all flush water being reused or directed to ultrafiltration plants which recover almost all internal protein as product.

The final step is to acknowledge that no stream is a waste stream and must be handled in sanitary way. Stream segregation is important as it permits less complicated treatment or regeneration processes. In a dairy plant wastewater streams contain thermophilic and spore-forming microorganisms and recirculation of this water can only be achieved if organism build-up prevention is practiced. Necessary precautions require that water be stored with cleaning agents to prevent the growth of such organisms or be stored with a very low content of BOD and nutrients. BOD and nutrients can be removed through the use of hyperfiltration. Cleaning agents are also necessary. Nitric and phosphoric acids and sodium hydroxide, and some complexing agents can all be recovered (except what has been neutralized), and ultrafiltration of these agents is a good way to remove proteins for animal feeds.

It was mentioned that these strategies have been introduced successfully into a pulp and paper factory in Kai Shan Tun in the Jilin Province in China. This plant recovers lignosulphonate from sulfite liquor using ultrafiltration. The lignosulphonate is used for paper gluing.

5.2 Scale of Operation: Specific plants or facilities were not mentioned however, the example given represented a commercial cheese manufacturing process line.

5.3 State of Development: This technology is fully developed.

5.4 Level of Commercialization: The example given represented a commercial cheese manufacturing run.

5.5 Balances and Substitutions: Water is treated before use and is conserved and regenerated throughout the cheese manufacturing process to effectively reduce the amount of new water required and eliminate wastewaters requiring disposal.

Specific amounts were not given.

6.0 Economics: The investment costs in a dairy operation where wastewaters are not produced are higher than those of a conventional process (due to hyperfiltration plants etc.) however, advantages include: almost all product ends up as valuable product; most cleaning chemicals are recovered; the amount can be reduced to 20-30% of the normal consumption; water consumption is minimized; no money is spent for wastewater treatment.

6.1 Investment Costs: Specific investment costs were not reported, although it was mentioned that investment costs for nonwastewater dairy plants were higher than conventional dairy plants.

6.2 Operational and Maintenance Costs: Specific costs were not mentioned; however, it can be assumed that savings can be realized with the reduction of cleaning agents and required water due to conservation and recycling, as well as, a reduction in wastewater treatment costs. Profit is also realized in the production of permeate powder and proteins from the hyperfiltration plants.

6.3 Payback Time: Payback time was not discussed although the benefits of recycling can be seen immediately.

7.0 Cleaner Production Benefits

Economic benefits are seen in a reduction of cleaning agents and water purchased, the production of proteins and permeate powder, a reduction in wastewater disposal costs, and an increase in productivity due to increased operating hours.

Regulatory compliance is easier with significantly reduced volumes of waste requiring hazardous waste disposal.

8.0 Obstacles, Problems and/or Known Constraints

The buildup of thermophilic and spore forming microorganisms in plant waters is a problem and must be controlled through additives and controlled storage. Water must be treated prior to use to eliminate the introduction of contaminants into plant waters.

9.0 Date of paper preparation was not provided.

10.0 Contacts and Citation

10.1 Type of Source Material: Paper presented at a Non-waste technology symposium held in Finland.

10.2 Citation: Madsen, Erik Rud, "Water and Raw Materials for Non-Waste Technology Processes", Technical Research Center of Finland, Espoo Finland, June 20-23, 1988, (51-62).

10.3 Level of Detail of Source Material: Source material was designed to present general strategies rather than specific technical information.

10.4 Industry/Program Contact and Address: Rud Erik Madsen, A/S De Danske Sukkerfabrikker, Nakskov, Denmark.

10.5 Abstractor and Address: Susan Wojnarowski, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043

11.0 Keywords:

11.1 Waste Type: Wastewater, Rinsewater, Whey

11.2 Process Type/Waste Source: Cheese manufacturing, SIC 2202

11.3 Waste Reduction Technique: Reclamation, Recovery, Rinsewater Reuse, Spill Control, Conservation, Filtration, Process Control.

11.4 Other Keywords: Hyperfiltration Plant, Denmark

Keywords: Wastewater, Rinsewater, Whey, Cheese Manufacturing, SIC 2202, Reclamation, Recovery, Rinsewater Reuse, Spill Control, Conservation, Filtration, Process Control, Denmark

***** DOCNO: 450-010-A-001 *****

1.0 Headline: Cheese manufacturer chooses source reduction over implementing a secondary biological treatment system to comply with effluent standards

2.0 SIC Code: 2022

3.0 Name and Location of Company

La Fromagerie de la Cooperative Agropur, Fromagerie d'Oka, Oka, Quebec, Canada

4.0 Clean Technology Category: This technology involves a facility-wide reorganization and modification of every step of cheese production.

5.0 Case Study Summary

5.1 Process and Waste Information: The production of cheese at La Fromagerie is divided into 5 stages. All of these stages were scrutinized and ways were found to decrease the amount of pollution at all levels of production.

*Milk Receiving: In order to eliminate the wasting of milk in the storage silos, a squeegee is used to squeeze out the excess. In addition, high-powered water jets reduce the amount of water used to clean the equipment.

*Pasteurization: To eliminate the wasting of milk and to decrease the volume of washing and disinfecting solutions, the company adjusted the dimensions of the stopper and the pasteurizer to allow pasteurization to occur in the tubs on a continual basis.

*Cheese making: To recover minute particles of cheese, cotton filters were used. To recover cheese from the floor, rubber scoops and brooms were used. To recover residues of cheese from the cleansing process, they are scooped up by hand. To reduce the rinsewaters and disinfection solutions in the food conduit from the tables, fixed conduits were replaced with rotary conduits. To recover lactoserum from the first rinsing of the conduits, the stock reservoirs are pumped. To recover milk and the rinses of the food conduits from the tubs, a conductivity meter is used.

*Molding the Cheese: To recover lactoserum, collection pipes are used.

*Disinfection: To eliminate phosphorous, products containing phosphorous were not used.

5.2 Scale of Operation: Not Available

5.3 Stage of Development: This technology is fully implemented and the quantitative figures noted throughout the text are based on actual production.

5.4 Level of Commercialization: This technology is fully commercialized.

5.5 Material/Energy Balances and Substitution

Material Category	Before	After
Purity of effluent	80%	98%
Reduction in Phosphorous Loss	N/A	93%
Loss of Milk	9%	2%
Recovering fine particles of cheese	0	50 kg/day

6.0 Economics*

6.1 Investment Costs: The company had a choice between implementing a secondary biological treatment system or reducing pollutants at the source. By choosing source reduction, the company saved $270,000 as illustrated below.

	Secondary Biological Treatment	Source Reduction
Capital Costs	$350,000	$80,000
Operation Costs	$20,000	$0
Energy Costs	$6,250	$0

6.2 Operational and Maintenance Costs: Since the changes made are at the source and are one-time changes, there are no operation costs.

6.3 Payback Time: Not Available

It is assumed cost data was reported in Canadian dollars

7.0 Cleaner Production Benefits: This process dramatically reduced the amount of pollutants in the effluent and increased production since cheese that would otherwise have been lost is reclaimed and put back into the manufacturing process.

8.0 Obstacles, Problems and/or Known Constraints: Not Available

9.0 Date Case Study Was Performed: These pollution prevention measures were initiated in 1985.

10.0 Contacts and Citation

10.1 Type of Source Material: Report

10.2 Citation: Secteur Agro-Alimentaire, Technologies Propres, Production Fromagere, Gouvernement du Quebec, Ministre de l'Environnement, Gestion et Assainissement des Eaux, Revised June 1988. Source document is in French.

10.3 Level of Detail of the Source Material: More detail is provided about the cheese industry in Quebec and diagrams illustrate how the equipment is used differently before and after the changes.

10.4 Industry/Program Contact and Address: Regional offices, addresses, and phone numbers are given on the back of the report.

10.5 Abstractor Name and Address: Blair M. Raber, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043

11.0 Keywords

11.1 Waste Type: Dairy wastes

11.2 Process Type/Waste Source: Cheese, Agriculture, Food and Kindred Products, and Food Products.

11.3 Waste Reduction Technique: Alternatives Evaluation, Food Processing, Food Preparations, Lactoserum recovery, filtration, material conservation.

11.4 Other Keywords: Canada, Increased Productivity, Increased Efficiency, Process Efficiency.

(*) Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Dairy Wastes, Cheese, Agriculture, Food and Kindred Products, Food Products, Alternatives Evaluation, Food Processing, Food Preparations, Lactoserum Recovery, Filtration, Material Conservation, Canada, Increased Productivity, Increased Efficiency, Process Efficiency

HEADLINE:	Recovery of lactoserum powder and heat reduces emissions.
INDUSTRY/SIC CODE:	Manufacture of Food, Beverages and Tobacco/ISIC 31
NAME/CONTACT:	Ministere de l'Environnement Direction de la Prevention des Pollutions 14 Boulevard du General Leclerc 92522 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	The company produces lactoserum powder with recovery of powder and heat from the discharged air. In both techniques, the lactoserum is injected into the drying tower where hot air(180°C) circulates. The lactoserum is recovered at the tower base. The outgoing hot air, loaded with powder, is used for pre-heating the incoming air and then washed with enriched hot lactoserum in order to recover lactoserum particles. With the standard technique, the air simply goes through two hydrocyclones and is discharged hot and heavily loaded with particles.
FEEDSTOCKS:	Liquid lactoserum
WASTES:	Emissions to the atmosphere have the following characteristics: particles: 3 kg per ton of powder (versus 10.5 kg). Temperature: 45°C (versus 87° C).
MEDIUM:	Air
COST:	
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Production of Lactoserum Powder with Recovery of Powder and Heat from Discharged Air", Monograph ENV/WP.2/5/Add.50.
KEYWORDS:	Foodstuff, Lactoserum, ISIC 31

IRON AND STEEL

****** DOCNO: DOCUMENT NOT AVAILABLE ******

1.0 Headline: Gas Phase Heat Treatment of Metals Using a Fluidized Bed of Alumina

2.0 SIC/ISIC Code: 3398

3.0 Name and Location of Company:

Chartered Metal Industries Pte Ltd, Singapore

4.0 Clean Technology Category: This technology uses a fluidized bed of alumina particles to heat treat steel parts. A mixture of air, ammonia, nitrogen, natural gas, liquified petroleum gas, and other gases are used as the fluidizing gas to carry out the heat treatment of the materials immersed in the bed. Hydrocarbon gases are used for carburizing, ammonia for nitriding and nitrogen for neutral hardening. The bed is heated by electricity or gas with quenching also performed in the bed. The hot exhaust gases are used for heat exchange.

5.0 Case Study Summary:

5.1 Process and Waste Information: The heat treatment of steel (i.e., hardening, carburising, and nitrocarburizing) are processes usually carried out in baths of molten salts, such as nitrates, nitrites, carbonates, cyanides, chlorides, and caustics. The combination of chemicals and high temperatures is conducive to explosion, burns, and poisoning. Environmental problems arise from the resulting vapors and the removal, transport, and disposal of the toxic salts. Quench water, oil, cleaning water, and washing water had to be neutralized before discharge to the sewer. Off gases had to be scrubbed before exhausting to the atmosphere. With the new fluidized bed heat treatment process, there is no salt management necessary nor are there toxic vapors to control.

5.2 Scale of Operation: Not Provided.

5.3 Stage of Development: Not Provided.

5.4 Level of Commercialization: The equipment is available from Quality Heat Treatment Pty Ltd, an Australian company that designs and sells advanced technology heat treatment processing equipment.

5.5 Material/Energy Balances and Substitutions: No quantitative figures were given but the new processes does not require salt management and disposal, there is no wastewater treatment necessary, and there is no need for scrubbing the heat treatment off gases.

6.0 Economics*

6.1 Investment Costs: The capital investment for four fluid beds used to replace their existing salt bath lines is US$180,000.

6.2 Operational and Maintenance Costs: Using the fluidized bed heat treatment system saves the facility US$36,000 a year in energy costs and US$51,000 a year in salt and maintenance costs. Costs for gas and alumina will increase using the fluidized bed, but costs for energy, parts cleaning, salt pot replacement, waste neutralization, and salt replacement will decrease.

6.3 Payback Time: Approximately 2 years.

7.0 Pollution Prevention Benefits

The biggest advantages are the reduction in wastewater discharges and the improved working environment. Additionally, the quality of the product may be superior in many cases to that produced using the older method.

8.0 Obstacles, Problems, and/or Known Constraints

All forms of heat treatment are amenable to the fluidized bed technique, although austempering is the most cost effective.

9.0 Date Case Study Was Performed: Not Provided.

10.0 Contacts and Citation

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "Gas Phase Heat Treatment of Metals," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: Mr. Koh Beng Hock, Chartered Metal Industries Pte Ltd, 249 Jalan Boon Lay, Singapore 2261, Tel: +65 660 7186

Mr. Ray W Reynoldson, Managing Director, Quality Heat Treatment Pty Ltd, Unit 1 18 Turbo Drive, Bayswater North, Victoria 3153, Australia, Tel: +61 3 720 2744

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Wastewater, Molten Salts (including cyanide), Toxic Vapors

11.2 Process Type/Waste Source: Heat Treatment of Metals

11.3 Waste Reduction Techniques: Process Modification

11.4 Other Keywords: Fluidized Bed Heat Treatment

11.5 Country Code:

12.0 Assumptions:

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wastewater, Molten Salts (including cyanide), Toxic Vapors, Heat Treatment of Metals, Process Modification, Fluidized Bed Heat Treatment

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Galvanizing of Steel Using Electromagnetic Application

2.0 SIC/ISIC Code: 3479

3.0 Name and Location of Company:

Delot Process S A, France

4.0 Clean Technology Category: This technology uses induction heating to melt the zinc, an electromagnetic field to control the distribution of molten zinc, and modern computer control of the process. Raw steel is fed in automatically continuously or in batches. Surface preparation is performed by controlled shot blasting, followed by induction heating. The steel then enters the coating chamber where melted zinc in an inert atmosphere is held in suspension by an electromagnetic field. The speed of the production line controls the thickness of the zinc coating.

5.0 Case Study Summary:

5.1 Process and Waste Information: Galvanizing is a corrosion protection treatment for steel. The traditional technique consists of chemically pretreating the steel, then immersing the steel in a bath of molten zinc. The process also generates a lot of waste and fumes. The new process eliminates the need for water and provides for more control over the coating quality.

5.2 Scale of Operation: Not Identified.

5.3 Stage of Development: This equipment is developed by Delot Process S A for coilable material. The company is presently developing the technology to handle rigid steel.

5.4 Level of Commercialization: This system was operated by Delot Process S A. The availability is not discussed.

5.5 Material/Energy Balances and Substitutions: This new process eliminates wastewater generated in the older galvanizing process.

6.0 Economics*

6.1 Investment Costs: Not Specified.

6.2 Operational and Maintenance Costs: Lower operating costs result in the coating process being 18 percent of the steel cost compared to 60 percent with traditional galvanizing methods.

6.3 Payback Time: Three years when replacing existing plant.

7.0 Pollution Prevention Benefits

Use of the cleaner technology eliminates wastewater, reduces the amount of zinc necessary to galvanize the steel, provides for better control of the quality and thickness of the zinc coat, reduces labor requirements, reduces maintenance, and provides a safer working environment.

8.0 Obstacles, Problems, and/or Known Constraints

None Identified.

9.0 Date Case Study Was Performed: Not Specified.

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "New Technology: Galvanising of Steel," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: M Guy Dussous, Managing Director, Delot Process S A, 10/20 Ave des Freres Lumiere, Post box 74, 78194 Trappes, Paris Cedex, France, Tel: +331 30 66 08 78

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Wastewater

11.2 Process Type/Waste Source: Steel galvanizing

11.3 Waste Reduction Techniques: Process modification

11.4 Other Keywords:

11.5 Country Code:

12.0 Assumptions

None.

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wastewater, Steel galvanizing, Process modification

***** Document No. 453-001-A-000 *****

1.0 Headline: Fugitive dust recovered and reused in an iron foundry

2.0 SIC Code: SIC 3322, Malleable Iron Foundries

3.0 Name and Location of Company:

Baxi Partnership
Brownedge Road
Bamber Bridge
Preston PR5 6SN, England

4.0 Clean Technology Category

This technology involves recycling fugitive dust back into the manufacturing process.

5.0 Case Study Summary

5.1 Process and Waste Information: Precision iron founding involves the production of moulds and cores from mixtures of sand and clay. In the traditional process, the factory space is ventilated by extractor fans. If scrubbers are used, the dust forms a sludge which is dumped at high cost.

At this foundry, the dust collected as sludge by water scrubbers is recovered by returning it to the mixer to make new moulds. A special sludge pumping system uses a centrifugal pump with a natural rubber impeller to overcome the problems associated with the abrasive properties of the sludge. The composition of the moulding material is controlled by using a highly effective and flexible electronic control and display system.

5.2 Scale of Operation: The facility has 400 employees on a 15 acre site. Over 25,000 tonnes of cast iron are melted per year using two 4MW electrical furnaces.

5.3 Stage of Development: The technology is fully implemented.

5.4 Level of Commercialization: Unknown.

5.5 Material/Energy Balances and Substitutions: The system recovers 1600 te per year of sludge.

6.0 Economics*

6.1 Investment Costs: The capital investment was 19,000 English Pounds.

6.2 Operational and Maintenance Costs: The annual savings are 84,000 English Pounds. (Material savings of 60,000 English Pounds. Reduced disposal charges of 24,000 English Pounds.)

6.3 Payback Time: 3 months.

7.0 Cleaner Production Benefits

The system recovers 99% of the moulding material and sludge generation is reduced by 1,300 m^3/year. Emissions are insignificant. Higher quality products are produced and the working environment is improved.

8.0 Obstacles, Problems and/or Known Constraints

None identified

9.0 Date Case Study Was Performed

Unknown

10.0 Contacts and Citation

10.1 Type of Source Material: Government Publication.

10.2 Citation: Clean Technology, Environmental Protection Technology Scheme, Department of the Environment, 2 Marsham Street, London SW1P 3EB, 1989, p6.

10.3 Level of Detail of the Source Material: Simple diagram of process provided.

10.4 Industry/Program Contact and Address: David Sumner, Project Engineer, Baxi Partnership, Brownedge Road, Bamber Bridge, Preston PR5 6SN, England, telephone (0772) 36201.

10.5 Abstractor Name and Address: John Houlahan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Dust, sand, clay, sludge

11.2 Process type/waste source: Iron foundry, scrubber sludge

11.3 Waste reduction technique: Recovery and reuse, sludge pump

11.4 Other keywords: United Kingdom, SIC 3322

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Dust, Sand, Clay, Sludge, Iron Foundry, Scrubber Sludge, Recovery and Reuse, Sludge Pump, United Kingdom, SIC 3322

***** DOCNO: 400-096-A-321*****

HEADLINE:	Recovery and regeneration of pickling baths reduces wastewater generation by 33% and increases recovery rate of chlorides and ferric oxide.
INDUSTRY/SIC CODE:	Iron and Steel Basic Industries/ISIC 3710
POLLUTION PREVENTION OPTIONS SUMMARY:	Chlorhydric acid pickling baths are regenerated and recycled for pickling of steel plates. The pickling baths go through a roasting oven where the chlorhydric acid is recovered, along with ferric oxide powder which is sold. Residual acid losses are neutralized and settled.
FEEDSTOCKS:	HCl - 2 kg/ton steel, lime - 1 kg, wash water - 0.2 m^3, energy (gas) -0.125 GJ.
WASTES:	Residual, used pickling baths, and washing water
MEDIUM:	Water
COSTS:	
CAPITAL COST:	25,000,000 francs (1979 franc)
OPERATION/MAINTENANCE:	4.90 francs/ton of steel
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Capital investment is increased by 21,200,000 francs, but operating costs are decreased by 5.06 francs/ton of steel. Recovered ferric oxide is sold for 1.10 franc.
FEEDSTOCK REDUCTION:	HCl requirement reduced by 18 kg/ton steel, lime is reduced by 8.5 kg, water by 0.2 m^3.
WASTE PRODUCTION:	Low waste techniques generates 0.2 m^3 of wastewater containing 0.25 chloride ions, compared to 0.3 m^3 water with 1.3 kg chloride ions with conventional technology. Ferric oxide mud is reduced from 7 to 0.6 kg.
IMPACT:	Wastewater generation is reduced by 33%, with a high recovery rate of chlorides and ferric oxide. The technique could be extended to other applications where chlorides are decomposed and recovery of metals is profitable.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Pickling Steel Plates with Chlorhydric Acid, After Hot Rolling: Recovery and Regeneration of Acid Pickling Baths", Monograph ENV/WP.2/5/Add.96.
KEYWORDS:	Steel, Pickling, Recovery, Recycling, Rinsewater, ISIC 3710

*****DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Use of acid purification unit on concentrated high temperature pickling liquor reduces iron concentration

2.0 SIC Code: ISIC 2105, Pickling Steel

3.0 Name & Location of Company:

Metal Koting
Continuous Colour Coat Ltd.
1430 Martin Grove Road
Rexdale Ont. M9W 4Y1
Canada
Phone (416) 743-7980

4.0 Clean Technology Category

Technology Principle: This technology involves the use of an acid purification unit (APU) consisting of filters and an ion exchanger to reduce iron content of the pickle acid.

5.0 Case Study Summary

5.1 Process and Waste Information: In the original pickling process, no purification of the acidic liquor was undertaken. The liquid was discarded in a continuous "bleeding" process after the "bleed" was neutralized with lime.

The new process involves use of equipment consisting of three basic pieces and one optional piece: an Eco-Tec Acid Purification Unit AP30-24 HT cartridge filter and ion exchanger, a feed pump, an Eco-Tec sand filter and an optional 400 gallon (1100 liter) water supply tank.

The pickle acid is pumped from the reservoir tank through a media filter to remove dirt and oil particles. The acid then passes through a second filter (0.5 μm) to remove very fine particulate and filter media from reaching the resin bed in an ion exchange unit. The following stage contains three steps per cycle: the water displacement stage, the byproduct (iron) removal stage, and the produce (acid) return stage.

The water displacement phase allows the pickle acid into the resin bed, displacing the water from the previous cycle. This water can be reused by sending it to the water supply tank, or sent to drain. This stage lasts approximately one minute.

The byproduct stage allows the pickle acid to continue its flow through the resin bed trapping the sulfate ions and allowing the iron to pass through to the drain. This phase also takes about one minute.

The product return phase stops the flow of acid from the reservoir and starts a counterflow of water from a pressurized source (main water line or water supply tank pump). The water picks up the sulfate ions and returns them to the tank of sulfuric acid. This stage takes about two minutes.

This three phase cycle continues automatically until the dirt build-up in the media filter causes the process to automatically shut down. A back flush procedure is necessary to clean the filter before restarting the system again. Backflushing time is approximately one hour.

Using the new process results in the reduction of the iron content of the acid solution from an initial 7.7% to a steady 2-3% during the latter half of the test period. An 89% decrease in use of sulfuric acid and lime also resulted. No new materials are introduced in the process. Since pickling uniformity is a product quality improvement, product quality is at least as good as before using the APU, but this was not quantified.

5.2 Scale of Operation: Not reported

5.3 Stage of Development: The installation is fully implemented. Data are derived from the last month of testing.

5.4 Level of Commercialization: The installation is commercially available. The vendor seems well equipped and experienced in construction and maintenance of the equipment.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Feedstock Use:		
Sulfuric acid (lbs/year)	629,089	67,558
Lime (tons/year) (Computed)	252	28

6.0 Economics*

6.1 Investment Costs: Investment costs were as follows:

Design and supply of equipment	$84,000.00
Equipment installation	$10,000.00
Start-up, supplies, etc.	$ 2,500.00
Total	$94,000.00

These costs do not include the test program nor the management personnel costs for the project.

6.2 Operational & Maintenance Costs: These costs are estimated at $2,500/year.

6.3 Payback Time: Payback time was calculated as 2.33 years. Annual savings on chemicals were calculated as $43,937. Not included in the calculations are an estimated $8,000 saved annually on sludge hauling.

7.0 Cleaner Production Benefits

Annual savings on chemicals were $25,942 for sulfuric acid and $17,995 for lime, or a total of $43,937. An estimated $8,000 were saved on sludge hauling. The project demonstrated that sulfuric acid used in preparing steel strip for electrogalvanizing could be reclaimed for continuous use.

8.0 Obstacles, Problems and/or Known Constraints

Except for some start-up problems, no other problems seem to have been encountered.

9.0 Date Case Study Was Performed: May 31, 1985 (date of source document)

10.0 Contacts and Citation

10.1 Type of Source Material: Report

10.2 Citation:

Acid Purification Unit for Use on Concentrated High Temperature Pickling Liquor (Sulfuric Acid).

10.3 Level of Detail of the Source Material: More detailed cost information is available in the source document.

10.4 Industry/Program Contact and Address:

Mr. M. Schulz
Head Training Secion
Environment Canada
3439 River Road South
Ottawa, Ontario K1 OH3
Canada
Phone (613)991-1954
Fax (613)991-1635

10.5 Abstractor Name and Address: M. Stein, RIVM, Dept. LAE, Anthonie van Leeuwenhoeklaan 1, Postbus 1, Bilthoven, Netherlands. Reformatted: Barbara M. Scharman, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords

11.1 Waste type: Pickle liquor

11.2 Process type/waste source: Steel strip

11.3 Waste reduction technique: Acid purification, ion exchange, filtration, iron reduction, acid reclamation

11.4 Other keywords: Canada

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Pickle Liquor, Steel Strip, Acid Purification, Ion Exchange, Filtration, Iron Reduction, Acid Reclamation, Canada, ISIC 2105

***** Doc # 501-016-A-000 *****

1.0 Headline: High-carbon ferrochrome smelting process cuts electric power consumption in half.

2.0 SIC Code: SIC 3313

3.0 Name and Location of Company: Shunan Denko, Japan

4.0 Clean Technology Category:

This technology involves a process modification whereby an additional process step is added prior to the ore entering the furnace.

5.0 Case Study Summary

5.1 Process and Waste Information: This plant makes high-carbon ferrochrome suitable as an addition agent in the production of stainless steel. Pellets of ore mixed with carbon are hot-charged into a closed-type electric furnace. The main feature of this technique is a pre-reduction step ahead of the furnace. Chrome ore is pelletized along with coke, binder and flux, and roasted in a rotary kiln. By pelletizing the fine, low-grade chrome ore more commonly available around the world, it is possible to use the closed-type electric furnace. This enables a substantial reduction in unit power consumption, and in pollution-abatement costs otherwise spent to control fugitive dust from handling dusty ore in the open.

5.2 Scale of Operation: A 60,000-ton/year plant uses this operation.

5.3 Stage of Development: The technology is fully implemented.

5.4 Level of Commercialization: Not reported

5.5 Material/Energy Balances and Substitutions: Energy use after the process modification is 2,000 to 2,100 kWh/ton of ferrochrome.

6.0 Economics

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Not reported

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Compared to the traditional smelting process this process cuts energy consumption by 50% and reduces dust generation by eliminating one of the ore handling steps.

8.0 Obstacles, Problems and/or Known Constraints

None were identified.

9.0 Date Case Study Was Performed

1974

10.0 Contacts and Citation

10.1 Type of Source Material: Book

10.2 Citation: Process Technology and Flowsheets, articles which appeared in Chemical Engineering over the last five years. V. Cavaseno and Staff of Chemical Engineering eds., McGraw-Hill, NY, NY, 1979. High-Carbon Ferrochrome Route Slashes Power Use, Kazuo Ichikawa. Pg. 110.

10.3 Level of Detail of the Source Material: Additional detail of each of the steps and ingredients as well as a process flowsheet are included in the article.

10.4 Industry/Program Contact and Address: Kazuo Ichikawa, Deputy Manager, Administration and planning Dept., Metals and Alloys Div. Showa Denko, K.K.

10.5 Abstractor Name and Address: John Houlahan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Ore dust

11.2 Process type/waste source: Blast furnace, ferrochrome smelting

11.3 Waste reduction technique: Pelletized ore, closed-type electric furnace

11.4 Other keywords: Japan, energy conservation

KEYWORDS: Ore Dust, Blast Furnace, Ferrochrome Smelting, Pelletized Ore, Closed-Type Electric Furnace, Japan, Energy Conservation, SIC 3313

LEATHER TANNING AND FINISHING

***** DOCNO: DOCUMENT NOT AVAILABLE (404) ***** <x>

1.0 Headline: Methane gas produced from tannery waste biomethanisation is usable for feeding boilers.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Aloy M
CTC
4 rue Hermann Frenkel
69367 Lyon Cedex 07
France
Tel: +33 78695012
Tlx:340497 F
Fax: +33 78612857

4.0 Clean Technology Category

Technology Principle: Solid waste benefits - nitrogen; Energy saving; Other environmental claims/cost of dumping saving. 75% less COD in waste. 62% less volatile and 44% less volume. 515 litres of gas (73% methane) per kg of volatile material, available for tannery boilers.

Used in: Waste treatment Energy usage.
Cleanness: Good - best available to-date. The organic matter transformation gives a lower quantity of waste for disposal. The waste is more friendly with the environment and gas is recovered.

5.0 Case Study Summary

Stage of Development: Trial / Prototype stage 1-10 estimated number of enterprises in year 2000. 1-5m sq ft of leather produced to date. Available: World First developed in: 1985

Results of Application: A mixture of liquid sludge and ground fleshings is sent to a digester with a 20 days retention time. Temperature is maintained at 35 deg C. Gas production is 615 litre of gas with 73% methane per kg of volatile matter sent to the digester. Gas, after washing and sulphide removal, is usable for feeding boilers in tanneries.

6.0 Economics

Investment Costs: Implementation costs: #1000001+

Payback Time: 4.5 years

7.0 Cleaner Production Benefits

Wastes: The elimination levels are: 75% COD; 44% dry material; 62% volatile material. Volume of waste to be disposed of can be reduced by 40%. 515 litres of gas (73% methane) per kg of volatile material, available for tannery boilers.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: High costs in investment. Technical problems of grease during cold periods.

9.0 Date Case Study was Performed: 1990

10.0 Contacts and Citations

Abstractor and Address:

Aloy M
CTC
France

Regulatory Compliance: Financial support from EEC (Project BM/185/83) and AFME (French Energy Agency).

Citation:

1. Biomethanisation des residus de tannerie: une experience industrielle, Aloy M, Mermet R & Sanejouand J, Industrie du Cuir, 1987, (5), 23-27.

2. Biomethanisation of tannery wastes : an industrial experiment, Aloy M, Mermet R & Sanejouand J, JALCA, 1989, 84, (4), 97-109.

Keywords: Leather, Tanning, Biomethanisation, Process Alternatives, Methane, Energy Reclamation

***** DOCNO: DOCUMENT NOT AVAILABLE (407) ***** <x>

1.0 Headline: Elimination of leather waste by production of ceramic pastes for paving and brickwork.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Barcelo ACO
INESCOP
PO Box 253
Poligono Industrial 'Campo Alto'
03600 Elda
Alicante
Spain
Tel:5395213
Tlx:68269
Fax:5381045

4.0 Clean Technology Category

Technology Principle: Recycled chromium; Solid waste benefits - chromium; Reduction in volume in the solid wastes. The production of a combustible carbon matrix. The production of activated carbons for use in adsorption. The production of combustible chemical products through distillation. Concentration of chromium oxide for storage and subsequent recovery.

Used in: Waste treatment.
Cleanness: Reasonable - better than other processes. It is a controlled process for the elimination of the leather wastes. It transforms the chromium compounds incorporated into the leather during tanning in chromium oxide (III) of great chemical stability. It avoids risks of contamination.

5.0 Case Study Summary

Stage of Development: Trial / Protype

Results of Application: Two ways to eliminate waste from the tanning and footwear industries.

1) Addition of small percentages (1-2%) of shredded leather to ceramic pastes for paving and exterior brickwork. This produced the occurrence of porosity due to the combustion of organic matter, and this process is therefore recommended only when special textures in the materials are required.

2) Under controlled temperature and atmospheric conditions in the inside of the suitable ovens, a carbonised material having acceptable calorific capacity, combustible chemical compounds through distillation, recovery of chromium oxide and production of activated carbons could be obtained from the leather wastes, for industrial purposes such as adsorbents.

6.0 Economics: Not reported

7.0 Cleaner Production Benefits

Reduction in volume of the solid wastes.

8.0 Obstacles, Problems and/or Known Constraints: Not reported

7.0 Cleaner Production Benefits

Wastes: Total replacement of chrome by Synektan TAL would satisfy any requirement regarding solid or liquid chrome-bearing waste. If a practical chrome offer, eg 1% Cr2O3, is retained (to maintain leather character), chrome discharges in the effluent might be approximately 10 ppm in the mixed wastestream. By optimising conditions, that level can be significantly reduced.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: No undesirable effects on the environment at present - legislation may apply Consent Limits. Post tanning steps have to be modified to take account of Al + Ti in the leather.

9.0 Date Case Study was Performed: Not reported

10.0 Contacts and Citations

Abstractor and Address: Dr. AD Covington, British Leather Confederation

Regulatory Compliance: EC supported Demonstration Project (ACE/88/UK/002/A21) currently being conducted at The British Leather Co Ltd, in collaboration with the British Leather Confederation.

Industry/Program Contact and Address: Ian Tate, ICI Colours and Fine Chemicals

Citation:

1. Tannages based on aluminium III and titanium III complexes by Covington, AD., J Amer Leather Chem Assoc, 1987 82(1)1.

2. Leather tanning process using aluminium III and titanium IV complexes by Covington, AD.

3. Proceedings IULTCS Conference, Philadelphia, USA by Tate IP, 1989.

Product code 36003
Company Information Pack

Keywords: Leather Tanning, Chromium Compounds, Chemical Alternatives, Source Reduction, Aluminum, Titanium

***** DOCNO: DOCUMENT NOT AVAILABLE (386) *****

1.0 Headline: Deliming using carbon dioxide in place of ammonium compounds and organic acids reduces odours and creates better working conditions.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Petersson M
AGA AB
S-181 81 Lidingo
Sweden
Tel:+46 8 7311000
Tlx:19820
Fax:+46 8 7652487

4.0 Clean Technology Category

Technology Principle: Alternative to ammonia; Liquid waste benefits - Bod/Cod Odour reduction; Better working conditions. (Cf 5) No ammonia odour. No lifting of sacks. Automation possible.
Used in: Beamhouse.
Cleanness: Very good - best possible. Ammonium-free process which does NOT increase COD (cf organic acids, etc).

5.0 Case Study Summary

Stage of Development: Limited commercial use 101-500 estimated number of enterprises in year 2000. 5m sq ft+ of leather produced to date.

Level of Commercialization: 2.5 years in commercial use. Available: Europe, N. America, S. America. First developed in: 1987

Results of Application: The process replaces ammonium compounds and organic acids with carbon dioxide as the deliming agent.

6.0 Economics

Investment Costs: #5001-10000

Payback Time: 1-2 years

7.0 Cleaner Production Benefits

Wastes: No ammonium / nitrogen load from the deliming step.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: H_2S formation has to be controlled. Time consumption for thick hides.

9.0 Date Case Study was Performed: Unknown

10.0 Contacts and Citations

Abstractor and Address:

Walter R
AGA AB
S-181 81 Lidingo
Sweden
Tel: +46 8 7311000
Tlx: 19820
Fax: +46 8 7652487

Industry/Program Contact and Address:

Munz KH
Vesuchsanstalt fur Lederindustrie

Citation:

1. IULTCS 20th Congress, Philadelphia, USA October 15-19, 1989.
2. Leder December 1989, p 251.
3. Leder June 1990, p 103.
4. Ind Cuir, January 1990, p 30.

Keywords: Leather, Tanning, Deliming, BOD/COD Reduction, Chemical Alternatives, Carbon Dioxide

***** DOCNO: DOCUMENT NOT AVAILABLE (387) *****

1.0 Headline: Tanning using vegetable tannins and aluminium sulphate in the same bath allows total replacement of chrome.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company: Not reported

4.0 Clean Technology Category

Technology Principle: Alternative to chromium; Liquid waste benefit - chromium; Solid waste benefits - chromium; Energy saving; Other environmental claims - chrome-free solid waste. 100% replacement of chrome.

Used in: Tanning.
Cleanness: Reasonable - better than other processes. Comparing with full vegetable tanning organic load in effluent is less. Discharges of aluminium may be subject to environmental pressure in the future.

5.0 Case Study Summary

Stage of Development: Trial / Protype stage

Level of Commercialization: First developed in: 1988

Results of Application: Total replacement of chrome with a combination of aluminium sulphate and vegetable tannins for the manufacturing of upper leather and clothing leather. The above tanning agents are added in the same bath. There is no formation of precipitation.

6.0 Economics: Not reported

7.0 Cleaner Production Benefits

Wastes: Total removal of chrome from the effluent. Reduction of vegetable tannins in effluent compared with effluent from vegetable tanned upper leather.

Feedstocks: Chrome-free solid waste. 100% replacement of chrome.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: Discharges of organic material.

9.0 Date Case Study was Performed: Unknown

10.0 Contacts and Citations

Abstractor and Address:

Pateropoulou Despina
Hellenic Leather Centre SA
Thisseos 7A
176 76 Kallithea
Athens, Greece
Tel:(01)9025595/6/7
Fax:(01)9025598

Citation:

1. Boziaris E, Tonigold L & Heidemann E: Eine unerwartete Beobachfung bei der Gerbung mit pflanzengerbstoffen Leder 39 (1988) 236-238.

2. Prof Dr E Heidemann. Institut fur Biochemie, Abtly. Eiweiss und Leder, Technische Hochschule Darmstadt.

Keywords: Leather, Tanning, Vegetable Tanning, Aluminum Sulphate, Chemical Alternatives

***** DOCNO: DOCUMENT NOT AVAILABLE (388) *****

1.0 Headline: Use of fresh hides and skins without preservatives or biocides by a beamhouse reduces water, energy, and time demands.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

4.0 Clean Technology Category

Technology Principle: Alternative to chloride; Liquid waste benefit - chloride; Solid waste benefits - chloride; Liquid waste benefits - total solids; Energy saving - 100% less salt in effluent coming from soaking 60% less water-demands for soaking 60% less required time for soaking.

Used in: Beamhouse.
Cleanness: Reasonable - better than other processes. Given that the removal of salt from liquid waste is nearly impossible, the above process is really important when the receiver is not the sea, as it happens usually in Greece. This method is not really a new technology. Some tanneries, simply, exploit the fact that these are located near slaughterhouses.

5.0 Case Study Summary

Stage of Development: -1m sq ft of leather produced to date. Available: World

Results of Application: Raw hides and skins, without any preservatives or biocides, are used in beamhouse. This rawstock needs less amount of water, and less time for soaking.

6.0 Economics: Not reported

7.0 Cleaner Production Benefits

Wastes: Total removal of salt from liquid and solid wastes coming from soaking.

Energy Use: Energy saving - 100% less salt in effluent coming from soaking 60% less water-demands for soaking 60% less required time for soaking

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: Technical problems.

9.0 Date Case Study was Performed: Unknown

10. Contacts and Citations

Abstractor and Address:

Pateropoulou Despina
EL.KE.DE. S.A.
Thisseos 7A
Kallithea 176 76
Athens
Greece
Tel:01-9025595/6/7
Fax:(01)9025598

Notes: Information is coming from tanneries which use, from time to time, Fresh raw material.

Keywords: Leather, Tanning, Chloride (Salt), Salt Removal, Source Reduction

****** DOCNO: DOCUMENT NOT AVAILABLE (389) ******

1.0 Headline: Recycling of chromium as tanning agent from the effluents of the tanning process through precipitation of chromium by adding magnesium oxide.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Van Vliet M
TNO, Leather & Shoe Research Institute
PO Box 135
5140 AC Waalwijk
Mr van Coothstraat 55
5141 ER Waalwijk
The Netherlands
Tel:0031-4160-33255
Fax:0031-4160-41735

4.0 Clean Technology Category

Technology Principle: Alternative to chromium; Recycled chromium; Better uptake of chromium - Chromium free waste-liquors. 99.9% reduction of chromium in waste Cr-liquors.

Used in: Waste treatment.
Cleanness: Very good - best possible. Almost total removal of chromium from the tanning effluents. Discharges of magnesium may be subject to environmental pressure in the future.

5.0 Case Study Summary

Stage of Development: Available: Europe

Results of Application: This technology combines the complete removal of chromium from the factory's effluents, with economic benefits which will be based on the reusual of the recovered chromium.

6.0 Economics

Payback Time: 2.5 to 3 years

7.0 Cleaner Production Benefits

Wastes: The chromium content of the effluents from the tanning process was reduced from 4000 ppm to 2 ppm, which means 99.9% reduction.

Feedstocks: Chromium free waste-liquors. 99.9% reduction of chromium in waste Cr-liquors.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: Magnesium in effluents.

9.0 Date Case Study was Performed: Unknown

10.0 Contacts and Citations

Abstractor and Address:

Barla M
Hellenic Leather Centre SA
Thisseos 7A
176 76 Kallithea
Greece
Tel:(01)9025595-6-7
Fax:(01)9025598

Industry/Program Contact and Address:

Hellenic Leather Centre SA, Thisseos 7A, 176 76 Kalli
John Germanakos Germanakos SA
Tannery 5 Leof Irinis
Agia Anna
Rentis
GR 182 33
Athens
Greece
Tel:(01)3461550

Keywords: Leather, Tanning, Chromium Recycling, Precipitation, Magnesium Oxide

***** DOCNO: DOCUMENT NOT AVAILABLE (392) *****

1.0 Headline: Fatliquoring using glue stock fat reduces waste generation and commercial fatliquor costs.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

4.0 Clean Technology Category

Technology Principle: Liquid waste benefits - grease; Solid waste benefits - grease. All fat from fleshings can be re-used. Less fatliquors have to be bought from chemical companies.

Used in: Dyeing & Fatliquoring.
Cleanness: Good - best available to-date.

5.0 Case Study Summary

Stage of Development: Research & Development (Experimental stage) 11-50 estimated number of enterprises in year 2000. Available: World

Results of Application: A process for the utilization of gluestock fat. The fat is transesterifized together with rapeseed oil using an immobilized lipese as catalyst. This transesterification lowers the melting point of the fat which makes it more suitable for fatliquoring of leather. It has been shown possible to replace up to 80% of a commercial fatliquor with this fat without any negative effect on the leather. The reaction time for the transesterification is between 4-8 hours.

6.0 Economics

Investment Costs: #1-5000

7.0 Cleaner Production Benefits

Wastes: The fat fraction from the fleshings can be reused for the fatliquoring.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: High costs

9.0 Date Case Study was Performed: Unknown

10.0 Contacts and Citations

Abstractor and Address:

Rydin S
Danish Technological Institute
Denmark

Industry/Program Contact and Address:

Rydin S
Danish Technological Institute

Citation:

1. Fatliquoring of leather using enzyme treated gluestock fat by Rydin S. Internal Report 1988.

2. Biological conversion of low grade fats by Rydin S. Licentiate Thesis, 1989.

Datasheet exists on product - but not for this application.

Keywords: Leather, Tanning, Fat Liquoring, Gluestock Fat Transesterification, Fat Recycling

***** DOCNO: DOCUMENT NOT AVAILABLE (393) *****

1.0 Headline: Incineration of chrome shavings allows extraction and reuse of chromium from ash.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

4.0 Clean Technology Category

Technology Principle: Recycled chromium

Used in: Waste treatment
Cleanness: Very good - best possible

5.0 Case Study Summary

Stage of Development: Trial / Protype stage. Available: World

Results of Application: The technique allows the combustion of chrome shavings to take place without any emission of chromium and ensures that the chromium in the ash will keep the original trivalent form and not be oxidized to hexavalent chromium. The chromium can then be extracted from the ash, 40% of which is chromium (Cr_2O_3). The incineration takes place under low oxygen - low temperature conditions.

6.0 Economics

Investment Costs: Implementation costs: #1000001+

7.0 Cleaner Production Benefits

Wastes: The chrome shavings can be re-used.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: High costs. Sensitive to changes in raw material. Needs large amount of chrome shavings.

9.0 Date Case Study was Performed: Unknown

10.0 Contacts and Citations

Abstractor and Address:

Rydin S
Danish Technological Institute
Denmark

Industry/Program Contact and Address:

Frendrup W
Danish Technological Institute

Citation: 1. Combustion of chrome shavings, Danish Technological Institute, Report 1987

Keywords: Leather, Tanning, Chromium Recycling, Incineration

***** DOCNO: DOCUMENT NOT AVAILABLE (394) *****

1.0 Headline: Chilling hides at slaughterhouses using ice reduces use and wasting of salt preservative.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Schroeder P
Hude-Centralen
Sindalsvej 8
DK-8240 Risskov
Denmark
Tel: +45 86212100
Tlx:68150

4.0 Clean Technology Category

Technology Principle: Less salt in effluent.

Used in: Rawstock
Cleanness: Reasonable - better than other processes
Technical problems in uniform chilling of the hides. If the temperature rises in any process stage because of technical problems the quality will be lower.

5.0 Case Study Summary

Stage of Development: Limited commercial use

Level of Commercialization: 2-3 years in commercial use. Available: World

Results of Application: The hides are iced directly at slaughterhouses immediately after slaughter (using 5 kg ice per hide). The ice is produced by installed ice making machines. After icing, the hides are sent overnight to Hude-centralens warehouse for grading and salting. The warehouse is refrigerated to 8 deg C in order to minimise bacterial action and preserve quality. According to Hude-centralen the shelf life of chilled unsalted hides is two weeks.

6.0 Economics

Investment Costs: Implementation costs: #1-5000

7.0 Cleaner Production Benefits

Wastes: No salt used for short-term conservation. However, at Hude-centralen most of the hides are salted before transportation to tanneries.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: Technical problems in uniform chilling of the hides. If the temperature rises in any process stage because of technical problems the quality will be lower.

9.0 Date Case Study was Performed: Unknown

10.0 Contacts and Citations

Abstractor and Address:

Rydin S Danish Technological Institute
Denmark

Industry/Program Contact and Address:

Rydin S, Danish Technological Institute

Citation:

1. Iced hides are better, Schroeder P, Leather, 1990, 192, 34-37.

2. Technical literature, Hude-centralen, Denmark.

Keywords: Leather, Tanning, Hide Preservation, Process Alternatives, Ice Chilling, Salt Use Reduction

***** DOCNO: DOCUMENT NOT AVAILABLE (395) *****

1.0 Headline: Deliming using sodium bicarbonate and hydrochloric acid reduces inorganic ammonia effluent loadings.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Heidemann E.
Technische Hochschule Darmstadt/Department of Protein and
Leather
Petersenstrasse 22
D-6100 Darmstadt
West Germany
Tel:0615/16 2175

4.0 Clean Technology Category

Technology Principle: Alternative to ammonia; Liquid waste benefit - ammonia; Liquid waste benefits - BOD/COD; Other environmental claims/deliming with CO_2. Ammonia might be reduced by 75%.

Used in: Beamhouse
Cleanness: Not so good
The cleanness of the process is good but there is a loading of sodium chloride or sodium sulphate in the effluent.

5.0 Case Study Summary

Stage of Development: Trial / Protype stage. Available: World. First developed in: 1987

Results of Application: Rapid and safe deliming process with hydrochloric acid (and other strong acids) in the presence of sodium hydrogen carbonate avoiding a pH value below 6 and without using ammonium salts.

6.0 Economics

Investment Costs: Implementation costs: #5001-10000

7.0 Cleaner Production Benefits

Wastes: Replacement of ammonia salts by sodium hydrogencarbonate and hydrochloric acid in the deliming process would reduce the effluent loading of inorganic ammonia. The reduction would be 75% ammonia. This would not satisfy the requirements. In this case the bating products must not contain ammonia salts and also no ammonia products may be used in the other processes.

8.0 Obstacles, Problems and/or Known Contraints

Problems Encountered: Undesirable effects on the environment from formation of sodium chloride or sodium sulphate. Technical problems in that an automatic adding system for the acid is required.

9.0 Date Case Study was Performed: Unknown

10.0 Contacts and Citations

Abstractor and Address:

Pauckner W
Westdeutsche Gerberschule Reutlingen
PO Box 29 44
Erwin-Seiz-Strasse 9
D-7410 Reutlingen, West Germany

Industry/Program Contact and Address:

Heideman E
Technische Hochschule Darmstadt
Dept Protein & Leather
Petersenstrasse 22
D-6100 Darmstadt
West Germany

Citation:

1. Hein A, Herrera P and Heidemann E, Leder, 1988, 39, (8), 141-145.

Keywords: Leather, Tanning, Deliming, Ammonia, Sodium Hydrogencarbonate

***** DOCNO: DOCUMENT NOT AVAILABLE (396) *****

1.0 Headline: Dyeing of leather with liquid 1:2 metal complex dyestuffs (Levaderm dyes) reduces BOD, COD, and salt content in effluent.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Traubel H
Bayer AG
ATEA-Leder
Bayerwerk
D-5090 Leverkusen
West Germany
Tel:0214 3071180
Tlx:85103-257

4.0 Clean Technology Category

Technology Principle: Liquid waste benefits - BOD/COD; It is possible to use these dyestuffs in drum, spraying and roller coating. They can be used in water and organic solvents (alcohol). They have no salts as do powder dyes and give good properties.

Used in: Dyeing & Fatliquoring
Cleanness: Reasonable - better than other processes
By using these dyestuffs, the exhaustion of the float is good. By spraying or roller coating, there are no effluents. The COD is similar.

5.0 Case Study Summary

Stage of Development: Widespread use 501+ estimated number of enterprises in year 2000. 5m sq ft+ of leather produced to date.

Level of Commercialization: 8-10 years in commercial use. Available: World

Results of Application: A new universally applicable range of liquid dyestuffs is described. The liquid dyestuffs are distinguished by good solubility in alcohols and water and by their strong bond to the leather fibers. They have only a very slight tendency to migrate by heat, solvents, water or perspiration. Good lightfastness owing to their metal complex character and high build up in the drum dyeing of different kinds of leather round off the advantage of the range.

6.0 Economics: Not reported

7.0 Cleaner Technology Benefits

By using 1:2 metal complex dyestuffs in the drum: The linking to the fiber is better, resulting in a reduction of COD in the effluent of the dyeing process. In addition, the salt content of the effluent is reduced owing to the liquid formation of the dyes.

8.0 Obstacles, Problems and/or Known Contraints

Problems Encountered: Undesirable effects on the environment due to addition of a small quantity of metals to the effluent. Several azo dyes (with carcinogenic amino components) are subject of discussions concerning the health risks.

9.0 Date Case Study was Performed: Unknown

10.0 Contacts and Citations

Abstractor and Address:

Pauckner W
Westdeutsche Gerberschule Reutlingen
PO 29 44, Erwin-Seiz-Str 9
D-7410 Reutlingen
West Germany
Tel: 07121/40056
Tlx: 729 868
Fax: 07121/4 54 93

Industry/Program Contact and Address:

Traubel H
Bayer AG
ATEA Leder
Bayerwerk
D-5090 Leverkusen
Tel: 0214/3071180
Tlx: 85103-257

Citation:

1. Westphal J, Proceedings VGCT Conference, Maastrickt, 1983.
2. Universal use of liquid metal complex dyestuffs, Westphal J, Leder, 1983, 34, 148-151/Leder Haute Markt, 1983, 29, 8-10.
3. Newer practical experiences with liquid dyestuffs in drum dyeing, Muller W and Westphal J, Leder Haute Markt, 1985, 37, 38-40 /Bayer Information for the Leather Industry, 1985.

Company information pack.

Keywords: Leather, Tanning, Leather Dyes, Metal Complex Dyestuffs, BOD/COD Reduction

***** DOCNO: DOCUMENT NOT AVAILABLE (390) *****

1.0 Headline: Partial replacement of chrome by an aluminium complex tanning agent may reduce chrome in spent tanning liquor by 90 percent.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

EL.KE.DE. S.A.
Thisseos 7A, Kallithea
176 76 Atherns
Greece
Tel:(01) 9023395/6/7
Fax:(01) 9023398

4.0 Clean Technology Category

Technology Principle: Alternative to chromium; Less chloride required; Better uptake of chromium; Solid waste benefits - chromium; Other environmental claims -Chrome-free solid by-product by pretanning for wet white. In pilot plant trials chrome in the spent tan liquor was reduced by approx 90%.

Used in: Tanning.
Cleanness: Good - best available to-date. Pretanning with aluminium complex salts not only simplifies the tanning process but reduces drastically pollution problems resulting from its combination-tanning with reduced quantities of chrome-salts. Only problem remains the future environmental pressure on aluminium discharges.

5.0 Case Study Summary

Stage of Development: Research & Development stage 11-50 estimated number of enterprises in year 2000.

Results of Application: (1) Pretanning for wet white, to reduce chrome presence both in the effluent and in the solid waste. Interesting applications of the wet white solid waste after the removal of aluminium tanning agent. (2) Partical replacement of chrome in main tannage to reduce chrome offers and aiding chrome uptake. Without changing the chrome character of the leather nevertheless improving its physicomechanical properties.

6.0 Economics: Not reported

7.0 Cleaner Production Benefits

Wastes: In pilot plant trials chrome in the spent tan liquor was reduced by approximately 90%.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: Undesirable effects - Legislation may apply consent limits. Post-tanning operations have to take into account the hardness of leather resulting from an aluminium pretanning. Corrections in fatliquoring and retannage must be modified.

9.0 Date Case Study was Performed: Unknown

10.0 Contacts and Citations

Citation:

Nikolaos Marnelakis
EL.KE.DE. S.A.
Thisseos 7a
176 76 Kallithea
Athens
Greece

Keywords: Leather, Tanning, Chemical Alternatives, Chromium, Aluminum Complex

***** DOCNO: DOCUMENT NOT AVAILABLE (397) *****

1.0 Headline: Use of titanium salt as a pretanning agent improves chrome uptake, reduces chromium in effluent, and produces chrome-free shavings.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Bagni W
Bitossi Dianella SpA
Via Pietramarina 18
I-50053 Sovigliane
Vinci
Firence
Italy
Fax: +571 50 98 87

4.0 Clean Technology Category

Technology Principle: Alternative to chromium; Less chloride required; Better uptake of chromium; Liquid waste benefit - chromium; Solid waste benefits - chromium; Other environmental claims/chrome-free solid by-products by pretanning for wet white. No chrome in solid wastes. Chrome can be reduced in the retanning.

Used in: Tanning
Cleanness: Good - best available to-date
Pretannage with titanium salts reduces the discharge of chrome in the effluent. The resulting chrome-free shavings are more suitable for versatile utilisations.

5.0 Case Study Summary

Stage of Development: Limited commercial use

Level of Commercialization: 2 years in commercial use. Available: Europe. First developed in: 1986

Results of Application: Non-chrome tanning agent useful in pretannage. All kinds of leathers were made by using 4-10% of ammonium titanyl sulphate. The received wet white can be stored for a long time without biocides. The solid wastes, eg, shavings, cuts, can be used for the production of animal feed, fertiliser and gelatine. The wet white can be retanned with chrome, vegetable and synthetic tanning agents for clothing leather, shoe upper leather, leather for leather goods and sole leather.

6.0 Economics: Not reported

7.0 Cleaner Production Benefits

Wastes: Total replacement of chrome is given in the pretanning effluents and the quantity of chrome in the retanning process can be reduced. The uptake of chrome is also better.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: Undesirable effects on the environment from ammonia in the effluent. Very low pH required at the beginning of the pretannage.

9.0 Date Case Study was Performed: Unknown

10.0 Contacts and Citations

Abstractor and Address:

Germann H-P
Westdeutsche Gerberschule Reutlingen
PO 29 44, Erwin-Seiz-Str 9
D-7410 Reutlingen
West Germany
Tel: 07121/40056
Tlx: 729 868 Fax: 07121/454 93

Citation:

1. Pauckner W, Proceedings 20th IULTCS Congress, Philadelphia, 1989.

Company information pack.

Keywords: Leather, Tanning, Chromium, Chemical Alternatives, Titanium Salt, Ammonium Titanyl Sulphate

***** DOCNO: DOCUMENT NOT AVAILABLE (399) *****

1.0 Headline: Pretannage of hides using aluminium sulphate for the production of wet white saves energy and reduces chrome in spent tan liquor by as much as 90-95%.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Heidemann E
TU Darmstadt / Dept Protein & Leather
Petersenstrabe 22
D-6100 Darmstadt
Tel:06151/16 2175

4.0 Clean Technology Category

Technology Principle: Alternative to chromium; Less chloride required; Better uptake of chromium; Liquid waste benefit - chromium; Solid waste benefits - chromium; Energy saving; Chrome free solid by-products by pretanning for wet white. Chrome in spent tan liquor might be reduced by 90-95%.

Used in: Tanning
Cleanness: Good - best available to-date
The pretannage with aluminium salt can make real reductions of discharged chrome with no current additional environmental problems. Discharges of aluminium may be subject to environmental pressure in the future.

5.0 Case Study Summary

Stage of Development: Limited commercial use 11-50 estimated number of enterprises in year 2000. 1m sq ft of leather produced to date

Level of Commercialization: 4 years in commercial use. Available: World. First developed: 1984

Results of Application: Aluminium sulphate alone or aluminium salts in combination with a polymer tanning agent are used for the preservation of pelts to yield wet white. The wet white is stable to shaving and its retanning with chrome salts results in a leather, that is stable to boiling. Using aluminium sulphate alone 8-10%, in combination with the polymer 1-2% of the aluminium salt are required respectively. In the first case it is necessary to wash out the aluminium salt with a pickle solution before the retannage with chrome or other tanning agents. In the second case the obtained wet white may be retanned immediately.

6.0 Economics

Investment Costs: Implementation costs: #5001-10000

Payback Time: 5 years

7.0 Cleaner Production Benefits

Wastes: The quantity of chrome for the retannage is smaller and a better uptake of the chrome salt is achieved. The effluent loading of chrome is reduced as compared to a normal chrome tanning and the wet white shavings are chrome-free. Chrome in spent tan liquor might be reduced by 90-95%.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: Undesirable effects on the environment - aluminium in effluent. It is not possible to get the same softness of the leather as with a chrome tannage. The wet white cannot be stored for a long time because of mold.

9.0 Date Case Study was Performed: 1990

10.0 Contacts and Citations

Abstractor and Address:

Pauckner W
Westdeutsche Gerberschule Reutlingen
Post Box 29 44
Erwin-Seiz-Str 9
D-7410 Reutlingen
Tel:07121/4 00 56
Tlx:729 868
Fax:07121/4 54 93

Industry/Program Contact and Address:

Heidemann E
TU Darmstadt/Dept Protein & Leather
Petersenstrasse 22
D-6100 Darmstadt
West Germany
Tel: 06151/16 2175

Citation:

1. Compensation of chrome by other tanning agents by Zissel A et al Leder 1980 31(2)17-24

2. Tanning with aluminia salts by Bay B et al LMH 1985(14)28

3. Production of wet white by Heidemann E et al Leder 1982 v.33 p.131-136, 1985 v.36 p170-175, 1986 v.37 p.221-224, 1987 v.38 p.71-75

4. Heidemann E & Balstros B Leder 1984 v.35 p.186-189 Lutan V (BASF), TI/P 3042 d

Company information pack

Keywords: Leather, Tanning, Pretannage, Aluminum Sulphate, Chromium Alternatives, Wet White

***** DOCNO: DOCUMENT NOT AVAILABLE (398) *****

1.0 Headline: Unhairing with enzymes and chrome tanning using the injection method (penetrator) saves chemicals and water and reduces effluent COD loads.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Petersen A
J Krause GmbH
Post Box 50 09 68
Planckstrabe 13-15
D-2000
Hamburg 50

4.0 Clean Technology Category

Technology Principle: Alternative to chromium; Less chloride required; Recycled chromium; Better uptake of chromium; Liquid waste benefit - chromium; Liquid waste benefits - BOD/COD; Better working conditions. Less COD in effluent, saving of chrome-discharge from residual tanning liquors, saving chemicals and water.

Used in: Beamhouse Tanning
Cleanness: Good - best available to-date

5.0 Case Study Summary

Stage of Development: Trial / Protype & Limited commercial use 11-50 estimated number of enterprises in year 2000.

Level of Commercialization: 1 year in commercial use. Available: Europe, N. America, Australia & NZ & Asia. First developed in: 1980.

Results of Application: The new process technology uses pressure to inject the chemicals from the flesh- or grain-side into the hides and skins. Basing on a direct recycling of the process liquors, the new method saves chemicals and water and reduces the effluent loading. The technology reduces the problem of diffusion drastically, thereby accelerating the desired process and achieving a more homogenous distribution of the chemicals inside the hides. The hides remain in the orientated position throughout the whole process, improving the possibilities of rationalization of through-feed processing.

6.0 Economics

Investment Costs: Implementation costs: #1000001 +

7.0 Cleaner Production Benefits

Wastes: COD is reduced by unhairing with enzymes and saving the hair and wool of hides and skins. The direct and continuous recirculation of the chrome liquor in the penetrator system eliminates an effluent loading in the tanning process.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: High costs initial outlay for the machine.

9.0 Date Case Study was Performed: 1990

10.0 Contacts and Citations

Abstractor and Address:

Germann HP
Westdeutsche Gerberschule Reutlingen
Post Box 29 44
Erwin-Seiz-Str 9
D-7410
Reutlingen
Tel:07121/4 00 56-58 Tlx:729 868 Fax:07121/4 54 93

Industry/Program Contact and Address:

Petersen A
See above

Citation:

1. Unhairing and tannage with the penetrator by Petersen A & Germann HP Leder 1989 40 (9) 187-191.

2. Pauckner W. Proceedings JULICS Conference Venice 1983.

3. Pauckner W. Proceedings B Lederkongress Budapest 1986.

4. Pauckner W. Proceedings Symposia Freiburg 1989.

Information pack of the machine factory

Keywords: Leather, Tanning, Chromium Recycling, Source Reduction, Chemical Injection, Unhairing, Alternative Process, BOD/COD

***** DOCNO: DOCUMENT NOT AVAILABLE (400) *****

1.0 Headline: Recycling of lime sulphide effluent using ultrafiltration reduces wastes and odor.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Aloy M
CTC (Centre Technique Cuir Chaussure Maroquinerie)
4 rue Hermann Frenkel
69367 Lyon Cedex 07
France
Tel:(33)78 69 50 12
Tlx:340 497 F
Fax:(33)78 61 28 57

4.0 Clean Technology Category

Technology Principle: Liquid waste benefit - ammonia; Recycled sulphide; Liquid waste benefits - BOD/COD; Liquid waste benefits - suspended solids; Odor reduction 90% residual sulphide recycled. 50-60% ammonia recovered as solid waste.

Used in: Beamhouse
Cleanness: Good - best available to-date
Using ultrafiltration can make very good sulphide recovery without damaging of hides and skins and giving the possibility to recover some proteins.

5.0 Case Study Summary

Stage of Development: Limited commercial use 11-50 estimated number of enterprises in year 2000. 5m sq ft+ of leather produced to date

Level of Commercialization: 10 years in commercial use. Available: World. First developed in: 1980

Results of Application: Recycling of lime sulphide effluent after ultrafiltration treatment giving two parts:

1. An ultrafiltrate (90% of the volume) containing sulphide, a little lime and a low quantity of organics.

2. A concentrate (10% of the volume) with the insoluble lime, and large quantities of organics (proteins). The ultrafiltrate can be reused for a new lime sulphide process.

6.0 Economics

Investment Costs: Implementation costs #50001-100000

Payback Time: 18 months

7.0 Cleaner Production Benefits

Wastes: COD elimination in concentrate 50 to 60%. Total nitrogen 50 to 60%. Sulphide 90% in ultrafiltrate. Odor

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: High costs and clogging of membranes with calcium hydroxide

9.0 Date Case Study was Performed: 1990

10.0 Contacts and Citations

Abstractor and Address:

Aloy M
CTC (Centre Technique Cuir Chaussure Maroquin
4 rue Hermann Frenkel
69367 Lyon Cedex 07
France
Tel:(33)78 69 50 12
Tlx:340 497
Fax:(33)78 61 28 57

Industry/Program Contact and Address:

Aloy M
CTC (Centre Technique Cuir Chaussure Maroqui
Donikian Mr
Gordon Choisy (reptile tannery)
5 rue de la Grande-Haie
77130 Montereau
France
Tel:(33)1 64 32 13 50
Tlx:211 362
Fax:(33)1 47 00 70 48

Gand Mr
Tacham (reptile tannery)
25 rue Louis Chatin
42400 Saint Chamond
France
Tel:(33)77 22 12 73

Citation:

1. Tannery and pollution by Aloy M et al CTC 1976 p.307
2. Essais en station pilote d'ultrafiltration de bains residuaires de l' industrie du cuir by Vulliermet B et al Technicuir 1976 v.6 p.94-99
3. Separation des proteines des proteines des dechets de peaux brutes par technique membrane by Dubois M et al Technicuir 1978 v.4 p.53-63

Rhone-Poulenc Membrane Division
24 Quai Paul Doumer
92408 Courbevoie Cedex
France
Tel:(33)1 47 68 08 01

Keywords: Leather, Tanning, Lime Sulphide, Recycling, BOD/COD, Ultrafiltration, Ammonia

***** DOCNO: DOCUMENT NOT AVAILABLE (401) *****

1.0 Headline: Stabilization of hides and skins using BSH (Blanc Stabilise Humide) or BSS (Blanc Stabilise Se) processes improves sorting of hides and skins and uptake of chromium while reducing solvent or chrome wastes.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Gavend G
CTC (Centre Technique Cuir Chaussure Maroquinerie
4 rue Hermann Frenkel
69367 Lyon Cedex 07
France
Tel:(33)78 69 50 12
Tlx:340 497
Fax:(33)78 61 28 57

4.0 Clean Technology Category

Technology Principle: Alternative to chromium; Less chloride required; Better uptake of chromium; Solid waste benefits - chromium; Alternative to solvents; Less solvents required; Liquid waste benefit - solvents; Liquid waste benefits - BOD/COD; Odor reduction; Better working conditions; Chrome free by-product. 10-15% better uptake chrome in tanning process. No solvent for sheep skin degreasing.

Used in: Beamhouse, Tanning & Other
Cleanness: Good - best available to-date
BSH process can make important reduction in chrome wastes (solid and liquid). Better valorization is possible in comparison with chrome solid waste (shavings). BSS process gives the possibility of solvent-free, or "freon"-free degreasing. BSH and BSS improve the sorting of hides and skins.

5.0 Case Study Summary

Stage of Development: Widespread use 51-100 estimated number of enterprises in year 2000 5m sq ft+ of leather produced to date

Level of Commercialization: 3 years in commercial use. Available: Europe, N. America, Australia & NZ & Asia. First developed in: 1986

Results of Application: Stage of preparation of hides and skins which presents: - potential diversification of the pickle without the acidity - stability of the wet blue without the problem of chrome use. It is a non-chrome process using the low tanning effect of complexed aluminum salts.

6.0 Economics: Not reported

7.0 Cleaner Technology Benefits

Wastes: Utilization of chrome tanning on BSH increases the fixation of about 10-15% of Cr_2O_3. Splitting and shaving of BSH give the possibility of considerable reduction of chrome solid wastes in tanneries. Degreasing of BSS is possible with water only and some surfactants. Chrome free by-product. 10-15% better uptake chrome in tanning process. No solvent for sheep skin degreasing.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: Undesirable effects on the environment - possibly in the future (Aluminium)

9.0 Date Case Study was Performed: 1990

10.0 Contacts and Citations

Abstractor and Address:

Gavend G
CTC (Centre Technique Cuir Chaussure Maroq
4 rue Hermann Frenkel
69367 Lyon Cedex 07
France
Tel:(33)78 69 50 12
Tlx:340 497 Fax:(33)78 61 28 57

Industry/Program Contact and Address:

Balas A
Tanneries Grosjean
88160 Le Thillot
France
Tel:(33)29 25 00 07
Tlx:960 193
Fax:(33)29 25 81 29

Citation:

1. Bleu ou Blanc by Balas A. Industrie du Cuir 1988 (8802) p.27-29.
2. Elimination of salt pollution : Coupling of cooling of hides and wet white technology by Vulliermet B & Gavend G. JSLTC 1988 72 2 p.68-72.
3. Nouvelle matiere premiere pour l'industrie du cuir, le BSS - Aspects fondamentaux by Haran R & Gervais-Lugan M. Industrie du Cuir 1989 (8901) p.28-32

Regulatory Compliance: CTC Patent n deg 87-02035 du 11/oc/1987

Keywords: Leather, Tanning, Chromium, Chemical Alternatives, Stabilization, COD/BOD

***** DOCNO: DOCUMENT NOT AVAILABLE (402) *****

1.0 Headline: Chilling of fresh (bovine) hides using cold air reduces salt in waste by 50%.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Gavend G
Centre Technique Cuir Chaussure Maroguinerie
4 rue Hermann Frenkel
69367 Lyon Cedex 07
France
Tel:+33 78695012
Tlx:340497
Fax:+33 78612857

4.0 Clean Technology Category

Technology Principle: Alternative to chloride; Liquid waste benefit - chloride; Solid waste benefits - chloride; Alternative to biocide; Liquid waste benefit - biocide; Liquid waste benefits - total solids; Odor reduction; Better working conditions; About 50% less chloride in effluents.

Used in: Rawstock
Cleanness: Good - best available to-date
Hides are free of salt or other chemicals and the possibility of valorization of by-products is better. It is possible to have a specific enzymatic process at the beamhouse stage (sulphide free unhairing systems on chilled hides).

5.0 Case Study Summary

Stage of Development: Limited commercial use 11-50 estimated number of enterprises in year 2000. 1-5m sq ft of leather produced to date

Level of Commercialization: 5 years in commercial use. Available: Europe, N. America, Australia & NZ.
First developed in: 1988

Results of Application: Preservation of fresh hides using cold air system with the possibility of antiseptic additives (level 2 degrees C to +2 degrees C). Optimization of manipulation of fresh and chilled hides, with diminution of labor costs. Adaptation and simplification of beamhouse process.

6.0 Economics

Investment Costs: Implementation costs: #10001-50000

Payback Time: 2 years

7.0 Cleaner Technology Benefits

Wastes: Suppression of salt in waste of curing units (liquid and solid). Important diminution of salt pollution in tanneries (about 50 to 60%).

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: Technical problems

9.0 Date Case Study was Performed: 1990

10.0 Contacts and Citations

Abstractor and Address:

Gavend G
CTC
France
Haefele C
4 rue Hermann Frenkel
69367 Lyon Cedex 07
France
Tel: +33 78695012
Tlx:340497
Fax: +33 78612857

Citation:

1. Elimination of salt pollution: coupling of cooling of hides and wet white technology, Vulliermet B & Gavend G, JSLTC, 1988, 72, (2), 68-72.

2. The OCS chiller, Mattson G & Tomoser T, Leather Manufacturer, 1988, 4, 24-26

Keywords: Leather, Tanning, Process Alternatives, Hide Chilling, Waste Reduction, Chloride (Salt)

***** DOCNO: DOCUMENT NOT AVAILABLE (403) *****

1.0 Headline: Finishing leather using ICC (Instant Colour Concept) process improves efficient use and reduces wasting of chemicals.

2.0 ISIC Code: Not provided

3.0 Name and Location of Company:

Gavend G
CTC
4 rue Hermann Frenkel
69367 Lyon Cedex 07
France
Tel:+33 78695012
Tlx:340497
Fax:+33 78612857

4.0 Clean Technology Category

Technology Principle: Alternative to solvents; Liquid waste benefit - solvents; Liquid waste benefits - BOD/COD; Odor reduction; Energy saving; Better working conditions; Other environmental claims/air pollution decrease. Non-solvent finishing. Nearly 100% use of finishing materials.

Used in: Finishing Energy usage
Cleanness: Good - best available to-date
Utilization of ICC process allows the best utilization of chemicals (no waste). It is a solvent free process.

5.0 Case Study Summary

Stage of Development: Limited commercial use 51-100 estimated number of enterprises in year 2000. -1m sq ft of leather produced to date

Level of Commercialization: 2.5 years in commercial use. Available: Europe, N. America, Australia & NZ, S. America. First developed in: 1987

Results of Application: Process of finishing of leather using UV reticulation of specific chemicals (UV curable polymers). This process is specially adapted for finishing of leather precuts for shoe manufacturing.

6.0 Economics

Investment Costs: Implementation costs: #50001-100000

Payback Time: 2 years

7.0 Cleaner Technology Benefits

Wastes: Total suppression of solvent emissions in the air. All the chemicals disposed on the leather are transformed in a finishing film after UV curing. Air pollution decrease. Non-solvent finishing. Nearly 100% use of finishing materials.

8.0 Obstacles, Problems and/or Known Constraints

Problems Encountered: Technical problems. Choice of finishes.

9.0 Date Case Study was Performed: 1990

10.0 Contacts and Citations

Abstractor and Address:

Gavend G
CTC
France

Industry/Program Contact and Address:

Vitteau B
CTC

Citation:

1. The challenge of ICC (Instant Colour Concept). Zero stock level and zero delay, by Vulliermet B, Vitteau B & Gavend G, Proc IULTCS Conf, Philadelphia, 1989, L-14.

2. Le challenge d'ICC - Zero stock, zero delai, by Vitteau B, Gavend G & Vulliermet B, Industrie du Cuir, 1988, 8807, 81-83.

CTC Patent No 87 09163, January 23, 1987.

Keywords: Leather, Tanning, Leather Finishing, Alternative Chemicals, Solvent, Ultraviolet (UV) Curable Polymers, Air Emissions

1.0 Headline: New tanning process reduces chromium use and waste in the leather tanning industry

2.0 SIC Code: Leather Tanning and Finishing/3111

3.0 Name and Location of Company:

British Leather Company
Tranmere Tannery
Birkenhead L41 9BS, England

4.0 Clean Technology Category: The tanning process was modified by using a two-stage process and metal combinations to allow a smaller amount of chromium to be used.

5.0 Case Study Summary

5.1 Process and Waste Information: The level of trivalent chromium normally used as a tanning agent for high quality leather is between 4-5 percent by weight. With even the most efficient processing some 30% of the chrome offered to the hide is left in the tanning liquor.

The new technology employs a two stage tanning process. The first stage uses the ICI 'TAL' process: the liquor is based on titanium, aluminum and magnesium. In the second stage, a chromium tan is used with 9 percent chromium instead of the normal 17 percent chromium. This results in a leather with a chromium content of about 3 percent but with characteristics comparable to traditional leather.

5.2 Scale of Operation: The company employs over 300 people at two tanneries and processes about 6,000 hides per week.

5.3 Stage of Development: The technology is fully operational.

5.4 Level of Commercialization: The technology is commercially available.

5.5 Material/Energy Balances and Substitutions: The technology reduces the chromium content of the spent liquor from 1,200 to 350 ppm and the level in the final effluent to 10 ppm.

6.0 Economics*

6.1 Investment Costs: Considerable research was carried out to identify the optimum tanning properties of the various combinations of metals used in the first stage of the process. No new capital equipment or investment is needed and the technology can be used with the existing plant.

6.2 Operational and Maintenance Costs: The company saved 160,000 English Pounds that it would have cost to install the wastewater treatment equipment required to achieve the same chromium effluent concentration achieved by the process change. A modest savings in tanning reagent costs is reported.

6.3 Payback Time: No information provided.

7.0 Cleaner Production Benefits

The main incentive to develop the new technology was an anticipated tightening of future wastewater discharge standards. The chromium level in the discharge is substantially reduced by this technology.

8.0 Obstacles, Problems and/or Known Constraints

None reported

9.0 Date Case Study Was Performed

Unknown

10.0 Contacts and Citation

10.1 Type of Source Material: Government Publication.

10.2 Citation: Clean Technology, Environmental Protection Technology Scheme, Department of the Environment, 2 Marsham Street, London SW1P 3EB, 1989, p4.

10.3 Level of Detail of the Source Material: Simple diagram of process provided.

10.4 Industry/Program Contact and Address: Arthur Jones, Production Director, The British Leather Co. Ltd, Tranmere Tannery, Birkenhead L41 9BS, England, Telephone (051) 647-6252.

10.5 Abstractor Name and Address: John Houlahan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Chromium wastes, spent tanning liquor

11.2 Process type/waste source: Tanning

11.3 Waste reduction technique: Process modification, source reduction, raw material substitution

11.4 Other keywords: United Kingdom, SIC 3111

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Chromium Wastes, Spent Tanning Liquor, Tanning, Process Modification, Source Reduction, Raw Material Substitution, United Kingdom, SIC 3111

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Chrome Recovery and Recycling in the Leather Industry Using Precipitation Technology

2.0 SIC/ISIC Code: 3111

3.0 Name and Location of Company:

Germanakos SA, near Athens, Greece

4.0 Clean Technology Category: Tanning of animal hides is performed with chromium sulfate at a pH of 3.5-4.0. This technology uses pH adjustment of the spent chrome tanning solution with magnesium oxide to a pH of 8.0 to precipitate chromium. This precipitate is then dissolved in concentrated sulfuric acid at a pH of 2.5. The liquor is now available for reuse in the tanning process.

5.0 Case Study Summary:

5.1 Process and Waste Information: Tanning of animal hides is a process that uses trivalent chromium to turn the hides into a stable material. Approximately 20-40 percent of the chromium used in the tanning process is discharged into wastewaters. However, recent limits for discharge have limited chromium discharge to as low as 2 mg/l in the wastewater discharge. Using the new process, 95-98 percent of the waste chromium can now be recycled.

5.2 Scale of Operation: Full-scale operation processing 2,200 tons of good quality upper leathers per year.

5.3 Stage of Development: Fully scale Research and Development project.

5.4 Level of Commercialization: This technology was developed by the Toegepast Natuurwetenschappelijk Ondersoek (TNO), the Netherlands organization for applied scientific research and carried out by their Institute of Environmental and Energy Technology.

6.0 Economics*

6.1 Investment Costs: $40,000 US includes a collection pit and a treatment tank with a stirrer.

6.2 Operational and Maintenance Costs: $30,200 US annual operating costs but provides an annual savings of $73,750 US for a total net savings of $43,150 per year.

6.3 Payback Time: 11 Months.

7.0 Pollution Prevention Benefits

Implementation of the recovery and reuse technology requires very little change to the existing production process and provides more consistent product quality. Also, this technology allows for easier water and chemical monitoring and a much reduced chromium content in the effluent discharge.

8.0 Obstacles, Problems, and/or Known Constraints

None Identified.

9.0 Date Case Study Was Performed: 1988-1990.

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "Chrome Recovery and Recycling in the Leather Industry," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: Mr. D. Papakonstantinou, General Manager, Hellenic Leather Center SA, Thiseos 7a Street, 17676 Kallithea, Athens, Greece, Tel: +30 1 9025 595

Mr. Rob Glaser, Inspector International Affairs, Ministry of Housing, Physical Planning and Environment, P.O. Box 7073 4330 GB, Middleburg, The Netherlands, Tel: +31 1180 33792

Mr. M van Vliet (Ex TNO), British Leather Confederation, Kings Park Road Moulton Park, Northampton NN3 1JD UK, Tel: +44 604 494131

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Wastewater

11.2 Process Type/Waste Source: Chromium leather tanning

11.3 Waste Reduction Techniques: Recovery, Reuse

11.4 Other Keywords: Greece

11.5 Country Code:

12.0 Assumptions

None.

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wastewater, Chromium leather tanning, Recovery, Reuse, Greece

***** DOCNO: 400-054-A-241 *****

HEADLINE:	Trivalent chromium recovered from effluent and reused in tanning process.
INDUSTRY/SIC CODE:	Manufacture of Leather/SIC 3111
NAME/CONTACT:	Institute for Leather and Shoe Research/tonNO; Ministry of Public Health and Environmental Protection of the Netherlands
TECHNOLOGY DESCRIPTION:	The company removes trivalent chromium from the effluent and re-uses it in the tanning process. The mean concentration of chromium (III) in the effluent is 5 kg/m^3. This effluent is treated with MgO, producing a fast-settling and compact precipitate, $Cr(OH)_3$. The chromium (III) concentration in the effluent is thus reduced to 2 g/m^3 (a reduction of more than 99 percent). The $Cr(OH)_3$ is then dissolved in sulfuric acid for re-use in the tanning process.
FEEDSTOCKS:	Tanning process effluents containing chromium (III), sodium sulfate, sodium chloride, and organic salts.
Wastes:	Effluent containing 1 g/m^3 trivalent chromium, 40 kg sludge/ton of hide material generated on sand filters.
MEDIUM:	Aqueous
COST:	Not reported
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	The advantages of the technology include a less pollution effluent and a 40 percent saving in the chromium required for tanning.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Recovery and Re-Use of Trivalent Chromium in the Leather Tanning Industry", Monograph ENV/WP.2/5/Add.54.
KEYWORDS:	Leather Tanning, Chromium, Precipitation, SIC 3111

METAL PRODUCTS MANUFACTURING

Hardening
Machining
Pickling
Painting

***** DOCNO: 400-071-A-308*****

HEADLINE:	Spinning rings hardened on a fluidized bed dry process eliminates waste production.
INDUSTRY/SIC CODE:	Manufacture of Metal Products, Machinery and Equipment/ISIC 38
POLLUTION PREVENTION OPTIONS SUMMARY:	This audit of manufacturer of spinning rings, used in the textile industry, suggests that by replacing the conventional cyanurated salts bath followed by rapid oil cooling hardening process with a dry process on a fluidized bed there is almost no waste generated. Baskets containing parts to be hardened are dipped into a fluidized bath of nitrogen and corundum particles at temperature between 840 and 860 degrees C. Baskets are then dipped into another fluidized bath at 50 degrees C. Corundum left on processed parts is recovered and recycled.
FEEDSTOCKS:	0.4 kg of corundum, 25 m^3 of nitrogen and 0.63 GJ of electricity per 1000 spinning rings.
WASTES:	Negligible amount of dust
MEDIUM:	Fluidized bath of nitrogen and corundum particles
COST:	(Annual production of 300,000 spinning rings)
CAPITAL COST:	FF 185,000 (1979 figures)
OPERATION/MAINTENANCE:	60% of the O&M costs for the standard technology (excluding treatment plant operating costs).
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	FF 125,000 (1979 figures, including the capital cost for the treatment plant).
FEEDSTOCK REDUCTION:	Corundum left on processed parts is recovered and recycled.
WASTE PRODUCTION:	The polluting wastes generated by the standard technology: used cyanurated salts, oil fumes, and rinse water at a pH of 12.5 (3.5 m^3 per 1,000 rings, containing 75 Equitox) are completely eliminated.
IMPACT:	This technology is more flexible in its application than the standard technology.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Hardening of Spinning Rings by a Dry Process on a Fluidized Bed", Monograph ENV/WP.2/5/Add.71.
KEYWORDS:	Textiles, Metal Hardening, ISIC 38, Fluidized Bed, Corundum, Recovery, Recycling

***** DOCNO: 400-008-A-199 ***** <x>

HEADLINE:	Energy saved by use of Zinquench process.
INDUSTRY/SIC CODE:	Hardening and Zinc-Coating of High-Strength Bolts, Chains and Wire Components/ISIC 3710
NAME/CONTACT:	Oy Navire Ab, SF-21600 Parainen, Finland Mr. Pentti Sippola
TECHNOLOGY DESCRIPTION:	The Zinquench process is a continuous hardening and zinc-coating process. In the Zinquench process the main stages are (1) austenitizing at normal hardening temperature (approx. 900° C), (2) quenching in zinc bath where the hot-dip coating simultaneously takes place at 400° C, (3) centrifuging and finally (4) water cooling.
FEEDSTOCKS:	
WASTES:	Not reported
MEDIUM:	Not reported
COST:	
CAPITAL COST:	$900,000
OPERATION/MAINTENANCE:	$115/g
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DIRECT COST:	$95/g
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	The process saves energy. Only about 40 per cent of the energy for conventional technology is needed (60 per cent energy savings). These savings result from the tempering furnace not being used in the process and the zinc bath not requiring a constant heat supply.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Continuous Hardening and Zinc-Coating (Zinquench)", Monograph Env/WP.2/5/Add.8
KEYWORDS:	Metal Hardening, Zinc Galvanization, Metal Treating, Zincquench, ISIC 3710.

***** DOCNO: 400-072-A-309*****

<x>

HEADLINE:	Ultrafiltration of spent cutting fluids allows reuse of oil and reduces disposal volume of spent oils.
INDUSTRY/SIC CODE:	Manufacture of Metal Products, Machinery and Equipment/ISIC 38
POLLUTION PREVENTION OPTIONS SUMMARY:	Ultrafiltration may be used to reduce the volume of spent cutting fluids generated from cold machining. The spent cutting fluids are first processed through a magnetic filter and a paper filter before ultrafiltration. The latter process ensures filtration at the molecular level because molecules of pollutants are generally larger than those of active products. The filtrate is then submitted to a quality test. If highly contaminated, the filtrate is incinerated. If not, it is recycled. The standard process does not include ultrafiltration.
FEEDSTOCKS:	Spent cutting fluids
WASTES:	Filtration solids, filtrate (if highly contaminated)
MEDIUM:	Spent fluids
COST:	
CAPITAL COST:	FF 200,000 (1976 figures)
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	FF 142,700 per year (1980 figures)
FEEDSTOCK REDUCTION:	476 m^3 of cutting fluids with the low-waste technology (versus 993 m^3)
WASTE PRODUCTION:	Eliminates disposal of 24 m^3 of cutting fluid.
IMPACT:	The volume of filtrate to be incinerated is reduced.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Cold Machining with Recycling of Cutting Fluids after Ultrafiltration", Monograph ENV/WP.2/5/Add.72
KEYWORDS:	Machining, ISIC 38, Ultrafiltration, Recycling, Cutting Oil

***** DOCNO: 400-036-A-225 *****

HEADLINE:	Rinse waters reused and need to detoxify nitric acid baths eliminated in etching process.
INDUSTRY/SIC CODE:	Manufacturing of Metal Objects, Machines and Material/ISIC 3819
NAME/CONTACT:	Ministere de l'Environnement et du Cadre de Vie Direction de la Prevention des Pollutions 14, Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	In the low pollution technique, the brass parts to be treated are first placed in a vibration apparatus with abrasive glass marbles and slightly acid additive. After rinsing, the parts are placed in a second apparatus for etching with steel balls and basic additive, then they are dried.
FEEDSTOCKS:	Brass parts
WASTES:	The wastes produced by the low pollution process are made of used baths of acid reagents, which are sent for detoxification. The rinse water is mixed with the baths of basic reagents. The mixture is then stored for pH control, filtered to eliminate heavy particles, and sent back into the circuit.
MEDIUM:	Water, Air
COST:	(1979 Francs)
CAPITAL COST:	F 265,000
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	The low pollution technique eliminates the need to detoxify nitric acid baths, perform soda neutralization of nitric vapor, and treat rinse waters
IMPACT:	Not reported
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Descaling of Metal Objects by means of Vibration/Abrasion", Monograph ENV/WP.2/5/Add.36.
KEYWORDS:	Process Change, Abrasive Cleaning, ISIC 3819

***** DOCNO: 400-097-A-322*****

HEADLINE:	Regeneration and copper recovery of sulfuric acid pickling baths is accomplished by recycling the rinse water back to the copper pickling process instead of detoxication.
INDUSTRY/ISIC CODE:	Non-ferrous Metal Basic Industries/ISIC 3720
POLLUTION PREVENTION OPTIONS SUMMARY:	Regeneration and copper recovery of sulfuric acid pickling baths is accomplished in a continuous electrolysis process. Part of the rinsing water is recycled to the copper pickling process, and the remaining part is detoxicated. Current technology requires detoxication of the chemical baths and all of the rinsewaters.
FEEDSTOCKS:	Electrical energy - 3.2 MJ, Sulfuric acid
WASTES:	Rinse water containing 40 g of copper and 50 g of free acid per ton of copper
MEDIUM:	Water
COSTS:	
CAPITAL COST:	140,000 francs (1977 franc) for pickling 12,000 tons of copper
OPERATION/MAINTENANCE:	Additional operating expenses are considerable lower than revenues from selling the copper, and savings in sulfuric acid and running cleaner operations
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Revenues from sales of 200 g of copper/ton processed
FEEDSTOCK REDUCTION:	Reduction in sulfuric acid requirements
WASTE PRODUCTION:	Rinse water is reduced in volume, copper content is reduced by 210 g, and free acid is reduced by 450 g
IMPACT:	This recycling technology significantly limits the volume of wastes requiring detoxication while recovering sulfuric acid feed, and copper for resale.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Pickling of Copper Parts: Electrolysis of Used Pickling Baths", Monograph ENV/WP.2/5/Add.97.
KEYWORDS:	Nonferrous Metal, Pickling, Recycling, Electrolysis, ISIC 3720

***** DOCNO: 450-003-A-358*****

HEADLINE:	Moyer Diebal replaced liquid paint system with powder coating process, eliminated paint sludge, and reduced energy consumption.
INDUSTRY/SIC CODE:	Machinery/ISIC 38
NAME/CONTACT:	Moyer Diebel Jordon, Ontario G. Evans
POLLUTION PREVENTION OPTIONS SUMMARY:	An automated powder coating process is used in a small paint line in the manufacture of vending machines. It was found that the powder coating sticks better and requires less cleaning. As a result, the company was able to reduce its 4-stage prewash system to 3 stages. An efficient overspray system allows for 95-99% of the 5,000 lbs of powder used each month to be used for coating. Thus, the company does not accumulate paint sludge wastes.
FEEDSTOCKS:	Powder coating
WASTES:	Waste feed materials, rinsewater
MEDIUM:	Powder, sludge
COST:	
CAPITAL COST:	$280,000
OPERATION/MAINTENANCE:	15% lower than a liquid paint line.
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Not reported
FEEDSTOCK REDUCTION:	Reduced paint requirements due to improved efficiency, 35% less energy required.
WASTE PRODUCTION:	Reduction in prewash stages reduces wastewaters, efficient powder use eliminates paint sludge.
IMPACT:	A more efficient, dry powder paint line allows for reduced raw material requirements and reduced waste generation.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects", Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 58.
KEYWORDS:	Paint, Coating, ISIC 38

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Waste Reduction in Steelwork Painting Using Airless Spray and Pressure Atomized Electrostatic Spray Paint Systems

2.0 SIC/ISIC Code:

3.0 Name and Location of Company:

Ostrowiec Steelworks, Poland

4.0 Clean Technology Category: The facility evaluated the improved efficiency of using airless spray and pressure atomized electrostatic spray paint systems over the existing air atomized system. The efficiency of painting improved from 30-50 percent to 85-90 percent for the pressure atomized electrostatic spraying. Implementation of the more efficient painting operation reduces waste disposal and raw material purchases.

5.0 Case Study Summary:

5.1 Process and Waste Information: The facility originally carried out painting operations using an air-atomized spray system that has the lowest transfer efficiency of the coating methods and yields large quantities of waste. The facility conducted a pollution prevention audit to reduce the quantity of wastes and costs of painting by a combination of improvements to the technology and good housekeeping. The facility also wanted to improve the quality of the coating and to reduce the amount of paint raw material. Comparison of the existing air-atomized painting system with two more efficient methods (airless spray and pressure atomized electrostatic spray) identified more efficient methods for applying paint.

5.2 Scale of Operation: Not Provided.

5.3 Stage of Development: The two spray systems were tested at a full-scale steel manufacturing facility.

5.4 Level of Commercialization: The airless spray and pressure atomized electrostatic spray systems are readily available.

5.5 Material/Energy Balances and Substitutions:

	Air-atomized spray	Airless Spray	Pressure Atomized Electrostatic Spray
Paints	8.0 m^3	6.8 m^3	5.6 m^3
Solvents	6.5 m^3	1.6 m^3	1.6 m^3
Wastes	2,400 kg	1,400 kg	500 kg

6.0 Economics*

6.1 Investment Costs: The capital investment of the airless spray system is about US$4,800 while the pressure atomized electrostatic spray system is about US$13,000.

6.2 Operational and Maintenance Costs: The cost savings from implementing the airless spray system is about US$38,500 a year and US$39,400 for the pressure atomized electrostatic spray system.

6.3 Payback Time: 1.5 months for the airless spray system and 4 months for the pressure atomized electrostatic spray system.

7.0 Pollution Prevention Benefits

Modification to a higher efficiency painting operation reduces waste disposal costs, reduces operating costs, decreases financial liability of hazardous waste management, improves public perception and acceptance in the business community, and also indicated potential reductions in the effluent concentrations of about 45 percent for sludge and 75 percent for organic solvents.

8.0 Obstacles, Problems, and/or Known Constraints

None Specified.

9.0 Date Case Study Was Performed: Not Identified.

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "Waste Reduction in Steelwork Painting," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: Mrs Lucyna Chrzanowska, Steelworks 'Ostrowiec', ul Swietokrzyska, 27-400 Ostrowiec Swietokrzski, Poland, Tel: +48 472 528 81

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Paint waste

11.2 Process Type/Waste Source: Painting, Iron and Steel

11.3 Waste Reduction Techniques: Process Modification

11.4 Other Keywords: Airless paint spray, Pressure atomized electrostatic paint spray

11.5 Country Code:

12.0 Assumptions

None.

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Paint waste, Painting, Iron and Steel, Process Modification, Airless paint spray, Pressure atomized electrostatic paint spray

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Minimization of Organic Solvents in Degreasing Using Alkaline Cleaners and in Painting of Metal Parts Using Electrostatic Powder Painting

2.0 SIC/ISIC Code:

3.0 Name and Location of Company:

Thorn Jarnkonst, Sweden

4.0 Clean Technology Category: Thorn Jarnkonst implemented two changes to provide for cleaner production. First, the plant installed a five stage washing/phosphating unit to degrease the metal parts and prepare the surface for painting. The degreasing is carried out in a tunnel 30 meters long with the metal parts suspended from an overhead conveyor and then passed through five zones where they are sprayed with an alkaline degreaser, a water rinse, an iron phosphate solution, another water rinse, and a deionized water rinse. The liquid runs off the metal parts and into tanks below where it is recirculated back to the spray nozzles. Second, the plant installed an electrostatic powder painting unit using polymer based paints that do not have any solvent in their formulation. The system has twelve automatic powder guns. The paint is positively charged relative to the metal parts. Now only 5 percent of the colors have organic solvents and are used only for the painting of short production runs in special colors or for retouching of the automatically sprayed items. Manual spraying is carried out in a ventilated booth fitted with two electrostatic guns.

5.0 Case Study Summary:

5.1 Process and Waste Information: Thorn makes light fittings from aluminum or steel sheets. Metal working, degreasing, and painting are the main phases of the production process. In the past, degreasing was performed using trichloroethylene. The painting plant consisted of an automatic lacquer line, with different colors using different organic solvents. The plant determined that adequate degreasing could be achieved using an alkaline cleaning process while electrostatic painting could be used for coating the metal parts. In addition, color changes were simplified using whole modules with containers of different colors.

5.2 Scale of Operation: Not Provided.

5.3 Stage of Development: These practices are fully implemented at the Thorn Jarnkonst facility.

5.4 Level of Commercialization: The 5-stage degreasing equipment is available from Br Michaelsen AB, Kunglav, Sweden. The automatic powder painting equipment is available from Gema-Volstatic AG, St Gallen, Switzerland. The manual powder painting equipment is available from Eisenmann AG, Boblingen, Germany.

5.5 Material/Energy Balances and Substitutions: The facility went from emitting 11 tons of trichloroethylene to the air and 5 tons of trichloroethylene sludge from the degreasing operations to less than 2 tons of sludge and no air emissions. The modification of the painting techniques resulted in the reduction of organic solvent air emissions from 65 tons to 7 tons a year and reduced hazardous waste generation from 10 m^3 solvents, 47 tons color residue, and less than one-half ton of powder residue to 2 m^3 solvent, 0.2 tons color residue, and 3 tons of powder residue.

6.0 Economics*

6.1 Investment Costs: Capital investment costs amounted to US$430,000. This includes the 5-stage degreasing and the electrostatic painting equipment.

6.2 Operational and Maintenance Costs: The alkaline degreasing operation is US$25,000 a year cheaper than the trichloroethylene degreasing system and did not require the installation of recovery equipment. The powder painting techniques have provided the following cost savings: paint-$206,000, cleaning-$62,000, disposal-$47,000, pumping-$33,000, and labor-$112,000.

6.3 Payback Time: 11 months for the powder painting operation.

7.0 Pollution Prevention Benefits

The elimination of solvent degreasing reduces both air emissions and hazardous waste generation. The changed painting technique provides a large reduction of the discharge of organic solvents, reduction of hazardous waste, improved work environment, and the ability to expand production without conflicting with environmental demands.

8.0 Obstacles, Problems, and/or Known Constraints

None Identified.

9.0 Date Case Study Was Performed: Not Specified.

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "Minimisation of Organic Solvents in Degreasing and Painting," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: Egon Conradi/Lars Blomqvist, Thorn Jarnkonst AB, P O Box 305, S-261 23 Landskrona, Sweden, Tel: +46 418 52000

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Air emission, hazardous waste

11.2 Process Type/Waste Source: Organic solvent degreasing, organic painting solvents

11.3 Waste Reduction Techniques: Process modification, Material substitution

11.4 Other Keywords: Electrostatic powder painting, Alkaline degreasing

11.5 Country Code:

12.0 Assumptions

None.

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Air Emissions, Hazardous Waste, Organic Solvent Degreasing, Organic Painting Solvents, Process Modification, Material Substitution, Electrostatic Powder Painting, Alkaline Degreasing

***** DOCNO: 400-032-A-221 *****

HEADLINE:	Solvent recovery using activated carbon and steam cleaning.
INDUSTRY/SIC CODE:	Manufacturing of Metal Products, Machines and Material/ISIC 3819
NAME/CONTACT:	Ministere de l'Environnement et due Cadre de Vie Direction de la Prevention des Pollutions 14, Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	The facility is involved with priming and lacquering aluminum foil. In the low pollution technique, the solvent vapors emitted during the hot air drying of the lacquer are recovered with activated carbon. The activated carbon, in a second operation, is steam cleaned. The solvent vapor and water vapor mix is sent into a distilling column after condensation. After condensation, the solvents obtained are recycled to the workroom where the lacquer is prepared. In the standard process, the solvent vapors from the drying of the lacquer are discharged directly into the atmosphere without treatment. This is the first industrial application of the recovery of ketonic solvent vapors, generally considered as a difficult procedure. As the technical results were positive as far as the reduction of pollution is concerned and the economic results should be satisfactory given the expected increase in the prices of petroleum based solvents, the use of this process should be extended to activities employing the same types of products.
FEEDSTOCKS:	Solvent vapors
WASTES:	The waste produced is made up of ketonic and ethylic solvent vapors.
MEDIUM:	Air
COST: CAPITAL COST: OPERATION/MAINTENANCE: MONTHS TO RECOVER:	(1978 Francs) F 3.85 million Not reported Not reported
SAVINGS: DIRECT COST: FEEDSTOCK REDUCTION: WASTE PRODUCTION:	Not reported Not reported Virgin solvent requirements reduced by a factor of three. With the low pollution technique, 30 kg of solvent vapors are released into the atmosphere per ton of solvent used. With the standard technique, the quantity of the waste released is 700 kg.
IMPACT:	The amount of new solvents required is reduced by three due to recycling. Energy needs are increased by 13.5 GJ per ton of solvent used in order to produce the vapor necessary for cleaning the activated carbon and the distillation of the recovered solution.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Recovery and Recycling of Solvents from Vapors Originating from Priming and Painting of Aluminum Foils", Monograph ENV/WP.2/5/Add.32.
KEYWORDS:	Solvent, Air Drying, ISIC 3819, Activated Carbon, Distillation

MINING

1.0 Headline: Thin layer process of copper and uranium ore-leaching cuts water use by up to 75% and reduces dust generation.

2.0 SIC Code: SIC 1021, SIC 1094, Copper ores/Uranium-radium-vanadium

3.0 Name and Location of Company:

Sociedad Minera Pudahuel, Ltda.
Santiago, Chile.

4.0 Clean Technology Category

This technology involves using thin-layer (TL) leaching to process ores using less water, thereby reducing tailings volume.

5.0 Case Study Summary

5.1 Process and Waste Information: The Thin Layer (TL) process involves spreading the crushed ore in layers 3 ft. thick or less for leaching. After treatment with concentrated sulfuric acid, which liberates the copper or uranium, the crushed ore is allowed to cure for a day. It is then spread over shallow beds for leaching. The shallowness of the beds permit uniform contact between the leach liquor and the ore by minimizing compacting and channeling. In agitation leaching, the conventional copper and uranium process, tailings are typically mixed with about 50 wt. % of water for disposal. In the TL process, water use may be as little as one-fourth the amount needed for agitation leaching.

5.2 Scale of Operation: The operation was expected to handle 2,600 metric tons/day of copper ore.

5.3 Stage of Development: Ore has been processed in bench tests and at an 8-ton/day uranium ore demonstration plant in Moab, Utah. Full scale implementation was scheduled for late 1979.

5.4 Level of Commercialization: The technology is commercially available.

5.5 Material/Energy Balances and Substitutions: This technology uses 25 percent less water than the conventional leaching method.

6.0 Economics*

6.1 Investment Costs: The investment is $30 million ($1,875 per annual ton of copper produced based on 355 production days/year) for the leach, solvent-extraction and electrowinning sections. Figures are in US dollars and based on 1978 prices. There is a 50% cost savings compared to an agitation leach facility. The comparison only includes the mill section.

6.2 Operational and Maintenance Costs: A 5% to 15% reduction in operating costs are expected compared to agitation extraction. A 40 to 60% smaller solvent-extraction plant is required because the metal concentration in the leach liquor can be controlled to a higher concentration than in agitation leaching. Tailing disposal costs are lower because tailings take up only 25% of the volume compared to tailings from agitation leaching methods.

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Economic benefits from reduced water use are expected. The tailings have about one-fourth those generated using the conventional process. Less fugitive dust is generated because the TL process only requires ore to be crushed to 3/8 inch size versus <65 mesh for cooper and <28 mesh for uranium so there are fewer fines, minimizing windblown dust.

8.0 Obstacles, Problems and/or Known Constraints

None were identified.

9.0 Date Case Study Was Performed

April 1978

10.0 Contacts and Citation

10.1 Type of Source Material: Book.

10.2 Citation: Process Technology and Flowsheets, articles which appeared in Chemical Engineering over the last five years. V. Cavaseno and Staff of Chemical Engineering, McGraw-Hill, NY, NY, 1979. Cu/U ore-leaching route cuts pollution, trims costs, Gerald Parkinson. Pg. 108.

10.3 Level of Detail of the Source Material: Detailed process information and flow sheet provided.

10.4 Industry/Program Contact and Address: Holms & Naver, Inc., 999 Town and country Rd., Orange, CA 92668.

10.5 Abstractor Name and Address: John Houlahan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: mine tailings, slurry

11.2 Process type/waste source: Metal mining, cooper ores, uranium ores

11.3 Waste reduction technique: process redesign, volume reduction thin-layer (TL) process

11.4 Other keywords: volume reduction, SIC 1021, SIC 1094

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Mine Tailings, Slurry, Metal Mining, Copper Ores, Uranium Ores, Process Redesign, Volume Reduction Thin-Layer (TL) Process, Volume Reduction, SIC 1021, SIC 1094

NONFERROUS METALS

***** DOCNO: 400-069-A-306*****

HEADLINE:	Copper pickling operation uses alcohol instead of acid and eliminates acid dumps and rinsewater discharges.
INDUSTRY/SIC CODE:	Metallurgical Industry/ISIC 38
POLLUTION PREVENTION OPTIONS SUMMARY:	A pickling of copper wire process which utilizes alcohol produces no pollutant discharge. The wire rod, hot and slightly oxidized, leaves the mill and enters a pickling chamber fed with alcohol which reduces copper oxides present in metal form. In the standard technology the pickling process is achieved with a similar installation, but acid is used to dissolve the oxides and the metal. It is then necessary to rinse with water.
FEEDSTOCKS:	Alcohol
WASTES:	None
MEDIUM:	Liquid
COSTS:	
CAPITAL COST:	FF 300,000
OPERATION/MAINTENANCE:	FF 8.55 per ton of pickled wire
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Not reported
FEEDSTOCK REDUCTION:	With the low-waste technology pickling one ton of wire requires 4 liters of alcohol solution, versus 2 kg of H_2SO_4 at 66 degrees. With the standard technology. Furthermore, the standard technology requires 750 liters of rinse water and 0.75 kg of effluent-neutralizing products.
WASTE PRODUCTION:	There is no polluting discharge with the low-waste technology. The standard technology generates 750 liters of waste per ton of pickled wire, consisting of: 20 g of suspended matter, 15 g of oxidizable matter, and toxicity = 0.3E. The neutralization process produces 2 kg of sludge per ton of pickled wire.
IMPACT:	The new process can be applied only to continuous casting and drawing units. Alcohol pickling is only feasible when surface oxidation is light and when the copper is at a temperature sufficiently high for the chemical reaction to occur.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Pickling of Copper Wire with Alcohol.", Monograph ENV/WP.2/5/Add.69.
KEYWORDS:	Metallurgical Industry, ISIC 3800, Pickling, Alcohol, Copper

***** DOCNO: 400-068-A-305*****

HEADLINE:	Mechanical descaling of wire-rod coils eliminates hot acid bath discharges and provides a more reliable and safer descaling process.
INDUSTRY/SIC CODE:	Metallurgical Industry/ISIC 38
POLLUTION PREVENTION OPTIONS SUMMARY:	The standard technology dips wire-rod coils in a hot acid bath, rinsed and then treated with lime in order to neutralize any trace of acid. In the new process, wire-rod is descaled by roller-binding. It then goes through a sanding chamber where it is sand blasted. The surface quality thus achieved permits wire-drawing. The low-waste dry and wet processes require 0.5 GJ per ton of descaled wire-rod versus 2.35 GJ in the standard technology.
FEEDSTOCKS:	Water
WASTES:	Scale from the metal descaling operation
MEDIUM:	Solid
COST:	
CAPITAL COST:	FF 500,000 (1979 figures)
OPERATION/MAINTENANCE:	FF 22.9 per ton (1979 figures)
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	FF 26.6 per ton descaled.
FEEDSTOCK REDUCTION:	3.99 m^3 of water per ton of descaled wire-rod.
WASTE PRODUCTION:	5 kg of scale
IMPACT:	Greater safety and reliability due to the absence of hot acid.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Mechanical Descaling of Wire Rods by a Dry or Wet Process", Monograph ENV/WP.2/5/Add.68.
KEYWORDS:	Metal Finishing, Wire, Descaling, ISIC 38

***** DOCNO: 400-098-A-260 *****

HEADLINE:	Blende transformed into zinc oxide by roasting to recycle SO_2.
INDUSTRY/SIC CODE:	Non-ferrous Metals/ISIC 3720
TECHNOLOGY DESCRIPTION:	This process transforms blende into zinc oxide by roasting with fabrication of H_2SO_4 through catalysis of roasting gases and integrated treatment of tail gases. The blende is roasted to obtain zinc oxide. The resulting gases are sent, in succession, to a scrubbing unit, a catalysis unit and then to a concentration column. Tail gases are treated and recycled. The resulting sulphite mud is mixed with wastes from the gas scrubber, neutralized, and settled.
FEEDSTOCKS:	Blende
WASTES:	Tail gases, sludge
MEDIUM:	Gaseous
COST:	(Francs 1980)
CAPITAL COST:	1,800,000
OPERATION/MAINTENANCE:	2 Francs per ton ZnO
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	2 Francs per ton ZnO
FEEDSTOCK REDUCTION:	The low pollution technique leads to the production of 1.037 tons of H2SO4 for one ton of ZnO.
WASTE PRODUCTION:	The production of one ton of ZnO gives rise to the rejection of 3 kg (against 22 kg for conventional technology) of SO_2 into the atmosphere.
IMPACT:	The low pollution technique permits improving catalysis efficiency through recycling of SO_2 and thus transformation efficiencies to be obtained that are comparable with that of the double catalysis process.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Transforming Blends into Zinc Oxide by Roasting With Fabrication of H2SO4 Through Catalysis of Roasting Gases and Integrated Treatment of Tail Gases", Monograph ENV/WP.2/5/Add98.
KEYWORDS:	Acid Catalysis, ISIC 3720, Tail Gases, Blende

HEADLINE:	Brass turnings are recycled and heat is recovered from recycling process reducing energy requirements.
INDUSTRY/SIC CODE:	Nonferrous Metal Basic Industries/ISIC 3720
POLLUTION PREVENTION OPTIONS SUMMARY:	Brass turnings are compressed and transformed into briquettes to reduce the free area and to reject part of the oil contained in the turnings. Remaining oil is removed by drying in an oven. Briquettes are then sent to a melting furnace. Fumes are filtered and heat is recovered. With the standard techniques, briquettes are sent directly to the melting furnace and resulting fumes are not processed.
FEEDSTOCKS:	Per one ton of briquettes, 1.06 tons of turnings are required, 980 MJ of electricity, 315 MJ of butane.
WASTES:	16,500 m^3 of fumes are rejected containing 0.5 kg of unburnt residues
MEDIUM:	Gaseous
COSTS:	
CAPITAL COST:	5,200,000 francs
OPERATION/MAINTENANCE:	650,000 francs/year (minus revenues of 780,000 francs)
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	700,000 francs in additional sales of brass, 80,000 francs from energy recovery (operating costs of low waste technology are 650,000 compared to 200,000 francs/year for conventional technology, investment is 5,200,000 compared to 2,000,000).
FEEDSTOCK REDUCTION:	Reduction of 0.03 tons of turnings, increased usage of energy consisting of 635 MJ electricity and 315 MJ butane.
WASTE PRODUCTION:	16,500 m^3 of fumes are rejected (compared to 3,700 m^3 with conventional technology) containing 0.5 kg unburnt residues (compared to 11 kg).
IMPACT:	Significant reduction in concentration of unburnt residues in fume emissions. Working conditions are also improved.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Melting of Brass Turnings in and Electric Furnace with Previous De-oiling of Turnings and Heat Recovery", Monograph ENV/WP.2/5/Add.95.
KEYWORDS:	Nonferrous Metal, Energy Recovery, Gas Filtration, Brass Turnings, ISIC 3720

***** DOCNO: 400-114-A-327*****

HEADLINE:	QSL Process, developed to smelt lead sulphide concentrates and sulphate secondaries, reduces fuel requirements by 60% and waste gases by 80%.
INDUSTRY/SIC CODE:	Non-ferrous Metal Basic Industries/ISIC 3720
POLLUTION PREVENTION OPTIONS SUMMARY:	The QSL Process has been developed to smelt lead sulphide concentrates as well as sulphate and mixed oxide-sulphate secondaries such as flue dusts, battery paste or lead-silver residues. As in conventional lead smelting, the gangue minerals contained in the raw materials are separated from the molten metal in the form of a fluid siliceous slag. Instead of two separate steps of sintering and blasting in a furnace, the QSL Process is a one-step process of continuous smelting of the charge, with the resulting pellets directly fed to the oxidation and reduction zones of the reactor. Sulphur dioxide gas emissions of about 15 to 25% by volume are utilized in the manufacture of sulfuric acid. Any sulphur contained in reduction coal or fuel is recovered, and the precipitated flue dust is directly recycled to the mixing section.
FEEDSTOCKS:	Lead concentrate, fuel (coal), oxygen, nitrogen, fluxes, electrical energy
WASTES:	Air exhaust, dust, discarded slag
MEDIUM:	Gaseous, solid
COST:	
CAPITAL COST:	DM 90-110 million
OPERATION/MAINTENANCE:	235 DM/ton lead bullion
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	30 million DM in capital cost, 149 DM/ton lead bullion in operating costs
FEEDSTOCK REDUCTION:	60% reduction in fuel consumption, recycling of precipitated flue dust
WASTE PRODUCTION:	Waste gases are reduced from 20,000 to 25,000 m^3/ton of lead (20 mg dust/m^3), to 4,000 to 5,000 m^3/ton of lead (10 to 20 mg dust/m^3). Sulphur dioxide gas can be used in sulfuric acid production, instead of emitting to the air.
IMPACT:	The QSL Process is a continuous one-step process with low investment and operating costs compared to the conventional technology. Energy recovery reduces the fuel requirements by 60%, and sulphur contained in the raw materials is recovered. The volume of waste gases emitted to the environment is reduced by 80%, and the SO_2 emissions are eliminated.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Continuously Operating Direct Lead Smelting Process (QSL)", Monograph ENV/WP.2/5/Add.114.
KEYWORDS:	Nonferrous Metal, Lead, Smelting, QSL Process, Energy Recovery, Reduction Furnace, Gas Collection, ISIC 3720

***** DOCNO: 400-009-A-200 *****

HEADLINE:	Ferrochrome process uses lower grade ores, recovers waste gases, and reduces slag generation.
INDUSTRY/SIC CODE:	Ferrochrome Production and Raw Materials/ISIC 3710
NAME/CONTACT:	Outokumpu Oy, SF-02200 Espoo 20, Finland Mr. Bengt Norrman
TECHNOLOGY DESCRIPTION:	Outokumpu Oy has developed a ferrochrome process, where chrome ore fines and ores with a low chrome content can be used as raw material to produce ferrochrome. Special attention has been paid to the environmental aspects, when developing this process, and total energy consumption is low. Ore fines or concentrate are first ground in a wet grinding mill with grinding media to the fineness required for pelletizing. Sludge from grinding is filtered before pelletizing, which is performed by a pelletizing disc. The sintering of pellets takes place in the vertical shaft furnace at the temperature of approximately 400° C. Its burners are designed to use electric furnace CO-gases and coal mixed with the pellets. The sintering pellets together with coke and slag forming materials are dosed into the preheating furnace, where carbon monoxide from the arc furnace is used as fuel. Preheated feed mixture is fed through the feeding ring continuously into the totally closed electric smelting furnace. Waste gas from the furnace is cleaned before use as a fuel in the sintering and preheating furnaces. Molten ferrochrome is granulated or cast into molds which are crushed after cooling.
FEEDSTOCKS:	Furnace CO-gas is used in the sintering furnace of pellets and in preheating the smelting charge.
WASTES:	From different stages of the process, dust recovered from waste gas purifications is brought back to the process through pelletizing.
MEDIUM:	Not reported
COST:	Not reported
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	Energy savings, use of lower grade ores and raw materials and reduced slag and gas generation.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Outokumpu Ferrochrome Process". Monograph ENV/WP.2/5/Add.9.
KEYWORDS:	Ferrochrome, ISIC 3710, Energy Recovery

PETROLEUM REFINING

***** DOCNO: 400-046-A-235 *****

HEADLINE:

INDUSTRY/SIC CODE: Petroleum Refining/ISIC 3530

NAME/CONTACT: The USSR State Committee for Science and Technology

TECHNOLOGY DESCRIPTION: The process of hydrodesulfurization is developed so that it can be used after the de-asphalting of the residue with light gasoline. Heavy residual products of sulfur and high sulfur crude petroleum is de-asphalted with light gasoline (virgin gasoline) in standard extraction columns at a temperature of 140-190° C and a dilution ratio of 3.5:1 to 5:1. The content of ash in the de-asphalted oil compared with the feed stock will be 2-4 times less and its coking tendency about 1.5-2 times less. In addition, 2-7 percent of the feed is in the form of a new product - petroleum asphaltite - containing 60-80 percent asphaltenes, 10-20 percent of resin and 10-20 percent of oil. The asphaltite is easily powdered and does not agglomerate in storage. The product can be used for thermo/hydroisolation of heat tubes, and in combination with vacuum residue it can be used to briquette coal fines and to produce bitumens of different grades.

FEEDSTOCKS: Not reported

WASTES: Flue gases from process furnaces.

MEDIUM: Not reported

COST: Not reported
CAPITAL COST: Not reported
OPERATION/MAINTENANCE: Not reported
MONTHS TO RECOVER: Not reported

SAVINGS: Not reported
DIRECT COST: Not reported
FEEDSTOCK REDUCTION: Not reported
WASTE PRODUCTION: Not reported

IMPACT: Not reported

CITATION/PAGE: Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Preconditioning of Petroleum Residues for Subsequent Catalytic Processing and Manufacture of New Material: Petroleum Asphaltite", Monograph ENV/WP.2/5/Add.46.

KEYWORDS: Petroleum, Asphaltite, ISIC 3530

***** DOCNO: 400-045-A-234 *****

HEADLINE:

INDUSTRY/SIC CODE: Petroleum Refining/ISIC 3530

NAME/CONTACT: The USSR State Committee for Science and Technology.

TECHNOLOGY DESCRIPTION: Sulfide-containing condensates are treated by means of distillation. Distillation of sulfide-containing condensates makes it possible to produce hydrogen sulfide and ammonia as products. The distillation unit allows the production of 95-97 per cent gaseous ammonia and 98 percent hydrogen sulfide. The effluent from the distillation unit contains 50-100 mg/1 of hydrogen sulphide and around 500 mg/1 of ammonia. This wastewater is either used in the pre-treatment unit or discharged into the sewer.

FEEDSTOCKS: Sulfide-containing condensates

WASTES: None

MEDIUM: Aqueous

COST: Not reported
CAPITAL COST: Not reported
OPERATION/MAINTENANCE: Not reported
MONTHS TO RECOVER: Not reported

SAVINGS: Not reported
DIRECT COST: Not reported
FEEDSTOCK REDUCTION: Not reported
WASTE PRODUCTION: Not reported

IMPACT: Non-waste process gives commercial products of hydrogen sulfide and ammonia.

CITATION/PAGE: Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Utilization of Process Condensate Resulting from Petroleum Refining", Monograph ENV/WP.2/5/Add.45.

KEYWORDS: Petroleum Refining, Condensates, Distillation, ISIC 3530

PLASTICS PROCESSING

**** DOCNO: 400-038-A-227 *****

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HEADLINE:	Pickling of ABS parts in concentration solution decreases acid consumption and reduces detoxification needs.
INDUSTRY/SIC CODE:	Chemical industry and manufacturing of chemical products, petroleum and coal derivatives and plastic and rubber products/ISIC 3560
NAME/CONTACT:	Ministere de l'Environnement et du Cadre de Vie Direction de la Prevention des Pollutions 14, Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	Pickling of ABS plastic matter in a sulfochromic solution with restoration and recycling of the solution. The pickling operation itself is identical to the standard technique except that a basket containing the plastic parts is dipped into a bath of concentrated sulfuric acid and chromic acid that ensures descaling. When the $Cr3^+$ ion concentration reaches 50 g/l, in the low pollution process, the bath is restored by electrodialysis and recycled in order to maintain the $Cr3^+$ concentration at between 20 g and 30 g/l. The restoration of the bath allows a reduction of sulfuric acid consumption from 12.5 kg/100 m^2 descaled to 3.3 kg and the consumption of chromic acid from 13 kg/100 m^2 descaled to 3.5 kg.
FEEDSTOCKS:	ABS plastic, sulfochromic solution
WASTES:	Sulfochromic baths sent for detoxification
MEDIUM:	Aqueous
COST: CAPITAL COST: OPERATION/MAINTENANCE: MONTHS TO RECOVER:	 F 100,000 Not reported Not reported
SAVINGS: DIRECT COST: FEEDSTOCK REDUCTION: WASTE PRODUCTION:	 F 76,000 Not reported No information is available concerning the wastes produced by the detoxification station. The baths sent for detoxification equal 9.5 l/100 m^2 for the low pollution technique against 35 l in the standard process.
IMPACT:	Since the number of times the baths are sent to the detoxification center is reduced by four, the risks of accidental pollution are reduced by as much.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Surface Treatment of Plastic Materials in a Sulfochromic Solution with Regeneration and Recycling of the Solution", Monograph ENV/WP.2/5/Add.38.
KEYWORDS:	Pickle Liquor, ISIC 3560

PRINTING

***** Document No. 453-001-A-000 *****

1.0 Headline: Use of water-based screen printing inks and radio-frequency dryers eliminate solvent emissions and save energy.

2.0 SIC Code: 2700, Screen printing

3.0 Name and Location of Company:

Sericol Group Ltd.
Westwood Road
Broadstairs
Kent CT10 2PA, England

4.0 Clean Technology Category

This technology involves development of water-based screen printing ink to replace solvent-based ink.

5.0 Case Study Summary

5.1 Process and Waste Information: Use of solvent-based inks results in fumes which are undesirable to the work and outdoor environments. Heat generated during the drying process also contributes to bad working conditions and to energy wastage.

Sericol developed a water-based ink whose performance is at least as good as the existing solvent-based inks. Although water-based inks can be used with conventional dryers their full potential is realized when radio-frequency (RF) dryers are employed. Using the microwave principle only the wet, i.e., printed, areas are heated.

5.2 Scale of Operation: The company has a staff of over 500.

5.3 Stage of Development: The technology is fully operational.

5.4 Level of Commercialization: Water-based inks are commercially available.

5.5 Material/Energy Balances and Substitutions: Not reported

6.0 Economics

Not reported

7.0 Cleaner Production Benefits

Advantages include elimination of solvent use and atmospheric emissions. If radio frequency drying is used, energy is saved and a higher drying speed can be obtained.

8.0 Obstacles, Problems and/or Known Constraints

None identified.

9.0 Date Case Study Was Performed

Unknown

10.0 Contacts and Citation

10.1 Type of Source Material: Government Publication.

10.2 Citation: Clean Technology, Environmental Protection Technology Scheme, Department of the Environment, 2 Marsham Street, London SW1P 3EB, 1989, p14.

10.3 Level of Detail of the Source Material: No additional detail is provided.

10.4 Industry/Program Contact and Address: David Seddon, Technical Director, Sericol Group Ltd., Westwood Road, Broadstairs, Kent CT10 2PA, England, Telephone (0843) 67071

10.5 Abstractor Name and Address: John Houlahan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Solvent-based ink

11.2 Process type/waste source: Solvent emissions, printing ink

11.3 Waste reduction technique: Raw material substitution, radio frequency (RF) dryers

11.4 Other keywords: United Kingdom, air emissions, energy conservation, SIC 2700

Keywords: Solvent-Based Ink, Solvent Emissions, Printing Ink, Raw Material Substitution, Radio Frequency (RF) Dryers, United Kingdom, Air Emissions, Energy Conservation, SIC 2700

***** DOCNO: 400-109-A-324*****

HEADLINE:	Recycling of printing ink to be reused by newspapers as black printing ink reduces waste disposal to treatment plant by seven tons.
INDUSTRY/SIC CODE:	Newspaper Production/ISIC 3420
POLLUTION PREVENTION OPTIONS SUMMARY:	Discarded printing ink is collected, purified, and reused as black printing ink. Waste ink produced from the printing process and from color changes is collected in an accumulation vessel and is passed through four filters, the last of which removes particles down to 25 microns. The purified ink is then mixed with new printing ink for reuse in newspaper production.
FEEDSTOCKS:	Waste ink with moisture content below 5% and other impurities such as oil and organic solvents below 2%, 0.05 kWh energy consumption per ton paper
WASTES:	Low volume of synthetic filters and objects from coarse filter
MEDIUM:	Solid
COST:	
CAPITAL COST:	37,000 Danish kroner (1980)
OPERATION/MAINTENANCE:	1.23 Danish kroner per ton of paper
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	3.0 Dk/ton of paper for destruction of discarded ink 21.5 Dk/ton savings for reusing the ink
FEEDSTOCK REDUCTION:	7 tons of discarded printing ink is treated per year
WASTE PRODUCTION:	7 tons of discarded ink requiring disposal in national treatment plant
IMPACT:	Seven tons of waste no longer require waste disposal in a treatment plant. With a net savings of 24.5 Dk per ton of paper, and about 185,000 tons of paper used per year in Denmark, the possible savings are 4 - 5 million Dk. Annual costs of printing ink are 50 to 60 million Dk (1980).
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Re-use of Printing Ink for Newspaper Production," Monograph ENV/WP.2/5/Add.109
KEYWORDS:	Ink, Printing, Recycling, Filtration, ISIC 3420

PULP AND PAPER

Wood Pulp Mills
Nonwood Pulp and Paper Mills
Synthetic Fibers Pulp Mills
Paper Mills

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Decrease and control of environmental loads of a pulp mill with a new mill layout.

2.0 SIC/ISIC Code: I3411.

3.0 Name and Location of Company:

CTS Engineering Oy, P.O.Box 193, SF-45101, Kouvola, Finland.

4.0 Cleaner Technology Category

Due to a centralized layout, consumption of electrical energy and heat can be decreased, and more power is produced to the market if compared with a mill based on today's technology. Thanks to the chosen technology, the degree of coloration, AOX emissions, and COD emissions are lower than in a conventional solution.

5.0 Case Study Summary

5.1 Process and Waste Information

Conventional chemical pulp mill that produces fully bleached pulp consists of about twenty departments that operate with different principles. The mill requires a lot of area. Subprocesses are far from each other, it is difficult to follow and manage material flows. Disturbances in production cause, besides reduced output, also environmental stress and decrease in product quality.

The target of the research work presented was to develop a chemical pulp mill that would be more centralized, more economical of energy and ecologically more beneficial. A sulphate pulp mill that uses pine as raw material was chosen as the basis for the survey. The result of the development work is a preliminary plan for a sulphate pulp mill, basing on a round layout, sited in a coherent roofed space. The mill is accommodated in a structural steel building. The soda recovery unit, auxiliary boiler and deep tank aeration system are located outside the circular building.

The maintenance work is done rapidly and efficiently, because all subprocesses are in the same warm building and near each other. The centralized control room improves the control of the mill.

Consumption of electric energy decreases as a result of shorter pipe lines, smaller amount of water that need treatment, and the chosen equipment. Most of the blow off heat from the digester plant is utilized at the evaporation plant; heat can thus be saved. More power is produced to the market compared with a mill based on today's technology.

The model enables the treatment and control of all emissions to the environment. Ducts for collecting the emissions into the air are short. Thanks to thorough effluent treatment, continuous digesting, oxygen bleaching, and well controlled process, the degree of coloration of the effluents, AOX-emissions, and COD-emissions are lower than in a conventional solution.

5.2 Scale of Operation: The mill's design production capacity is 1500 t/d. The steel building's diameter is 200 m and eave height 35 m.

5.3 Stage of Development: Preliminary study stage.

5.4 Level of Commercialization: See 5.3.

5.5 Material/Energy Balances and Substitutions

Material Category	Quantity Before	Quantity After
Waste Generation:		
AOX	100	55
COD	100	70
Colour	100	45
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:		
Electricity	100	90
Steam	100	90
Extra power produced		204 kWh/Adt

6.0 Economics

6.1 Investment Costs: On the basis of received budgetary tenders and made calculations the studied pulp mill is approximately 3 % cheaper than the reference mill.

6.2 Operational and Maintenance Costs: The need for operating personnel is according to calculations about 210 persons, whereas the corresponding number in the reference mill is about 300.

6.3 Payback Time:

7.0 Cleaner Production Benefits

See 4.0.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study was Performed: This preliminary study will be published in 1992.

10.0 Contacts and Citation

10.1 Type of Source Material: An abstract provided by the contact person.

10.2 Citation:

10.3 Level of Detail of the Source Material: Additional information is not available in the source material.

10.4 Industry/Program Contact and Address: Vesa Junttila, CTS Engineering Oy, P.O.Box 193, SF-45101, Kouvola, Finland, phone: 951-2971, fax: 951-11684, telex: 52308 tsfin sf

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Tel. +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf.

11.0 Keywords

11.1 Waste type: Pulp mill effluent.

11.2 Process type/waste source: Chemical pulp mill, Sulphate pulp mill.

11.3 Cleaner Production Technique: Centralized layout, Control of environmental loads.

11.4 Other Keywords:

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Chemical pulp mill, Sulphate pulp mill, Centralized layout, Control of environmental loads.

***** DOCNO: 400-044-A-233 *****

HEADLINE:	Use of dry bark stripping process eliminates wastewater and generates energy.
INDUSTRY/SIC CODE:	Pulp and Paper Industry/ISIC 3411
NAME/CONTACT:	The USSR State Committee for Science and Technology
TECHNOLOGY DESCRIPTION:	Wet barking in drums is substituted with dry wood barking which virtually eliminates the generation of wastewater. Instead of adding water to the barking drum, the dry bark stripping process uses steam to intensify the bark stripping, producing only solid wood waste. The wet bark stripping process supplies hot and cold water to the barking drums to intensify the process. This process produces a water-borne waste and solid waste.
FEEDSTOCKS:	Wood material for the manufacture of pulp and paper products (pulpwood)
WASTES:	Solid waste, wood
MEDIUM:	Not reported
COST:	Not reported
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	Dry barking provides significant cost savings not only because of the exclusion of the treatment of wet bark and bark containing wastewater but also because of the higher energy content of the dry bark. Bark-fired boilers can provide up to 20 per cent of a facility's steam requirements. The combined method results in a substantial reduction of water requirements compared to conventional wet barking.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Technological Process of Dry Bark-Stripping of Wood in Barking Drums," Monograph ENV/WP.2/5/Add.44.
KEYWORDS:	Pulp and Paper, ISIC 3411

***** DOCNO: 400-006-A-197 *****

HEADLINE:	Pressurized grinding of processed wood, reduces energy consumption, and improves paper properties.
INDUSTRY/SIC CODE:	Pulp and Paper Industry; Mechanical Pulping by Stone Grinding/ISIC 3411
NAME/CONTACT:	Oy Tampella Ab, SF-33100 Tampere 10, Finland. 26 March 1979/Mr. Matti Aario, Product Engineering Manager of Stock Preparation Department
TECHNOLOGY DESCRIPTION:	The company changed the construction of the conventional hydraulic stone grinder so that the processed wood is ground in a gas tight space under pressure. Pressurized grinding has been implemented as a batch process. The experiments were carried out with a production scale T 1512 grinder, by altering the machine to perform under pressure. As a result of the trial runs, mechanical pulp of a new type was obtained, the strengths of which - especially the tearing resistance - were considerably better than those of the stone-ground wood, corresponding to the strength figures of thermomechanical pulp. Furthermore, it became evident that the energy consumption needed by the process was lower than of the presently known processes for manufacturing of mechanical pulp. The feeding of wood into the grinder was done manually through a gate that can be lifted by a crane so that during the feeding the pressure is released from the grinder.
FEEDSTOCKS:	Not reported
WASTES:	Not reported
MEDIUM:	Not reported
COST:	At the present development stage of the process investment requirements are not available.
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	Improved paper properties and reduced energy consumption.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Pressurized Stone Grinding for Mechanical Pulp Production," Monograph ENV/WP.2/5/Add.6.
KEYWORDS:	Pulp and Paper, ISIC 3411, Mechanical Stone Grinding

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The APCEL pulp mill development project would improve effluent quality.

2.0 SIC/ISIC Code: I3411.

3.0 Name and Location of Company

Apcel Pty Ltd, Princes Highway, Snuggery, South Australia 5280, Australia.

4.0 Cleaner Technology Category

The Apcel pulp mill redevelopment project, by expansion in long-fibre softwood chemical pulping capacity and by converting the existing chemical pulp mill to use Eucalyptus, both based on the magnesium bisulfite process, called the Magnefite process and peroxide bleaching would improve effluent quality.

The project would significantly improve the quality of the plant's main drain effluent through the addition of chemical recovery, peroxide bleaching and secondary effluent treatment facility. Biological oxygen demand, adsorbable organohalogens, AOX, total suspended solids and colour would be reduced.

5.0 Case Study Summary

5.1 Process and Waste Information

The Magnefite pulping process was chosen for the Apcel redevelopment for the following reasons:

- Sulfite pulp has an unbleached brightness of 55% compared with 30% for Kraft pulp. This allows sulfite pulp to be bleached to a level acceptable to the market, without the use of chlorine or chlorine compounds.

- The capital cost of an installed and operating Magnefite mill is approximately half to two-thirds of that of a Kraft mill.

- The Magnefite process allows recovery and recycling of the cooking chemicals.

The spent cooking liquor would pass through the following steps in the chemical recovery stage:

- The liquor is concentrated by evaporation in several stages and combusted in a recovery boiler, resulting in the formation of magnesium oxide and sulfur dioxide in the boiler flue gases. Chemical recovery follows, where magnesium oxide would be recovered in a wet scrubber. The magnesium oxide would then be passed to another scrubber through which the sulfur dioxide-rich flue gases would pass, resulting in the formation of raw magnesium bisulfite liquor. The raw liquor would be clarified and filtered for reuse.

- The pulp would be bleached using the peroxide steep bleaching process.

- The secondary treatment plant would consist of either aeration lagoons or activated sludge treatment, or a combination of these two techniques.

- Significant improvements in effluent quality would result from the proposed redevelopment.

5.2 Scale of Operation: The expansion in soft-wood chemical pulping capacity would be achieved by the construction of a new chemical pulp mill with a capacity of 250 ADt/d (90,000 ADt/a). The existing chemical pulp mill would be converted to a 110 ADt/d (40,000 ADt/a) capacity Eucalyptus mill.

5.3 Stage of Development: The technology has been fully implemented.

5.4 Level of Commercialization: The technology is commercially available.

5.5 Material/Energy Balances and Substitutions

Material Category	Quantity Before	Quantity After
Waste Generation:	BOD 188 kg/ADt	7 kg/ADt
	AOX 7.6 kg/ADt total suspended solids	<0.1 kg/ADt
	15.4 kg/ADt colour 1 075 HU	5 kg/ADt <200 HU
Feedstock Use:	N/A	N/A
Water Use:	35 ML/d	35 ML/d
Energy Use:	21 MW	27 MW

6.0 Economics

6.1 Investment Costs

The project would result in a expenditure of $195 million (Australian dollars).

6.2 Operational and Maintenance Costs

6.3 Payback Time

7.0 Cleaner Production Benefits

By the proposed redevelopment of the Apcel operations, the company will meet the community expectations for effluent discharges to the adjacent Lake Bonney. Applicable effluent standards will be met or bettered. Odorous air emissions resulting from the pulp cooking process will be reduced. The use of chlorine or chlorine compounds to bleach pulp will be eliminated. The acute and chronic toxicity of effluent will be reduced. The solid waste disposal practices will be improved.

8.0 Technical Constraints

The existing chemical pulp mill would require comparatively few equipment changes to convert it to the Magnefite process. These changes would include a new large dual use heat exchanger, an additional washing stage, new primary and secondary knotter screens, pumps and pipework to transfer cooking liquor, and fans and ductwork to transfer non-condensable gases to the new pulp mill recovery plant.

9.0 Date Case Study was Performed

The new pulp mill would be commissioned in the third quarter of 1992 and the existing chemical pulp mill conversion in late 1992. The secondary effluent treatment plant is proposed to be installed in 1994.

10.0 Contacts and Citation

10.1 Type of Source Material

Journal article and a draft environmental impact statement.

10.2 Citation

1. Trafford, J., A new look at a an old process - The application of peroxide steep bleaching to radiata pine bisulfite and thermomechanical pulps, Appita, Vol. 43, No. 5, September 1990, pp. 358-366.

2. APCEL Pulp Mill Redevelopment Project, Draft Environmental Impact Statement, Prepared for Apcel Pty Ltd by Kinhill Engineers Pty Ltd, June 1990, 17 p.

10.3 Level of Detail of the Source Material

Additional information on the laboratory tests, pulpwood resources and environmental impacts is available.

10.4 Industry/Program Contact and Address

John Trafford, Environmental and Development Chemist, Kimberly-Clark Australia, Apcel Mill, Millicent, South Australia, 5280.

10.5 Abstractor Name and Address

Mrs. Virve Tulenheimo, MSc, Research Engineer
Technical Research Centre of Finland
Non-Waste Technology Research Unit
P.O. Box 205
SF-02151 Espoo
Finland

Tel. +350 0 4561
Telefax +358 0 460 493
Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Chemical pulp mill effluent.

11.2 Process type/waste source: Bisulfite pulping, Pulp bleaching.

11.3 Cleaner Production Technique: Magnesium bisulfite pulping, Peroxide steep bleaching.

11.4 Other Keywords: Eucalyptus.

11.5 Country Code: Australia.

12.0 Assumptions

13.0 Peer Review

Yes (No 1 in 10.2) and known (No. 2 in 10.2).

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

KEYWORDS: Chemical pulp mill effluent, Bisulfite pulping, Pulp bleaching, Magnesium bisulfite pulping, Peroxide steep bleaching, Eucalyptus.

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The Milox organosolv pulping process offers a workable alternative to sulphate cooking and does not need any chlorine bleach chemicals.

2.0 SIC/ISIC Code: I3411.

3.0 Name and Location of Company:

The Finnish Pulp and Paper Research Institute, P.O.Box 70, SF-02151 Espoo, Finland.

4.0 Cleaner Technology Category

The Milox process is a sulphur-free peroxyformic acid pulping method, which was the first process to produce fully bleached chemical pulp both from hardwood and softwood totally without sulphur and chlorine chemicals.

Milox method can also be used to prebleach conventional kraft pulps. The prebleaching makes it possible to reach high brightness in a subsequent final bleaching entirely without chlorine chemicals.

5.0 Case Study Summary

5.1 Process and Waste Information: Peroxyformic acid has the ability selectively to delignify wood. The lignin is oxidized and broken down, and together with extractives and hemicelluloses, dissolves in the pulping liquor. The sulphur-free lignin can be precipitated from the spent liquor.

A three-stage cooking process allows peroxide consumption to be reduced. The first stage involves acid cooking in the presence of small amounts of peroxide at 80°C; this is followed by refluxing in formic acid without peroxide, at 100°C. The process ends with oxidative peroxyformic acid cooking, again at 80°C.

This method converts both birch and pine into pulps with well separated fibres in yields of 40-50% depending on the Kappa number. Some pulping experiments have been made with Eucalyptus Globulus. The viscosity of the pulp is high, indicating little chemical damage to the cellulose.

At the end of the cooking process, birch pulp reaches a brightness of 47%, while pine pulp achieves 35%, with Kappa numbers of 3.5 and 9.0 respectively. Both birch and pine peroxyacid pulps can be bleached to over 90 brightness by means of an alkaline hydrogen peroxide.

Viscosity remains high and the low lignin content of the fibres keep peroxide consumption down. The strength properties of Milox birch pulps are close to those of birch kraft pulp. However the strength characteristics of pine peroxyacid pulps are much poorer than those of the corresponding sulphate pulps.

The kraft pulps prebleached with peroxyformic acid reach a brightness of 86% with alkaline hydrogen peroxide only. In a final stage using oxygen, ozone and peroxide, kraft can be bleached to 90 brightness.

Both birch and pine Milox bleached kraft pulps show strength characteristics and optical properties similar to those of conventional kraft pulps.

Pulps produced using the Milox method and kraft pulps bleached with chlorine-free Milox method are all compatible with grades where kraft pulp is used today. Hardwoods can also be made into dissolving pulp.

5.2 Scale of Operation: Laboratory scale. A pilot plant, which comprises in the first phase a cooking and bleaching unit to produce around 100 kg of pulp at a time, started up in autumn 1991. Formic acid recovery and recycling systems will be added in 1993.

5.3 Stage of Development: Laboratory stage, moved to pilot stage.

5.4 Level of Commercialization: Provided the results are positive, planning of a full scale mill could be envisaged after five years.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: The cost of the first phase (cooking and bleaching) pilot will be around FMK 10 Mill. If the second phase is built the figure will be around doubled.

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

So far the effluents have not been characterized. The recovery systems of the pilot plant should provide important data. The greatest advantage is, however, that the effluent contains no chlorinated organic compounds.

8.0 Obstacles, Problems and/or Known Constraints

Use for the precipitated lignin has not yet been found.

9.0 Date Case Study Was Performed: Work on the process was begun in 1985. The pilot plant was ready in autumn 1991.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles and a book.

10.2 Citation:

(1) Pride, D., Chemical pulping and bleaching - Old pulps for new, Paper, 6 November, 1990, pp. 26-28;

(2) Pulping technology - Beyond the kraft process, Asia Pacific Pulp & Paper, May 1991, pp. 15-17;

(3) Poppius, K., Sundquist, J. and Wartiovaara, I., Chemical pulping of birch and pine chips by the three stage peroxyformic acid method, in Wood Processing and Utilization, John Wiley & Sons, pp. 87-92.

10.3 Level of Detail of the Source Material: Information on pulp properties is available in the source material.

10.4 Industry/Program Contact and Address: K. Poppius-Levlin, The Finnish Pulp and Paper Research Institute, P.O.Box 70, SF-02151 Espoo, Finland.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Pulping effluent, Bleaching effluent

11.2 Process type/waste source: Chemical pulping

11.3 Cleaner Production Technique: Organosolv pulping, Milox-process, Peroxyformic acid method, Chlorine and sulphur-free pulping

11.4 Other Keywords: Hydrogen peroxide, Formic acid, Bleaching

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulping effluent, Bleaching effluent, Chemical pulping, Organosolv pulping, Milox-process, Peroxyformic acid method, Chlorine and sulphur-free pulping, Hydrogen peroxide, Formic acid, Bleaching

***** DOCNO: 400-088-A-317*****

HEADLINE:	Addition of oxygen bleaching reduces quantities of reagents and water used and coloration of wastes.
INDUSTRY/SIC CODE:	Manufacture of Pulp, Paper and Paperboard/ISIC 3411
POLLUTION PREVENTION OPTIONS SUMMARY:	This case study presents a modification to the bleaching stage of pulp manufacturing. Bleached kraft pulp is manufactured by cooking, washing, and bleaching wood chips. Modification of the standard bleaching process by preceding the chlorine, caustic soda, and chlorine dioxide bleaching with oxygen bleaching will reduce the quantities of reagents and water used in the conventional bleaching process. Washing water resulting from oxygen bleaching may be used for washing the pulp after cooking. This process reduces the coloration of wastes.
FEEDSTOCKS:	Material requirements for low-pollution manufacturing one ton of pulp: 4 tons of wood, 50m^3 of water, 25 kg of caustic soda, 45 kg of chlorine, 10 kg of chlorine dioxide, 30 kg of oxygen, 8.78 GJ of primary energy.
WASTES:	Polluting wastes consist of bleaching effluents.
MEDIUM:	Aqueous
COST:	
CAPITAL COST:	FF 24,000,000 (1973 figures) for an annual production of 170,000 tons of pulp
OPERATION/MAINTENANCE:	FF 13.3 per ton of pulp (1973 figures)
MONTHS TO RECOVER:	
SAVINGS:	
DISPOSAL & FEEDSTOCK:	FF 9.1 per ton of pulp in raw chemicals cost and water consumption
FEEDSTOCK REDUCTION:	The following reductions in feedstocks have been reported per ton of pulp manufactured: 50 m^3 of water, 10 kg of caustic soda, 55 kg of chlorine, 5 kg of chlorine dioxide.
WASTE PRODUCTION:	Polluting wastes by the bleaching process consist of the bleaching effluents. Switching from the standard to the low pollution technique permits reducing by half the rate of coloration of wastes.
IMPACT:	Additional variable expenses of energy and manpower (F 13.3 per ton) are partly offset by savings in chemicals and water (F 9.1).
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Paper/board Making with Closed Water Systems," Monograph ENV/WP.2/5/Add.88
KEYWORDS:	Paper, Pulp, Bleaching, Kraft Paper, ISIC 3411

***** DOCNO: 450-003-A-361*****

HEADLINE:	Eddy Forest modernizes plant, improves pulp quality and reduces discharges and emissions of particulates and sulfur gases.
INDUSTRY/SIC CODE:	Paper and Allied Products/SIC 26
NAME/CONTACT:	Eddy Forest Products, Ltd. Espanola, Ontario
POLLUTION PREVENTION OPTIONS SUMMARY:	This pulp mill pioneered commercial oxygen bleaching of softwood kraft pulp in 1977 by using the Modo-cil-oxygen/alkali bleaching process and reducing chlorine consumption by over 50%. A modernization project has increased capacity of the chip handling, digester, bleach plant, recovery boiler and evaporator. A new black-liquor evaporation system that can produce black liquor up to 75% solids and a new low-odor recovery boiler have been installed. Foul condensates from the digester and evaporator are steamstripped to remove sulfur gases and methanol, which are incinerated. A new bleaching line consists of two 3-stage lines which are each preceded by an oxygen and hot chlorination stage. Effluent is recycled through the system.
FEEDSTOCKS:	Wood chips, chlorine, fuel
WASTES:	Emissions, methanol, BOD wastes
MEDIUM:	Air, liquid, solids
COST:	Not reported
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Dollar values not reported.
FEEDSTOCK REDUCTION:	Oxygen bleaching has reduced chlorine consumption by over 50% and bleaching costs by 10-15%.
WASTE PRODUCTION:	Oxygen bleaching has reduced effluent BOD by 50%. A new secondary water-treatment system has decreased BOD levels by 80-95%. The recovery boiler system has reduced emissions by 88% for particulates, and 99% for sulfur gases.
IMPACT:	Plant Modifications have enabled the company to meet government water pollution regulations, have increased bleaching capacity to 1000 tons/day, and have improved product quality.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects," Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 63.
KEYWORDS:	Pulp and Paper, Bleached Kraft Pulp, Sulfur, Chlorine, Recycling, Process Change, SIC 26

***** DOCNO: 452-003-A-001 *****

1.0 Headline: Advanced pulp bleaching technology and mill design reduce adsorbable organic halogen (AOX) levels

2.0 SIC Code: 2611

3.0 Name & Location of Company

Wisaforest, Jakobstad
Pietarsaari, Finland

4.0 Clean Technology Category: The technology involves advanced pulp bleaching technology using oxygen bleaching, washing, and screening to reduce AOX levels.

5.0 Case Study Summary

5.1 Process and Waste Information: The company produces bleached and unbleached pulp, mostly from hardwood, with some eucalyptus from South America. The clean technology involves use of the Sunds Defibrator pulp technology in the bleaching, washer, and screening plant. The five-stage bleaching plant has a D/D-OE-D-E-D sequence. The oxygen bleaching technology and effluent controls reduce AOX levels below regulatory levels.

5.2 Scale of Operation: The facility produces 540,000 tpy of bleached and unbleached pulp.

5.3 Stage of Development: The technology is fully developed.

5.4 Level of Commercialization: The facility uses the Sunds Defibrator pulp technology.

5.5 Material/Energy Balances and Substitutions: No information provided.

6.0 Economics*

6.1 Investment Costs: No information provided.

6.2 Operational & Maintenance Costs: No information provided.

6.3 Payback Time: No information provided.

7.0 Cleaner Production Benefits: AOX levels are reduced below regulatory levels.

8.0 Obstacles, Problems, and/or Known Constraints: No information provided.

9.0 Date Case Study Was Performed: Information not provided.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article

10.2 Citation: Pride, D. Old pulps for new. Paper, 6 November, 1990. p. 28.

10.3 Level of Detail of the Source Material: A brief description of the companies other subsidiaries is provided. docu

10.4 Industry/Program Contact and Address: The technology is produced by Sunds Defibrator. Martin Granhold of Wisaforest is the facility contact.

10.5 Abstractor Name and Address: Barbara M. Scharman, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords

11.1 Waste type: AOX effluents

11.2 Process type/waste source: Pulp mills, bleaching

11.3 Waste reduction technique: Oxygen bleaching, effluent controls

11.4 Other keywords: Finland

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleaching, Process Modification, Pulp Mills

***** DOCNO: 452-003-A-001 *****

1.0 Headline: Chlorine and sulphur-free pulp process planned for pilot plant project

2.0 SIC Code: 2611

3.0 Name & Location of Company

Finland

4.0 Clean Technology Category: The technology involves a cooking process for hard and soft woods using peroxyformic acid and a bleaching process using alkaline peroxide to produce a chlorine and sulphur-free pulp.

5.0 Case Study Summary

5.1 Process and Waste Information: Sulphate cooking and bleaching of pulp have traditionally been used in pulping mills. An alternative technology, the Milox process, involves cooking the wood using a three-stage process. The first stage involves acid cooking at 80 degrees C in the presence of small amounts of peroxide. The second stage involves refluxing with formic acid at 100 degrees C. The final stage consists of cooking at 80 degrees C with peroxyformic acid. The peroxyformic acid selectively delignifies wood and the lignin can be recovered from the spent liquor. The cooking is accelerated using this process and peroxide consumption is minimized. The resulting pulp from the cooking process can be bleached with alkaline hydrogen peroxide to a brightness over 90% for birch and pine. Kraft pulps reach a brightness of 86% and can be treated with oxygen, ozone, and peroxide to achieve 90% brightness.

The new technology converts both birch and pine into pulps with well separated fibers in yields of 40-50%, depending on the Kappa number. Experiments have also been conducted with Eucalyptus Globulus. Little chemical damage to the cellulose occurs, as indicated by the high viscosity of the pulp. The strength characteristics of pine peroxyacid pulps are inferior to those of pine sulphate pulps. The potential effluents from the process have not yet been characterized but the recovery system in the pilot plant may provide some information. However, no chlorinated organic compounds should be present.

5.2 Scale of Operation: The pilot project's first phase will consist of a unit with a capacity of about 100 kg.

5.3 Stage of Development: Experimental studies have been conducted. The first phase of the pilot plant project is scheduled for fall, 1991. If successful, formic acid recovery and recycling systems will be added in 1992.

5.4 Level of Commercialization: A full-scale mill could be planned after five years, if results of the pilot plant are positive.

5.5 Material/Energy Balances and Substitutions: No quantitative data were provided concerning raw materials usage or waste generation.

6.0 Economics*

6.1 Investment Costs: The cost of the first phase will be about 10M (FM). If the second phase is added, consisting of the recovery and recycling systems, the cost will be another 10M.

6.2 Operational & Maintenance Costs: No information provided.

6.3 Payback Time: No information provided.

7.0 Cleaner Production Benefits: The new technology will produce a chlorine and sulphur-free pulp. No chlorinated organic compounds will be present in the effluent. Peroxide use is minimized and lignin can be recovered from the spent liquor although a use for it has not been found.

8.0 Obstacles, Problems, and/or Known Constraints: Strength characteristics of pine peroxyacid pulps are inferior to those of pine sulphate pulps.

9.0 Date Case Study Was Performed: Information not provided.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article

10.2 Citation: Pride, D. Old pulps for new. Paper, 6 November 1990. p. 26.

10.3 Level of Detail of the Source Material: The article briefly discusses another pilot plant involved in chlorine-free high whiteness pulping.

10.4 Industry/Program Contact and Address: The technology was developed by Professor Jorma Sundquist at the Finnish Pulp and Paper Research Institute.

10.5 Abstractor Name and Address: Barbara M. Scharman, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords

11.1 Waste type: Chlorinated organics

11.2 Process type/waste source: Pulp mills

11.3 Waste reduction technique: Process modification, material substitution, material conservation, Milox process

11.4 Other keywords: Chlorine reduction, sulphur reduction, Finland

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Chlorinated Organics, Material Substitution, Material Conservation, Milox Process, Process Modification, Pulp Mills, Chlorine Reduction, Sulphur Reduction, Finland

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Use of a Drum Displacer (a multistage pulp washer) allows all the washing stages to be carried out in a single drum.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Enso-Gutzeit Corporation's Kotka mill and Kymmene Corp., at the Kaukas mill, both in Finland.

4.0 Cleaner Technology Category

The pumping energy and the washing water quantity are reduced.

5.0 Case Study Summary

5.1 Process and Waste Information: The Drum Displacer is a new multistage washer where all washing stages are carried out with one drum. The washer consists of a rotating drum with sectors and of a housing around the drum. Further, the housing has been divided into various zones. One of the main components is the distribution valve.

Pulp is pumped at a consistency of 4-6% to the feed zone, where it is thickened approximately up to 10%. Pulp is washed at this consistency, but is not diluted nor thickened during washing. In the thickening zone, the pulp is dewatered by means of vacuum. Then the consistency rises approximately up to 15%. The pulp is discharged by compressed air.

The washing is carried out as a four stage displacement washing on the counter-current principle. The washing liquid is pumped to the fourth washing zone, from where the liquid passes through the pulp to the third washing zone. This is repeated in the second and first washing zones. The filtrate from the first zone flows to the filtrate tank.

5.2 Scale of Operation: The Enso-Gutzeit's washer capacity is 80 ADMTPD (air dry metric ton per day) and the Kymmene's 200 ADMTPD. The raw material in both mills is saw dust of birch and pine.

5.3 Stage of Development: The Drum Displacer pulp washer is fully implemented.

5.4 Level of Commercialization: The process discussed is commercially available. The washing machinery is specially designed for this application.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	100	reduced (see water)
Feedstock Use:	100	100
Water Use:	100	80
Energy Use:	100	50

6.0 Economics*

6.1 Investment Costs:

6.2 Operational and Maintenance Costs: The single unit process reduces the maintenance requirement to a minimum. The average maintenance time the washer has required is 8 hours/year.

6.3 Payback Time: The reduced number of equipment (25 vs. 100) enables installation in a smaller space. Pulp is not diluted between different washing stages. The quantity of liquid to be pumped and the energy needed for pumping decrease considerably. Pulp washing is carried out in a pressurized liquid phase resulting in more complete displacement. Pulp can be washed clean with a smaller water quantity. During washing the quantity of circulating wash liquid is small and the retention time short (3 min) compared to the filter washing line (more than 600 min). The washing is controlled almost without retention time.

7.0 Cleaner Production Benefits

The reduced number of equipment (25 vs. 100) enables installation in a smaller space. Pulp is not diluted between different washing stages. The quantity of liquid to be pumped and the energy needed for pumping decrease considerably. Pulp washing is carried out in a pressurized liquid phase resulting in more complete displacement. Pulp can be washed clean with a smaller water quantity. During washing the quantity of circulating wash liquid is small and the retention time short (3 min) compared to the filter washing line (more than 600 min). The washing is controlled almost without retention time.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed: The mill scale installations where reported in 1987.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal, a report of technologies from Finland and Conference proceedings.

10.2 Citation: (1) Advances is Pulping, Tappi Journal, November 1988, pp. 16-20; (2) Environmental High-Technology from Finland, prepared by Mexpert Consulting Engineers Ltd. for the Ministry of the Environment, Helsinki 1987, pp.23-24; (3) Perkola, M., Sundquist, H., Pikka, O., Qvintus, H. and Sainiemi, J., Drum Displacer - A new concept for brown stock washing, Tappi Proceedings, Pulping Conference, 1988, pp. 117-122.

10.3 Level of Detail of the Source Material: Additional information on the operating principle of the DD washer is available in the source material.

10.4 Industry/Program Contact and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

10.5 Abstractor Name and Address: Same as in 10.4.

11.0 Keywords

11.1 Waste type: Pulping waste water

11.2 Process type/waste source: Washing, Pulp washing, Brownstock washing

11.3 Cleaner Production Technique: Multistage pulp washer, Drum Displacer, Displacement washing

11.4 Other Keywords:

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

Unknown.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulping waste water, Washing, Pulp washing, Brownstock washing, Multistage pulp washer, Drum Displacer, Displacement washing

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Pressurized groundwood (PGW) and super pressurized groundwood (PGW-S) processes produce pulps of almost same strength properties as TMP (thermomechanical) pulps using less energy.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

There are almost twenty mills all over the world using the PGW technology in grinding and the following two using the PGW-S technology:

Kymmene Corporation, Kaukas Voikkaa Division, Voikkaa Paper Mill, Voikkaa, Finland.

Myllykoski Oy, Myllykoski Mill, Myllykoski, Finland.

4.0 Cleaner Technology Category

The mechanical pulp strength properties can be developed by the PGW process without more energy. The PGW-S process requires significantly less energy to achieve strength comparable to TMP. The PGW-S improves the properties compared to PGW.

5.0 Case Study Summary

5.1 Process and Waste Information: The groundwood pulp flows out of the pressurized grinder through a shredder, discharged through a blow valve into a blow cyclone, and then into a filter. From the filter the hot filtrate returns to a shower water tank and the discharge pulp is re-diluted to a controlled consistency ahead of screening.

In the PGW and PGW-S processes the grinder has been built to be pressure proof. The grinder can be pressurized by using air, thus the grinding temperature can be raised. Due to the higher temperature and pressure the lignin is softened in the grinding, resulting in stronger and more fibrillated pulp.

The effect of the shower water temperature on groundwood pulp properties was compared in the tests. Shower water temperatures ranged up to 140°C and grinder overpressure up to 450 kPa. From the results it can be confirmed that mechanical pulp strength properties can be developed without more energy. The use of superheated shower waters and higher overpressures improves the strength properties of super pressure groundwood by 15 to 20% compared to conventional PGW.

5.2 Scale of Operation: The technology has been implemented in full scale mechanical pulp mills.

5.3 Stage of Development: Fully implemented. First commercial PGW plant was started in the summer 1980, and the first PGW-S plant in 1991. The method has been patented in the countries most important from the point of view of paper production.

5.4 Level of Commercialization: There are pressure grinders operating all over the world.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before (TMP)	Quantity After (PGW-S)
Waste Generation:		
BOD[7]	15-25 kg/t paper	12-17 kg/t paper
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:		
electricity	1.7-1.9 MWh/t	1.1-1.3 MWh/t
steam		4.2 GJ/t
Pulp yield:	95%	97%

6.0 Economics*

6.1 Investment Costs: The costs will be calculated case by case.

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

The main goals of the research and development work have been to produce fiber that better meets the market need, to lower the consumption of energy, and to keep the consumption of more and more limited wood material as low as possible.

Due to better properties of pressure groundwood pulps, the share of chemical pulp in paper production could have been decreased from 20% to 10%.

8.0 Obstacles, Problems and/or Known Constraints

Spruce, different pine species and populus are the best raw materials for PGW and PGW-S processes. Hardwood can't be used. Some exotic hardwoods can be tested in the pilot plant.

9.0 Date Case Study Was Performed: Since the year 1976 Tampella Ltd (Finland) has made research work for the possibilities to improve the properties of groundwood. Preliminary trials were made in the year 1977 and a full-sized prototype construction was started in 1979. The first commercial PGW plant started in 1980 and the first PGW-S plant in 1991.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles, conference proceedings and brochures.

10.2 Citation:

(1) Mitchell, G. and Tapio, M., PGW/CPGW Mills Report Low Effluent Loads, Reduced Steam Contamination, Pulp & Paper, June 1990;
(2) Pulping: Kymmene puts pressure on, PPI, February 1992, p. 50 and p. 57;

(3) Beaudry, R.N., Towards a Zero Effluent PGW Pulp Mill, 77th Annual Meeting, Technical Section, Canadian Pulp & Paper Association, January 1991, Montreal, Canada, pp. B339-B340;
(4) Pasanen, K., Peltonen, E., Haikkala, P. and Liimatainen, H., Experiences in using super pressure groundwood (PGW-S) in Myllykoski SC-paper mill, Proceedings, International Mechanical Pulping Conference, June 1991, Minneapolis, USA, 8 p.;
(5) Haikkala, P., Liimatainen, H., Manner, H. and Tuominen, R., Pressure groundwood (PGW), super pressure groundwood (PGW-S) and thermomechanical pulp (TMP) in wood-containing printing papers, Preprints, International Mechanical Pulping Conference, Helsinki, June 1989, Volume 1, 13 p.;
(6) Pressure groundwood mechanical pulp, Tampella papertech, brochure;
(7) Pressure groundwood process, Tampella, Pulping and paper machinery group, Brochure.

10.3 Level of Detail of the Source Material: Fiber balances in TMP, GW and PGW processes, process conditions and pulp properties are available in the source material.

10.4 Industry/Program Contact and Address: Tampella Papertech Oy, Mechanical Pulping Machines, P.O.Box 606, SF-33101 Tampere, Finland, tel. +358-31-24 12 111, telex 22650 tamas sf, fax +358-31-149 810

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Pulp mill effluent

11.2 Process type/waste source: Mechanical pulping, High-yield pulping, Pressure groundwood, Super pressure groundwood, Thermomechanical pulp, Paper production

11.3 Cleaner Production Technique: Energy saving

11.4 Other Keywords:

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

Yes (No 1 and 2 in 10.2) and unknown (No 3-7).

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulp mill effluent, Mechanical pulping, High-yield pulping, Pressure groundwood, Super pressure groundwood, Thermomechanical pulp, Paper production, Energy saving

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Treatment of pine wood chips with recyclable commercial ethanol (96oGL) as a pre-treatment for the thermomechanical pulping process (TMP) allows possible separation of toxic wood extractives.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

4.0 Cleaner Technology Category

Process modification with solvent and extractives recovery.

5.0 Case Study Summary

5.1 Process and Waste Information: Process Area: Thermomechanical pulp plant.

Base Process: In the thermomechanical pulping process (TMP), the wood chips are washed, receive a steam treatment at atmospheric pressure, and are then compressed by a screw press that feeds them into a pressurized vessel where a steam treatment (pre-steaming) is applied. The wood chips are transformed into a pulp when they are forced between the two disks of a pressurized refiner. This is the first step of the TMP process. The pulp produced undergoes one or two further refining operations carried out under atmospheric pressure. This is the second step of the TMP process.

Process Changes: Inclusion of two operations in the original TMP process: first, the impregnation of wood chips with commercial ethanol. Second, the evaporation of the ethanol extract and recovery of the solvent.

Effect of Wastes: In the base TMP process, wood chips are screw-pressed and yield a toxic component rich waste concentrate that has to be treated. In the alternative process, effluents are evaporated, the solvent is recycled, and the wood extractives are separated and can be burned.

Raw materials: Pinus elliottii var. elliottii is the main raw material, reduced to wood chips. Commercial ethanol is necessary to start the process.

Energy Usage: As the wood chips are softened, there is a reduction of energy consumption in the first and second steps of the base TMP process. The recovery operations may effect the final energy balance.

Operating Procedures: In this alternative process, the ethanol extract obtained in the normal TMP process is collected in a storage tank. The liquor is pressurized with a pump and flashed into a tank heated up with the steam generated in the first step of the TMP process.

5.2 Scale of Operation: Full-scale TMP mills have a pulp output of 50-400 ADMT/day. The present alternative process is still in the experimental stage.

5.3 Stage of Development: Bench scale.

5.4 Level of Commercialization: The technology is not yet ready for commercialization, but the equipment used in the suggested alternative are available in commercial scale.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: Large-scale economic figures are not available. A rough technical and economic evaluation of the suggested modification of the regular TMP process is presented in the literature cited.

6.2 Operational and Maintenance Costs: Rough information about operational costs is presented in the mentioned literature.

6.3 Payback Time: Not available.

7.0 Cleaner Production Benefits

This alternative offers a possibility of an easy separation of part of the wood extractives that are very toxic.

8.0 Obstacles, Problems and/or Known Constraints

The need to work with a solvent (ethanol).

9.0 Date Case Study Was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Personal contact, conference proceedings, research work notes, academic thesis.

10.2 Citation: 1. Neves, J.M., Impregnacao de cavacos de Pinus elliottii var. elliottii com alcool etilico a 96oGL como pre-tratamento na producao de pastas termomecanicas. Tese. EPUSP/Depto Engenharia Quimica, Sao Paulo, 1984.

2. Neves, J.M. e Rossi, H., Pre-tratamento de cavacos de Pinus elliottii com alcool etilico no processo termomecanico, in: Congr. Anual de Celulose e Papel, 19, ABCP, Sao Paulo, 1986, p. 161-176.

10.3 Level of Detail of the Source Material: Fairly well detailed.

10.4 Industry/Program Contact and Address: Dr. Jose Mangolini Neves, Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

10.5 Abstractor Name and Address: Dr. Jose Mangolini Neves, Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

11.0 Keywords

11.1 Waste type: Wood extractives

11.2 Process type/waste source: TMP process, pulp production

11.3 Cleaner Production Technique: TMP process, pulp production

11.4 Other Keywords:

11.5 Country Code: Brasil.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wood extractives, TMP process, pulp production

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: A chemithermomechanical pulping pilot based on bivis extruder produces pulp for paper and board trials with equipment adapted to use a new bleaching process.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Centre Technique du Papier, Domaine Universitaire, BP 7110, 38020 GRENOBLE cedex, France.

The pilot is located at the Lancey Mill, Aussedat Rey Group, close to Grenoble.

4.0 Cleaner Technology Category

The main feature of this process is pulp or chips sulfonation in reducing medium followed by H2O2 bleaching giving pulps at high level of brightness with good mechanical properties. It seems possible to replace all of the hardwoods chemical pulp and partly the softwood chemical pulp in coated base paper by the bivis pulp without modification of the paper quality.

5.0 Case Study Summary

5.1 Process and Waste Information: This bivis process, called SRP process (sulfite reducing peroxyde), is characterized by the following sequence:

- Pretreatment of chips with a chelating agent and washing.
- Impregnation with a sodium sulfite solution containing a more electronegative reducing agent than the sulfite ions. Afterwards heating in the absence of air at a temperature above 100°C during 3 to 30 minutes.
- Washing and bleaching of the sulfonated pulp with hydrogen peroxide in alkaline medium.

The second step is the key point of the process; the impregnation must be carried out at ambient temperature in the absence of air. The reducing agent is added to the sulfonation liquor just before the impregnation. The most efficient agent is sodium borohydrite used in the form of alkaline solution containing 12% of sodium borohydrite and 40% of caustic soda. The molar ratio $Na^2SO^3/NaBH^4$ should be higher than 8.

The pilot unit is running continuously producing pulp lots for paper and board trials. It includes principally two bivis machines and a double discs refiner operating in series. Chips defiberizing and sulfonation in reducing medium is carried out in the first machine, washing and bleaching in the second bivis machine. The bleaching reaction is carried out in a storage chest during one hour at 90°C. Then the bleached pulp is refined, screened and dewatered on the wet lap machine ready for use on a paper machine.

The installation also includes equipment for white waters recovery and their recycling in the process and for the preparation of chemicals mixtures for sulfonation and bleaching.

Bleached bivis pulps have been manufactured from softwoods chips (mixture of fir, spruce, sawmill waste) and from hardwoods (poplar).

5.2 Scale of Operation: The capacity of the bivis pilot unit is 10 t/day of bleached chemithermomechanical pulps.

5.3 Stage of Development: The Lancey bivis pilot plant has been running continuously. The figures are based on actual production.

5.4 Level of Commercialization: The process is patented and it needs special machinery (twin-screw extruders, which can be considered as a high temperature - short time reactor).
This machinery is built and sold by Clextral Company, Z.I.de Chazeau BP 10, 42702 FIRMINY, France, tel: 77 40 31 31, fax: 77 40 31 23.

5.5 Material/Energy Balances and Substitutions: See 6.2.

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	6-7 m_3/t of pulp
Energy Use:	N/A	1700-1800 kWh/T of pulp (softwoods) 1600-1700 kWh/T of pulp (hardwoods)

6.0 Economics*

6.1 Investment Costs: Total investment for a CTMP green field mill based on BIVIS technology:

- pulp capacity: 50 t/d (cotton); 20 million US$, (machinery: 6.5 million US$)
- pulp capacity: 75 t/d (wood): 23,5 million US$, (machinery: 7.5 million US$)

6.2 Operational and Maintenance Costs:

- wood consumption: 1.76 t of wood/t of pulp AD (process yield: 92%)
- cotton consumption: 1.38 t of cotton/t of pulp AD (process yield: 87%)
- kWh: 1,700-1,800 kWh/t (softwood), 1,600-1,700 kWh/t (hardwood)
- chemicals:
  - sodium hydroxide: 40 kg/t of pulp AD
  - sodium sulfite: 40 kg/t of pulp AD
  - hydrogen peroxide: 30-40 kg/t of pulp AD.
- maintenance costs
  - operating supplies: 8 US$/t of pulp AD
  - maintenance costs: 4% of investment cost/year.

6.3 Payback Time:

7.0 Cleaner Production Benefits

The Centre Technique du Papier (Grenoble) has been studying this new bleached high yield pulping process with reduced energy consumption for several years. The equipment is well adapted to use the new bleaching process developed by Atochem (chemical group) for the manufacture of softwoods and hardwoods pulps. The bleaching is carried out with hydrogen peroxide. Both brightness of the unbleached CTMP pulp and the hydrogen peroxide response to bleaching are greatly improved. Furthermore, it is possible to produce very strong pulps at high brightness levels because the brightening ability of sodium

borohydrite allows the use of higher levels of caustic in the sulfite treatment. Chemicals could be saved when very high brightness is required.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article and conference proceedings.

10.2 Citation:

(1) de Choudens, C., Angelier, R., Devic, M. and Kervennal, J., Chemithermomechanical pulps at high level of brightness obtained by the bivis process associated with a sulfonation in reducing medium, Paperi ja Puu - Paper and Timber 72 (1990):3, pp. 248-252;

(2) Devic, M., Kervennal, J. and Lachapelle, R.C., CTMP - Improved brightness and strength by sulfonation in presence of a reducing agent, Tappi Proceedings, 1988 Pulping Conference, New Orleans, Oct.30 - Nov. 2, Book 2, pp. 491-495.

10.3 Level of Detail of the Source Material: Additional information on bivis pulp and coating base paper properties is available in the source material.

10.4 Industry/Program Contact and Address: C. de Choudens and R. Angelier, Centre Technique de l'Industrie des Papiers, Cartons et Celluloses, B.P. 7110, 38020 Grenoble, France

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type:

11.2 Process type/waste source: Chemithermomechanical pulp, brightness, sulfonation

11.3 Cleaner Production Technique: Bivis extruder

11.4 Other Keywords:

11.5 Country Code: France.

12.0 Assumptions

13.0 Peer Review

Yes (articles in 10.2).

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Chemithermomechanical pulp, brightness, sulfonation, Bivis extruder

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The Neutral Sulfite-Anthraquinone (NS-AQ) pulping process offers advantages over kraft pulping.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

The United Paper Mills, Ltd., Rauma pulp mill, Finland.

4.0 Cleaner Technology Category

The NS-AQ pulping process results in higher yields and unbleached brightness levels than kraft pulping. NS-AQ pulps consume less active chlorine in bleaching than kraft pulps.

5.0 Case Study Summary

5.1 Process and Waste Information: Pine and birch chips were screened and the fraction of 2-6 mm thickness was used for pulping. The chips were pulped in a forced-circulation digester or in an electrically heated rotating group digester with autoclaves. The pulping liquor for the NS-AQ cooks was prepared for first absorbing SO^2 into a NaOH solution until the pH was 11.2, after which sodium carbonate was added as a buffer.

The NS-AQ cooks were performed under the following conditions: total alkali was 19-24% (as NaOH); the AQ dose was 0.1-0.2% of owen dry wood; the alkali ratio (Na^2SO^3:total alkali) was 0.6-0.94; the liquor-to-wood ratio was 3.5-4; the time to maximum temperature was 90-180 min; and the time at 165-185°C was 20-240 min.

In all cooks anthraquinone was mixed into the cooking liquor before adding it to the digester. The progress of delignification was followed in NS cooks under the following conditions: the liquor-to-wood ratio was 4.5; total alkali was 24% (as NaOH); the AQ charge was 0.2%; time to maximum temperature was 95 min; and time at 175°C was 280 min. The cooks were interrupted at different stages of pulping for total yield, carbohydrate, lignin, and similar determinations.

After pulping the pulps were washed in the digester or in a diffuser with warm water. High-kappa-number pulps were defibered in a refiner.

Reference pine kraft pulps were also prepared.

The bleachability of pine and birch NS-AQ pulps was studied with the following bleaching sequences: CEDH,CE/ODH, DE/ODH, OCEDH, ODE/ODH. In the C-stage no ClO^2-addition was used. The reference kraft pulps were bleached using the conventional sequence (C+D)EDED, where Cl^2-addition in C-stage was 15% of active chlorine.

The trials resulted in chemically defibered pulps with high yields (55-64% on wood) and a brightness of 45-55% ISO, the kappa number being 40-50. The optimum S:Na^2 ratio was 0.80-0.85. The pulps were fairly easy to bleach with the above mentioned sequences. The bleached yield of pine pulp was 49-51% and that of birch pulp 53-55%. The papermaking properties of the NS-AQ pulps were quite equal to those of kraft pulps except for the lower tear strength. The NS-AQ pulps are suitable for reinforcement pulp in newsprint, certain kraft papers, offset paper and liner body layer with higher yields than corresponding kraft pulps.

5.2 Scale of Operation: The above described tests were conducted in a laboratory scale digester of 20-liter volume.

NS-AQ pulping has also been tested in full scale mill trials. All together 15,000 tons of fully bleached pulp was made.

5.3 Stage of Development: Fully implemented. See 5.4.

5.4 Level of Commercialization: The produced pulp was tested in various end uses with pretty good results. However, there still remains many difficulties unsolved in the chemical recovery system and the research work on NS-AQ process is currently not going on.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs:

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

The NS-AQ process offers many advantages compared to the kraft process. Some of them are listed below:

-higher pulping yield
-fully bleached softwood pulps 5-7%-points
-fully bleached birch pulp 1-3%-points
-liner board body pulp 15%-points
-this means lower costs for wood raw material
-higher brightness of unbleached pulp
-easier to bleach to high brightnesses (less bleaching stages)
-no foul odor of liquor or condensates
-direct contact evaporation possible without odor problems
-many papermaking properties are exceptionally good despite the high yield
-sulfur-free crude turpentine and tall oil can be produced
-smaller inert load in chemical cycle

8.0 Obstacles, Problems and/or Known Constraints

The main drawbacks of the NS-AQ process are:

-pulping time at 175°C is about 25-30% longer than in kraft pulping at 170°C when aiming at a kappa number of 35-40
-delignification stops at a kappa level of 40, which means high total active chlorine consumption in bleaching or alkaline oxygen stage to start the bleaching

-some NaOH needs to be added (pH 10) to the spent liquor to avoid sticky precipitation in evaporation
-if oxygen stage is used for fully bleached pulps, additional NaOH is needed, which means that a small causticizing plant would be necessary
- the heat value of spent liquor is lower than that of kraft pulping black liquor
-the preparation of the cooking liquor containing mainly Na2SO3 and Na2CO3 is rather complicated. A recovery boiler is needed and the green liquor has to be converted to cooking liquor.

9.0 Date Case Study Was Performed: United Paper Mills Rauma pulp mill (previously Rauma-Repola) made fullscale mill trials with NS-AQ process during the years 1989-90.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles and conference proceedings.

10.2 Citation: 1. Aziz, S. and Sarkanen, K., Organosolv pulping - a review, Tappi Journal, March 1989, pp. 169-175.

2. Ojanen, E., Tulppala, J. and Virkola N-E., Neutral sulphite anthraquinone (NS-AQ) cooking of pine and birch wood chips, Paperi ja Puu-Paper and Timber, No 8, 1982, pp. 453-464

3. Tikka, P., Tulppala, J. and Virkola, N-E., Neutral sulphite AQ pulping and bleaching of pulps, Tappi Proceedings, International Sulfite Pulping Conference, 1982, pp. 11-21

10.3 Level of Detail of the Source Material: Additional information on the pulping tests conducted is available in the source material.

10.4 Industry/Program Contact and Address: Jukka Kettunen, The United Paper Mills Ltd., Rauman Sellu, P.O.Box 250, 26101 Rauma, Finland, phone: 938-3311, fax: 938-333404.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit,P.O.Box 205, SF-02151 Espoo, Finland, Tel. +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Pulping effluent.

11.2 Process type/waste source: Chemical pulping.

11.3 Cleaner Production Technique: Organosolv pulping, NS-AQ pulping, Neutral sulfite-anthraquinone pulping.

11.4 Other Keywords:

11.5 Country Code: Finland

12.0 Assumptions

13.0 Peer Review

Yes

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulping effluent, chemical pulping, organosolv pulping, NS-AQ pulping, neutral sulfite-anthraquinone pulping

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The Alkaline Sulfite Anthraquinone (ASAM) methanol pulping process produces pulps with strength properties comparable to kraft pulp using chlorine-free bleaching of softwood pulps with minimal environmental impact.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Kraftanlagen Aktiengesellschaft, Im Breitspiel 7, Postfach 103420, W-6900 Heidelberg, Germany.

4.0 Cleaner Technology Category

Kraft pulping is not allowed in Germany due to emissions to the air and the unacceptable effluent load. Sulfite pulp production is limited, because this process is not suitable for all wood, including the abundantly available pine. As a result, the pine wood must be exported and pulp imported from other countries. Sulfite pulp production could make a come-back in a cleaner form from the ASAM process.

5.0 Case Study Summary

5.1 Process and Waste Information: The process consists of three main sections. These are digestion and brownstock washing, screening and 4-stage bleaching, evaporation and methanol rectification.

The chips are pre-steamed for 15 minutes before the cooking liquor is added. A typical liquor consists of up to 25% inorganics, calculated as NaOH, based on dry wood, where 20% are Na^2SO^3 and the remaining 5% are added as NaOH or Na^2CO^3 or a combination thereof, 10-20% methanol, and around 0.1% of anthraquinone (AQ) as a catalyst. Cooking temperatures of 170-180°C must be maintained for 90-180 minutes. The cooking process can be modified to make different pulp grades for papers and boards by changing the cooking liquor's composition and pulping conditions.

Because unbleached ASAM pulp has very low lignin content, almost no extractives, and considerable initial-brightness, chlorine free bleaching is possible. After an initial oxygen delignification, ozone is used in a specially built reactor. Ozone has to be generated and consumed onsite. Hardwood and softwood pulps can be bleached to approximately 90% ISO brightness with the sequence OZWP.

The filtrates from the bleaching stage are led countercurrent and are mixed with the black liquor after brownstock washing. This enables the dissolved organic substances and the inorganic bleaching chemicals to be caught in the black liquor.

The chemical recovery process stages are comparable to those used with sodium based sulfite pulping, after the methanol has been stripped off the waste liquor evaporation and combustion, inorganic chemical conversion, cooking liquor preparation, and by-product making. Methanol separation and chemical conversion are added as different process steps to the recovery compared with kraft pulping. Most methanol can be condensed from the relief gases when the digester is opened, and the remaining part is stripped from the black liquor.

The AQ is almost completely dissipated in the cook, and none will be reclaimed.

As much water as possible is evaporated from the black liquor. The strong black liquor is burned in a boiler under reducing conditions. In the chemical recovery furnace, inorganic salts are recovered from the spent liquor in the smelt as sodium sulfide and sodium carbonate, and the

energy values of the organic materials are recovered to make steam and electricity for the pulp mill. In the chemical conversion the inorganic chemicals Na^2CO^3 and Na^2SO^3 are regenerated.

5.2 Scale of Operation: The pilot plant capacities are:

Digestion and brownstock washing, assuming two cooking cycles, 1.3-1.5 moisture free metric tons/day

Screening and bleaching 4.6-5.0 moisture free metric tons/day

Water evaporation 29.0 metric tons/day.

5.3 Stage of Development: The process was developed by Professor Patt and Dr. Kordsachia at the University of Hamburg. Energy systems manufacturer Kraftanlagen Heidelberg bought the process and patented it. Feldmuhle co-operated in the practical aspects of the process. The ASAM pilot plant was started in November 1989 and was dedicated at Feldmuhle's Baienfurt mill in early April 1990

5.4 Level of Commercialization: See 5.3. Kraftanlagen Heidelberg has recently filed worldwide patent applications for the process.

Conventional machinery and components can be used.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:		
COD	N/A	< 10 kg/ADt pulp
BOD^5	N/A	<0.5 kg/ADt
AOX	N/A	0
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: In regard to green field mill, investment cost for an ASAM mill are about the same as for a kraft mill. By July 1991 Kraftanlagen Heidelberg will have spent DEM 20 million for R&D, with 30% of the amount paid by the FRG's Ministry of Research and Technology.

6.2 Operational and Maintenance Costs: Due to higher yields in ASAM cooks, savings in wood cost in case of hardwood of about 6-10% and in case of softwood of about 4-6% are gained. Cost for make up of cooking chemicals (Na^2SO^4, NaOH) are slightly higher for ASAM; reclaim efficiency of methanol is about 99% Under certain conditions, caustizing plant and lime kiln are not required.

According to our calculation, an OZEP respective an OEP sequence results in lower operating cost than an OCDED or an C/D E/O DED sequence. Actual costs for ozonization largely depend on prices for chemicals and electrical energy, which vary from country to country and from mill to mill. Ozone consumption usually ranges from 5 to 8 kg/ton of pulp; production cost for ozone

are estimated to be: in Finland(February 1991) US$ 1.28/kg, in Austria (June 1991) less than US$ 1.75/kg and in Germany (June 1991) US$ 1.45/kg.

Savings in effluent treatment are gained due to reduced flows.

An ASAM mill is as self-supporting in both heat and power as a modern kraft mill.

6.3 Payback Time: Payback time is as for a kraft mill.

7.0 Cleaner Production Benefits

No reduced sulfur compounds are made during the ASAM process and methanol is kept in a closed cycle system.

ASAM pulp can be bleached to high brightness in chlorine free sequences, and as a result, there are no toxic, difficult-to-degrade organic chlorine compounds. The bleached pulp is also free of dioxins and furans.

Poisonous and oxygen consuming substances are nearly at a zero level in the effluents. Official wastewater quality requirements as stated in Germany can be met easily, including the limits for COD and BOD, and for toxicity to maritime life. AOX will be zero because no chlorine chemicals are used, and for toxicity to maritime life. High yield and superior quality are among the economies the ASAM process offers in comparison with other pulping processes. It also permits the use of some unbleached hardwoods for the production of writing and printing papers.

The chemicals in ASAM process can be recovered together because the same base is used in the bleach plant as in the cook. The process can be used with a wide variety of raw materials, and there is no special requirements for debarking or chip quality.

8.0 Obstacles, Problems and/or Known Constraints

Due to volatility of pulping chemicals no leaks and spills can be tolerated, both for environmental and economic reasons.

9.0 Date Case Study Was Performed: The pilot plant operation started in November 1989 with the departments cooking and evaporation including the methanol recovery. The inauguration was held in April 1990. In June 1990 the bleach plant went on line.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article, conference proceedings, brochures and unpublished material.

10.2 Citation:

(1) Zimmermann, M., Patt, R., Kordsachia, O., and Hunter, W.D., ASAM Pulping of Douglas-fir Followed by a Chlorine-free Bleaching Sequence, Tappi Journal, November 1991, pp. 129-134;

(2) Kopfmann, K., Conversion of an Existing Kraft Pulp Mill to an ASAM Mill, Tappi Proceedings, Pulping Conference, November 1991, pp. 925-931;

(3) Fuchs, K., Rimpi, P., and Brown, C., Chemical Recovery System for an ASAM Mill, Tappi Proceedings, Pulping Conference, November 1991, pp.259-270;

(4) The Right Approach to Pollution-free Pulping, ASAM Pilot Plant Confirms Laboratory Test Results, Kraftanlagen Heidelberg, brochure, 8 p.;

(5) The Right Approach to Pollution-free Pulping, ASAM-Report 1, Kraftanlagen Heidelberg, brochure, 8 p.;

(6) Der Richtige Weg zur Umweltfreundlichen Zellstoff-erzeugung, Kraftanlagen Heidelberg, brochure, 8 p.;
(7) Fuchs, K., The ASAM Process, Kraftanlagen Heidelberg, 13 p.;

(8) Patt, R., Schubert, H-L., Kordsachia, O., Oltmann, E., and Ridder, W., The ASAM Process - Competitor to Kraft Pulping?, 24 p.

10.3 Level of Detail of the Source Material: Additional information is available in the source material.

10.4 Industry/Program Contact and Address: Kraftanlagen Aktiengesellschaft, Im Breitspiel 7, Postfach 103420, W-6900 Heidelberg, Germany, phone: -6221/94-01, fax: -6221/94-1707, telex: 461831.

10.5 Abstractor Name and Address: Mrs. Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Tel. +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf.

11.0 Keywords

11.1 Waste type:

11.2 Process type/waste source: Chemical pulping, Delignification, Closed cycle mill, Sulfite pulping with methanol, Dissolved lignin

11.3 Cleaner Production Technique: ASAM pulping, Counter current flow of bleach filtrates, AOX elimination, Anthraquinone

11.4 Other Keywords:

11.5 Country Code: Germany.

12.0 Assumptions

13.0 Peer Review

Yes (No 1 in 10.2) others unknown.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Chemical pulping, Delignification, Closed cycle mill, Sulfite pulping with methanol, Dissolved lignin, ASAM pulping, Counter current flow of bleach filtrates, AOX elimination, Anthraquinone

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The ORGANOCELL-organosolv pulping process produces easy to bleach, sulphur-free pulps bleachable with chlorine products and genrates sulfurfree lignin as a by-product.

2.0 SIC/ISIC Code: I3411, I3511

3.0 Name and Location of Company:

The ORGANOCELL process has been developed by ORGANOCELL GmbH, a subsidiary of Technocell AG, Both companies with main office in Muenchen, Germany.

4.0 Cleaner Technology Category

In a country with no kraft pulping industry and with stringent environmental regulation, the ORGANOCELL process is the only means of producing bleached pulps from locally available raw materials, such as hardwoods, resinous softwoods as well as annual plants without the use of sulfur and chlorine containing bleaching chemicals. The ORGANOCELL process is a complementary pulping process to existing pulping processes. The ORGANOCELL process offers the user the means of producing chemical pulps without sulfur emissions. Bleach plant effluent streams are not contaminated with chlorinated waste products since no chlorine products are used for bleaching purposes.

5.0 Case Study Summary

5.1 Process and Waste Information: The ORGANOCELL process is essentially an all-alkaline pulping process. In the operation of the demonstration plant the wood chips are initially impregnated at a temperature of 110-140°C with a mixture of alcohol and water. Either methanol or ethanol can be used in the process.

From the impregnation stage the softened wood chips are transported into the digester where alkali and catalytic amounts of anthraquinone (AQ) are added. The pulping liquor is indirectly heated to 165-170°C, which produces a pressure of approximately 13 bar in the dome above the chip pile inside the digester, due to the methanol, 25-30% by volume, in the aqueous pulping liquor. The wood chips are then cooked for a period of 120 minutes, the alkali charge and the cooking time depending on the degree of delignification of the wood chips desired.

From the cooking zone, the delignified wood chips move inside the digester downward into the high-heat wash zone where they are washed countercurrently with wash liquor from the pulp washers following the in-digester wash zone. Once discharged from the digester, the pulp is screened on a knotter screen to remove knots and coarse uncooked wood pieces and then sent to the bleach plant. In the first bleaching stage, oxygen and alkali are mixed with the pulp.

While in the oxygen stage, the main objective is to remove residual lignin from the pulp fiber without imparting damage to the cellulose during the alkaline oxygen treatment, the bleaching stages following the oxygen stage bring the most brightness improvements.

Attached to the ORGANOCELL demonstration plant is an experimental plant for the electrolytic recovery of sodium ions from black liquor. The plant is being operated on an intermittent basis to collect sulfur-free lignin and also to gain operational experience in the operation of said plant.

The ORGANOCELL process is capable of producing a wide range of pulps from hardwoods, softwoods and annual plants. ORGANOCELL type pulps are equal in quality to Kraft pulp properties. These pulps are bleached without chlorine products to quite high brightness levels. AOX discharges from bleach plants are insignificant.

5.2 Scale of Operation: The demonstration plant is capable of producing up to 5 tpd bleached pulp.

5.3 Stage of Development: The demonstration plant can be operated on a continuous basis, 24 hours/day.

5.4 Level of Commercialization: Since 1988, ORGANOCELL GmbH is the owner of the Bayerische Zellstoff GmbH at Kelheim, Germany. The mill used to produce 65,000 tpy fully bleached specialty pulps by a Mg-bisulfite process, however, was to be shut down because of environmental reasons. In early 1989, engineering was started to convert the mill to the ORGANOCELL process with a yearly capacity of 150,000 tons fully bleached softwood pulp. The pulp produced will be bleached totally chlorine free. Start-up of the new plant will be during the third quarter 1992.

The rebuild of the Kelheim mill is carried out by the engineering company ORGANOCELL THYSSEN GmbH. The same company will also handle greenfield pulp mill projects as well as mill rebuilds to the ORGANOCELL process world-wide.

5.5 Material/Energy Balances and Substitutions: The operation of conventional pulp mills is characterized by the emission of sulfur containing products into the air. With the conversion of a mill to the ORGANOCELL process, these emissions no longer exist. The ORGANOCELL process does not produce any hazardous waste by-products. Since no sulfur is used in the process, by-products from the process can either be used in other industries (e.g., cement industry) or can be disposed by burning.

With the operation of the mill at Kelheim with an expanded capacity of 150,000 tpy, wood residues from several hundred saw mills in the region will be used. As a consequence, this will result in a more efficient use of regionally available fiber materials.

It is anticipated that the amount of fresh water used in the process will be approximately 30 cubic meters per ton pulp produced. The mill will be energy self sufficient by burning the organic wood degradation products produced in the pulping process. Some natural gas will be required in the chemicals recovery area of the mill to reburn calcium carbonate to lime.

6.0 Economics*

6.1 Investment Costs: The ORGANOCELL process is the first solvent pulping process commercially implemented for the use of softwoods. Investment cost as well as operational cost for an ORGANOCELL type pulp mill will be lower than those for a Kraft mill since no odor control equipment will be required. The chemicals recovery portion of the plant is also simpler than that of a Kraft mill due to the absence of sulfur from the process.

6.2 Operational and Maintenance Costs: These costs will be lower than for a conventional Kraft mill since no odor control equipment will have to be operated or maintained.

6.3 Payback Time: The payback time will be the same, if not shorter, than for a conventional Kraft mill due to the lower investment cost for an ORGANOCELL type pulp mill.

7.0 Cleaner Production Benefits

The ORGANOCELL process produces a sulfur-free pulp as well as sulfur-free lignin. The pulp can be bleached to market-accepted brightness levels without any chlorine products.

8.0 Obstacles, Problems and/or Known Constraints

ORGANOCELL type pulps are processed in the demonstration plant in a manner similar to Kraft pulps. No special equipment is required and plant operating practices are similar to those of a Kraft mill. Pulp

is washed inside the digester countercurrently with wash water from the brown stock washers. Fresh water is applied to the last stage of the brown stock washers and the filtrate cascaded back into the high-heat wash zone of the digester and ultimately into the evaporators/chemicals recovery plant.

In the 5-year operation of the demonstration plant, no unstable operating situations have ever been encountered. Pulping trials with mixed North American hardwoods have produced pulps which have physical properties superior to those which are normally produced from the same fiber source by the Kraft process.

9.0 Date Case Study Was Performed: The ORGANOCELL demonstration plant, located in a residential area of Muenchen, Germany, has been operated since 1987 without any objectionable impact on the surrounding area.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles.

10.2 Citation:

(1) Dahlmann, G. and Schroeter, M.C., The Organocell Process- Pulping with the Environment in Mind, Tappi Journal, April 1990, pp. 237-240;

(2) Aziz, S. and Sarkanen, K., Organosolv Pulping - A Review, Tappi Journal, March 1989, pp. 169-175;

(3) Aziz, S., McDonough, T., Thompson, N. and Doshi, M.R., Solvent Pulping - Promise and Programs, Tappi Journal, February 1988, pp. 251-256;

(4) Newsfront, Pulp Bleaching - The race for Safer Methods, In Chemical Engineering, January 1991, pp. 37-43;

(5) Pride, D., Old Pulps for New, Paper, 6 November, 1990, pp. 26-28;

(6) Pulping Technology - Beyond the Kraft Process, Asia Pacific Pulp & Paper, May 1991, pp. 15-17.

10.3 Level of Detail of the Source Material: Some additional information, specially on pulp properties, is available in the source material used.

10.4 Industry/Program Contact and Address: Gerhard Dahlmann, chief executive officer and Martin C. Schroeter, Dr., project manager, Organocell Thyssen GmbH, Brauhausstrasse 4a, D-8033 Planegg, Germany, phone: 0 89/8 56 08-0, fax: 0 89/8 56 09-13.

10.5 Abstractor Name and Address: Gerhard Dahlmann, chief executive officer and Martin C. Schroeter, Dr., project manager, Organocell Thyssen GmbH, Brauhausstrasse 4a, D-8033 Planegg, Germany, phone: 0 89/8 56 08-0, fax: 0 89/8 56 09-13.

11.0 Keywords

11.1 Waste type: Pulp plant effluent

11.2 Process type/waste source: Pulping, Chemical pulping, Organosolv lignins

11.3 Cleaner Production Technique: Environmental control, Organosolv pulping, Solvents, Methanol, Alcohols, ORGANOCELL process

11.4 Other Keywords:

11.5 Country Code: Germany.

12.0 Assumptions

13.0 Peer Review

Yes (all articles in 10.2).

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulp plant effluent, Pulping, Chemical pulping, Organosolv lignins, Environmental control, Organosolv pulping, Solvents, Methanol, Alcohols, ORGANOCELL process

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Alcell-organosolv pulping process produces high-quality, fully bleached pulps without water-soluble waste or noxious gases.

2.0 SIC/ISIC Code: I3411, I3511

3.0 Name and Location of Company:

Repap Enterprises Inc., Newcastle, New Brunswick, Canada.

4.0 Cleaner Technology Category

The Alcell-process uses simple aqueous ethanol as a pulping liquor. Organosolv pulping methods offer a means of curtailing volatile sulphur compound emissions in digestion and chlorinated organics in bleach plant effluents. The simplicity of organosolv pulping makes it possible to establish minimills (200 tpd capacity) in locations with limited wood supplies.

5.0 Case Study Summary

5.1 Process and Waste Information: Repap Enterprises started up a mill at Newcastle to demonstrate and test a proprietary organosolv pulping method known as Alcell process. The pulping process consists of the following steps. The key to the process is to sequence pulping in three stages. Preheated chips are packed in the digester using steam, and the steaming is continued to displace air from the chips. Preheated solvent, 50% (weight/weight) denatured ethanol/water mixture that has been previously used as a wash liquor for two earlier batches is pumped in and rapidly brought up to pulping temperatures of 190-200°C, corresponding to an operational pressure of 400-500 psig. The liquor is continuously circulated during the pulping. At the end of this period, the liquor is displaced by wash liquor that was used in the second washing stage of the previous batch. The displaced liquor flows to the lignin and sugar recovery system. The third-stage wash liquor is displaced by fresh liquor and flows into an storage tank for use in the second stage. The second stage-wash liquor is drained into another tank for use in the digester.

At this point, the digester contains soaked, delignified chips and alcohol-water vapor at pulping temperature and pressure. It is depressurised and the departing vapor is condensed for reuse as fresh pulping liquor. Finally, the alcohol remaining in the digester is driven off by steaming. The pulp is diluted with water and pumped out of the digester for cleaning and bleaching treatments. The first-stage spent liquor entering the by-product recovery area is first flashed and then diluted with process water to precipitate the dissolved lignin. After settling, the solid lignin is separated by centrifugation, washed and dried. The filtrate enters a distillation tower, where alcohols and some acetic acid and furfural are recovered. Finally, the remaining aqueous liquor is further evaporated to a sugar syrup.

The facility has produced pulp from individual species as well as mixtures of northern hardwoods, aspen, birch and maple. The pulp has been bleached in the adjacent kraft mill's bleach plant, mostly in combination with softwood kraft, using conventional oxygen bleaching procedures and further bleaching by DED sequences. In general, the pulps are more easily bleached than kraft. The physical properties of bleached Alcell and kraft pulps were comparable. The specific bending stiffness of Alcell pulps is improved over kraft pulps. It is an advantage in alkaline papermaking, where significant filler is used in the sheet.

The product lignin can amount to about 18% by weight of the dry wood charge. It is highly hydrophobic, contains no measurable sulfur and very low ash, and as a consequence is quite distinct from either lignosulfonates or kraft thiolignin. It is a uniform product with a number average molecular weight of about 1000 daltons, a softening point of about 145°C, and a glass transition

temperature of about 100°C. The dried and bagged product has a moisture content of less than 3%, and a median particle size of 20-40 um.

The by-product furfural, which is recovered as an impure side draw, is upgraded and sold.

5.2 Scale of Operation: The facility can produce more than 15 tons of unbleached pulp per day. More than 5 tons of Alcell lignin are being produced daily.

5.3 Stage of Development: A demonstration plant of 15 tpd capacity is working and a commercial-scale mill with an approximate capacity of 300 metric tons/day is planned to be designed.

5.4 Level of Commercialization: The Alcell process is patented and it can be accomplished on existing mill equipment.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: The facility in Newcastle has cost in excess of 95 million CAD (1989 or 1991) to build and operate.

Without a need for a recovery furnace, lime kiln, causticizers, and brownstock washers, the Alcell process has a substantial capital cost advantage over a comparably scaled kraft mill.

6.2 Operational and Maintenance Costs: See 6.1.

Without the recovery furnace and other high-maintenance equipment, an Alcell mill should have lower maintenance and operating labor costs. On the other hand, the recovery and sale of lignin and other by-products creates additional demand for externally generated energy. So the utility and cooking chemical cost is higher.

6.3 Payback Time:

7.0 Cleaner Production Benefits

The process is odorless, is free from TRS (total reduced sulfur) and methyl mercaptans, is free from liquor dregs and lime grits, and produces minimal amounts of knots and rejects. The major effluent, apart from the bleach-plant effluent, is the stillage evaporator condensate, which contains only easily treated BOD (mostly acetic acid, ethanol, and a few other minor organic volatiles). The bleach-plant effluent, as currently anticipated for the 300-metric-ton/day mill, will contain no dioxins or furans, and AOX levels should be below 1 kg/metric ton of pulp. An Alcell mill requires far less water than a kraft mill.

8.0 Obstacles, Problems and/or Known Constraints

Due to volatility of pulping chemicals no leaks and spills can be tolerated, both for environmental and economic reasons.

9.0 Date Case Study Was Performed: The demonstration plant at Newcastle started up in March 1989.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles.

10.2 Citation:

(1) Pye, E.K., and Lora, J.H., The Alcell Process, Tappi Journal, March 1991, pp. 113-118;

(2) Pride, D., Old Pulps for New, Paper, 6 November, 1990, pp. 26-28;

(3) Aziz, S. and Sarkanen, K., Organosolv Pulping - A Review, Tappi Journal, March 1989, pp. 169-175;

(4) Aziz, S., McDonough, T., Thompson, N. and Doshi, M.R., Solvent Pulping - Promise and Programs, Tappi Journal, February 1988, pp. 251-256.

10.3 Level of Detail of the Source Material: Some additional detail information is available in the source material used.

10.4 Industry/Program Contact and Address: Mrs. Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf.

10.5 Abstractor Name and Address: Same as in 10.4.

11.0 Keywords

11.1 Waste type:

11.2 Process type/waste source: Chemical pulping, Delignification, Organosolv lignins

11.3 Cleaner Production Technique: Organosolv pulping, Solvents, Alcohols

11.4 Other Keywords:

11.5 Country Code: Canada.

12.0 Assumptions

13.0 Peer Review

Yes (all articles in 10.2).

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Chemical pulping, Delignification, Organosolv lignins, Organosolv pulping, Solvents, Alcohols

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Sulphur- and chlorine-free oxygen-alkali cooking process

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

The Pulp and Paper Research and Production Complex (VNPObumprom), 194021, St Petersburg, Soviet.

4.0 Cleaner Technology Category

The process produces sulphur-and chlorine-free pulps. The untreated effluent has been shown to be totally non-toxic.

5.0 Case Study Summary

5.1 Process and Waste Information: The process uses oxygen-alkali cooking and a type of pulsed digester. Conventional technology is used before and after pulping. Pre-steaming is necessary.

The digester vessel contains a number of plates that divide it into zones. Gaseous oxygen is dispersed at each of the plates and the digester is agitated by pulsation. This pulsation action creates a coarse fibre screening and helps in the fine dispersion of the oxygen.

The three process components - oxygen, chips, cooking liquor - are in constant motion so there are no dead zones within the digester. The process achieves three things: pulping, screening and degradation of non-easily oxidizable organics.

Three possible alkaline agents can be used: ammonium hydroxide, sodium carbonate or sodium hydroxide. There is no difference in pulp quality, no matter which agent is used. Cooking time is four hours for hardwood, a little longer for softwood. Studies are now under way to reduce the cooking time by using catalysts.

All chemical agents are recovered in the process and the cooking liquor is evaporated and burned. Crystalizers are used. The evaporators handle up to 50% solids, and there is no problem with fouling. Because oxygen is used as a cooking agent, the resin fatty acids are oxidized during the pulping process.

The cooking process occurs at the surfaces of the chips and hydrodynamic forces ensure continuous removal of fibres out of the digester. When fibres at the surface have been delignified, they are removed, exposing a new surface. Therefore, chips of standard thickness can be used. As the outer layers detach during delignification, they move to a discharge zone. Chip quality does not play a big role. Also, various wood species may be cooked together with no negative effect on pulp quality.

Bleaching is a three-stage process using oxygen and other oxygen-containing substances (peroxide) and brightness levels as high as 87 may be achieved. The bleached pulp does not lose mechanical strength properties. With no chlorine needed for bleaching, the process has eliminated chlorinated organics.

5.2 Scale of Operation: There is a 0.5 tpd pilot plant at the Sjas mill near St Petersburg.

5.3 Stage of Development: Pilot stage.

5.4 Level of Commercialization: A semi-industrial size plant, 35,000 tons per annum, is under construction with start-up due in 1992. The equipment needed is commercially available. Digester construction is of the same steels used in Kamyr digesters.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use: O2	N/A	400 kg/t pulp
Water Use:	N/A	N/A
Energy Use:	N/A	N/A
Pulp yield:	100	105-107

6.0 Economics*

6.1 Investment Costs: Production and equipment costs are 20% below those of kraft, based on studies done by an independent foreign firm.

6.2 Operational and Maintenance Costs: See 6.1.

6.3 Payback Time:

7.0 Cleaner Production Benefits

See 4.0

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed: The semi-industrial plant will start-up in 1992. At the same time, equipment for producing 100,000 and 250,000 tons per annum is being developed and designed.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article and conference proceedings.

10.2 Citation:

(1) Rodden, G., Now It's Glasnost for Pulping, Paper, 4 September, 1990, p.15.;

(2) Germer, E.I., Oxygen-alkaline Delignification Catalysis, Ligno-Cellulosics - Science, Technology, Development and Use, (Ed.) J.F.Kennedy, G.O. Phillips, P.A. Williams, Ellis Horwood 1992, pp. 227-237.

10.3 Level of Detail of the Source Material: Additional information is not available in the source material.

10.4 Industry/Program Contact and Address: Mrs. Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf.

10.5 Abstractor Name and Address: Same as in 10.4.

11.0 Keywords

11.1 Waste type: Pulp plant effluent

11.2 Process type/waste source: Chemical pulping, bleaching

11.3 Cleaner Production Technique: Oxygen-alkali cooking, Oxygen bleaching, Peroxide bleaching

11.4 Other Keywords: Sulphur-free, Chlorine-free, Non-toxic

11.5 Country Code: Soviet.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulp plant effluent, Chemical pulping, bleaching, Oxygen-alkali cooking, Oxygen bleaching, Peroxide bleaching, Sulphur-free, Chlorine-free, Non-toxic

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The Modified Continuous Cooking (MCC) process adapts the principles of extended delignification to continuous pulping.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

The method has been applied in about ten mills in Scandinavia, North America, and Japan. One of them is at Iggesund in Sweden.

4.0 Cleaner Technology Category

The principles of extended delignification have been adapted to continuous pulping. The process is known as modified continuous cooking (MCC). Kappa number reductions of 8 units for softwood and 4-5 units for hardwood have been accomplished without loss of strength properties. About 20-25% less total active chlorine is needed to bleach the pulp to about 90% ISO brightness, compared to the conventional kraft pulp.

The MCC process is a process that produces pulps of high viscosity suitable for oxygen delignification. MCC, oxygen delignified, bleached pulps were prepared using bleaching sequences with and without chlorine, using a four stage sequence of (C+D)(EO)DD and D(EOP)DD. At 100% substitution of chlorine dioxide for chlorine in the first stage AOX is less than 1,0 kg/ton in the effluent before external treatment, chlorinated phenols are 98% eliminated, and the dioxin content of the bleached pulp is close to the limit of detection.

5.0 Case Study Summary

5.1 Process and Waste Information: The MCC process rectifies the drawbacks in a conventional, continuous kraft cook. The effective alkali concentration through the duration of the cook is evened out by decreasing it at the beginning of the cook and increasing it at the end. This makes up for the high effective alkali concentration at the beginning and low concentration at the end of a conventional kraft cook.

In a conventional cook, the high bulk lignin concentration at the end of the cook hinders diffusion of dissolved lignin out of the chips, causing reprecipitation. This is tackled by reducing the concentration of bulk lignin from the digester and adding fresh chemicals, accomplished by carrying out the final cooking stage countercurrently, where white liquor is also added.

The MCC process has been accomplished through the modification of two-vessel Kamyr continuous digesters to allow both the introduction of white liquor at several points and the countercurrent flow of the liquor during the final cooking phase.

A nonchlorine fiber line, which has been commissioned, consists of a digester for medium-consistency cooking and a medium-consistency, oxygen-delignification stage, followed by an efficient post-oxygen washing stage with pressure diffuser and a wash press. Bleaching is carried out with the sequence (C+D)(EOP)DD with a pressurized extraction stage and a pressure diffuser for efficient washing. If required, the first stage can be carried out without chlorine.

Compared with conventional bleaching, a nonchlorine alternative has some significant effects on the environment. AOX is less than 1.0 kg/ton in the effluent before external treatment. Chlorinated phenols are 98% eliminated. Finally, the dioxin content of the bleached pulp is extremely low, close to the limit of detection.

5.2 Scale of Operation: The modified continuous cooking process has been successfully introduced in the pulp industry. Today the method has been applied in about ten mills. A laboratory study was conducted to show the bleachability of MCC pulp. The bleaching sequences were (C+D)(EO)DD and D(EO)DD.

5.3 Stage of Development: The MCC process has been successfully introduced in mill scale.

5.4 Level of Commercialization: The MCC process has been developed by Kamyr AB and it has been commercialized. The commercial mills using MCC technology reported are Ahlström's mill in Varkaus, Finland, the Metsä-Botnia's mill in Äänekoski, Finland and the Korsnäs' mill in Gävle, Sweden.

5.5 Material/Energy Balances and Substitutions

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs:

6.2 Operational and Maintenance Costs: The extra chemical costs for D(EOP)DD bleaching are about $10/ton (1989) or less, a reasonable cost when compared with conventional alternatives.

6.3 Payback Time:

7.0 Cleaner Production Benefits

The above mentioned fiber line,which have been commissioned in a Scandinavian mill, can be regarded as one of the most advanced in the world today, meeting current and future requirements for the environment while still producing fully competitive pulp. It is possible to produce bleached pulp without the use of chlorine, achieving brightnesses even above 90% ISO, the level required for the most demanding market pulps.

8.0 Obstacles, Problems and/or Known Constraints

The absence of chlorine requires extra efforts in all process stages from cooking to final bleaching. For final bleaching, the sequence D(EOP)DD is suitable, with some modifications of normal practice. In the first stage, the chemical charge should be generous. Low-multiple alternatives are not relevant when chlorine is absent. Also, in the enforced extraction stage, both temperature and oxygen pressure should be high. Magnesium is a good viscosity protector in such an EOP stage and when the hydrogen peroxide is absent.

9.0 Date Case Study was Performed: The MCC process has been operated on a commercial scale since 1983

10.0 Contacts and Citation

10.1 Type of Source Material: Journal Articles

10.2 Citation:

(1) Dillner, B., Larsson, L. and Tibbling, P., Nonchlorine Bleaching of Pulp Produced by the Modified Continuous Cooking Process, Tappi Journal, August 1990, pp. 167-172;

(2) Bowen, I.J. and Hsu, J.C.L., Overview of Emerging Technologies in Pulping and Bleaching, Tappi Journal, September 1990, pp. 205-217;

(3) Heimburger, S.A., Blevins, D.S., Bostwick, J.H. and Donnini, G.P., Kraft Mill Bleach Plant Effluents: Recent Developments Aimed at Decreasing Their Environmental Impact, Part 1, Tappi Journal, October 1988, pp. 51-60;

(4) Pride, D., Old Pulps for New, Paper 6 November 1990, pp.26-28;

(5) Reduction of Chloro-organic Discharge in the Nordic Pulp Industry, Environment Report 1989:6E, Prepared by Jaakko Põyry for The Nordic Council of Ministers, April 1989, 103 p.

10.3 Level of Detail of the Source Material: Additional information on pulp properties and effluent characteristics is available in the source material.

10.4 Industry/Program Contact and Address: Dillner, Larsson and Tibbling, Kamyr AB, Karlstad, Sweden.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf.

11.0 Keywords

11.1 Waste type:

11.2 Process type/waste source: Kraft pulping, Oxygen delignification, Bleaching, Chlorination

11.3 Cleaner Production Technique: Modified continuous cooking, Extended delignification, Hydrogen peroxide

11.4 Other Keywords: Strength properties, Chlorine dioxide

11.5 Country Code: Sweden.

12.0 Assumptions

13.0 Peer Review

Yes (all articles in 10.2).

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Kraft pulping, Oxygen delignification, Bleaching, Chlorination, Modified continuous cooking, Extended delignification, Hydrogen peroxide, Strength properties, Chlorine dioxide

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The Rapid Displacement Heating (RDH) process allows extended delignification requires less active chlorine to bleach the pulps to 90% ISO brightness than in conventional kraft pulping and decreases caustic soda consumption.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

United Paper Mills, Joutseno-Pulp, 54120 Pulp, Finland.

4.0 Cleaner Technology Category

The RDH process has proven itself not only by cooking stronger, more uniform pulp than conventional systems, but by significantly reducing energy and chemical costs at the same time. Because the RDH cooking process removes more lignin from wood chips than do conventional systems, less chlorine based chemicals are needed in the bleaching phase (when cooking to lower kappa number). Caustic soda consumption is also decreased.

5.0 Case Study Summary

5.1 Process and Waste Information: In the operating cycle of the RDH system, the batch digester is charged with chips and packed with liquor or steam. The technique increases packing density by up to 10%, thereby increasing pulp production per digester. The digester is then filled with warm liquor of high sulfidity (low active alkali) at 100°C. The elevated pressure in the digester serves to uniformly impregnate the chips. The warm liquor is displaced with hot white and black cooking liquors. The digester is heated, and the cook continues to the desired H-factor.

At the end of the cook, displacement continues with washer filtrate until the pulp temperature is below boiling point. The displaced liquor is collected in an accumulator. The digester is discharged either with compressed air or by using pumping machine. Special heat exchangers are employed to preheat the white liquor for the next cook to about 155°C.

The pulp made via extended delignification was bleached to 90% ISO using 7.5% active chlorine (11.7% for conventional kraft pulp). Caustic soda consumption decreased from 4.3% to 2.7%. Pulp strength properties were equal to or superior to the conventional kraft pulp.

Unbleached and bleached pulp strength increased 10% at Joutseno. Displacement of the hot spent liquor with washer filtrate is equivalent to a washing stage.

5.2 Scale of Operation: The capacity of the Joutseno Pulp mill is 800 ADt/day of bleached pulp.

5.3 Stage of Development: The RDH process has been developed by Beloit Corp. and it is on a commercial stage of development. It was introduced to the industry in 1985.

5.4 Level of Commercialization: RDH is now on stream at Joutseno, Finland; S.D. Warren's Westbrook mill; Bowater Southern at Calhoun, Tenn.; Fletcher Challenge Canada at Crofton, B.C.; at Willamette in Bennettsville, S.C., and at Chung Hwa in Taiwan , while Potlatch will go on stream with RDH at their mill in Cloquet, Minn., in about two years.

5.5 Material/Energy Balances and Substitutions

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	4 GJ/t	2 GJ/t

6.0 Economics

6.1 Investment Costs: The rebuild of an existing cooking department implies a significant investment.

6.2 Operational and Maintenance Costs: Slightly higher than in conventional cooking.

6.3 Payback Time: Over 10 years.

7.0 Cleaner Production Benefits

The RDH process is cooking stronger, more uniform pulp, reducing energy and chemical costs. It requires less chlorine based bleaching and an added side benefit has been less soda loss over the washing line. The fossil fuel consumption and the blow tank sulfur TRS emissions have been reduced.

8.0 Obstacles, Problems and/or Known Constraints

When rebuilding existing digesters for the modified cooking process, new screens have to be mounted in the digesters and a number of large pressurized accumulators installed.

9.0 Date Case Study was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles and an Environment report.

10.2 Citation:

(1) Kaiser, M. and Pitre, R., Beloit's (RDH) displacement heating at Owens-Illinois, Valdosta, Georgia, Tappi Journal, October 1986, pp. 45-48;

(2) Revolution in Kraft Pulping Technology - international Kraft pulpers gather in Maine to discuss RDH, reference not known, pp. 26-28;

(3) Bowen, I.J. and Hsu, J.L., Overview of emerging technologies in pulping and bleaching, Tappi Journal, September 1990, pp. 205-217;

(4) Reduction of Chloro-organic Discharge in the Nordic Pulp Industry, Environment Report 1989:6E, Prepared by Jaakko Põyry for The Nordic Council of Ministers, April 1989, 103 p.

10.3 Level of Detail of the Source Material: Some additional information on the cooking cycle is available in the source material.

10.4 Industry/Program Contact and Address: Seppo Pursiainen, United Paper Mills, Joutseno-Pulp, 54120 Pulp, Finland, phone: 953-3071, fax: 953-307378.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Tel. +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf.

11.0 Keywords

11.1 Waste type: Pulp mill effluent.

11.2 Process type/waste source: Kraft pulping, Extended delignification.

11.3 Cleaner Production Technique: Energy saving, RDH, Displacement heating.

11.4 Other Keywords:

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

Yes (all articles in 10.2).

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulp mill effluent, Kraft pulping, Extended delignification, Energy saving, RDH, Displacement heating.

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: "Super Batch" cooking process based on the principles of extended delignification been developed to reduce chlorinated compounds in the discharge of bleach plant effluent.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

The first "Super Batch" cooking process will be started in 1992 at the Enocell Oy's pulp mill in Finland.

4.0 Cleaner Technology Category

The "Super Batch" cooking system was originally developed to make batch cooking more energy efficient. The system has been modified to achieve extended delignification in some mills. Environmental influence of effluents from bleaching of modified pulps is reported to be reduced if compared to conventional pulps.

5.0 Case Study Summary

5.1 Process and Waste Information: Extended delignification refers to modifications of pulping processes, particularly the kraft processes, so as to prolong or extend the cooking to lower pulp lignin content or the kappa number in the digester. The main operational drawbacks to extended delignification are increased steam consumption and cooking time. These drawbacks have been overcome by coupling this technology with "Super Batch" cooking.

In the "Super Batch" system the chips are preimpregnated and preheated with warm black liquor. Impregnation improves air removal from the chips. The digester will be hydraulically filled with liquor thus resulting in more uniform cooking.

Impregnation is followed by displacement with hot black and white liquor which gives very uniform pulp quality, high strength, low shives content, good heat economy, higher yield and makes extended cooking with good pulp properties possible.

Displacement with wash liquor at the end of cooking stops cooking reactions, cools the pulp and improves pulp washing by lowering the final black liquor solids.

5.2 Scale of Operation: Extensive mill-scale test runs have been performed in a Scandinavian pulp mill to observe the effects of extended cooking on the entire fiber line. The capacity of this mill is 900-1000 AD metric tons/day of bleachable-grade softwood or hardwood sulfate pulp.

The amount of Super Batch type pulp for the paper machine test runs was about 700 tons.

5.3 Stage of Development: Fully implemented, the first "Super Batch" mill is starting in 1992.

5.4 Level of Commercialization: The "Super Batch"- process has been developed by Sunds Defibrator AB, Sweden. The equipment is readily available. Quantitative figures are based on actual mill trials.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After (in bleaching effluent)
Waste Generation:	AOX 3.0 kg/t of softwood pulp	< 1.0 kg/t of softwood pulp
	COD 70 kg/t of softwood pulp	< 30 kg/t of softwood pulp
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	reduction in steam	consumption 70%

6.0 Economics*

6.1 Investment Costs:

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

The "Super Batch" cooking system enables very low steam consumption, washing in the digester and above all significantly improves the pulp quality and pulp yield.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article and a brochure and conference material.

10.2 Citation:

(1) Pursiainen, S., Hiljanen, S., Uusitalo, P., Kovasin, K. and Saukkonen, M., Mill-scale experiences of extended delignification with Super Batch Cooking method, Tappi Journal, August 1990, pp. 115-122;

(2) Super Batch Cooking System, Sunds Defibrator, brochure, 6 p.;

(3) Kovasin, K.K. and Tikka, P.O., Superbatch cooking results in superlow kappa numbers, Paper to be presented at SPCI, ATICELCA, "New available techniques conference", Bologna, Italy, May 19-22, 1992, 18 p.

10.3 Level of Detail of the Source Material: Some additional information on the bleaching process used and pulp properties is available.

10.4 Industry/Program Contact and Address: Päivi Uusitalo, Chief Engineer and Kari Kovasin, Manager of R&D, Sunds Defibrator Rauma Oy, Pori, Finland.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Tel. +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf.

11.0 Keywords

11.1 Waste type: Bleach plant effluent, Chlorinated organic material

11.2 Process type/waste source: Sulfate pulping, Chemical pulping

11.3 Cleaner Production Technique: Extended delignification, Super Batch cooking, Modified pulps

11.4 Other Keywords:

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

Yes (No 1 in 10.2) and no (No 2 and 3 in 10.2).

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleach plant effluent, Chlorinated organic material, Sulfate pulping, Chemical pulping, Extended delignification, Super Batch cooking, Modified pulps.

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Steam Explosion Pulping (SEP) uses less refining energy and may produce papers with strengths superior to conventional CMP or CTMP.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Universite du Quebec a Trois-Rivieres, Centre de recherche en pates et papiers, C.P.500, Trois-Rivieres, Qc G9A 5H7 CANADA, phone: (819)376-5075, fax: (819)376-5148

4.0 Cleaner Technology Category

The SEP pulping process produces hardwood/softwood pulp of strength comparable to that of low yield hardwood kraft pulp. In addition, the SEP process uses appreciably less refining energy than the conventional chemimechanical pulping processes. The environmental aspect of SEP process is similar to that of ultra-high yield CMP as far as cooking effluent is concerned and is about 50% lower in bleaching effluents.

5.0 Case Study Summary

5.1 Process and Waste Information: The steam explosion pulping process consists of the chemical impregnation of chips, short time steam cooking, pressure release, refining and bleaching. In order to protect the chips against oxydation during the cooking stage and to simultaneously develop hydrophilic groups on the fiber surface during the steam treatment, the impregnation solution contains antioxidant agents like Na^2SO^3. To assure good swelling of chips and, at the same time, to prevent acid hydrolysis leading to yield loss, swelling agents such as NaOH, Na^2CO^3 or $NaHCO^3$ are present especially during hardwood cooking. The chemical up-take is from 8% to 10%.

Short cooking time varying from 30 seconds to 6 minutes at temperatures varying from 170°C to 210°C leads to ultra-high-yield (90%+) explosion pulps of excellent pulp and paper properties.

Properties of exploded aspen, birch, maple or eucalyptus pulps are substantially better than those of corresponding ultra-high-yield CTMP or CMP and can approach those of equivalent low yield kraft pulps.

The brightness of exploded aspen pulps (60%+) can be increased to 80%+ level by application of 4% H^2O^2.

In the case of hardwood pulps, the explosion pulps lead to considerably stronger papers when compared to equivalent CMP/CTMP pulps but using substantially lower refining energy. The strength can be up to 50% superior and the refining energy requirement up to 50% less than those of conventional pulps.

5.2 Scale of Operation: In the experiments reported, eight tonnes of aspen chips were impregnated with sulphite and caustic.

Mills of 100,000 tons of pulp per year have been evaluated by several consulting companies like NLK, Nystrom Lee and Kobyashi, etc.

5.3 Stage of Development: Pilot stage.

5.4 Level of Commercialization: The technology is ready for commercialization via Stake Technology Ltd, Toronto, Canada.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before CMP	Quantity After SEP
Waste Generation:		
cooking		
BOD	40-65	30-60
COD	100-170	120-180
bleaching		
BOD	30	13-15
COD	50	35
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use: refining	100	50

6.0 Economics*

Investment costs, operational and maintenance costs and payback time are available from Stake Technology Ltd.

6.1 Investment Costs: The SEP require considerably lower capital investment (1/2) as well as operating cost than low yield hardwood kraft pulping. The SEP process can be economical in much smaller size (100 t/day).

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

Bleaching with one stage H^2O^2 is environmentally acceptable. Primary and secondary treatment of effluents decreases BOD, solid substances and toxicity to very low levels.

8.0 Obstacles, Problems and/or Known Constraints

The new technology has to be proven on industrial scale. The same proven equipments used in conventional CMP processes are completed with a continuous Stake-Tech Digester already being used on industrial scale in biomass production (the continuous Stake Tech reactor replaces one refiner, therefore the capital cost of SEP is comparable to that of CMP).

9.0 Date Case Study Was Performed: The results were reported in December 1990.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article and a book.

10.2 Citation:

(1) Barbe, M.C., Kokta, B.V., Lavallee, H-C. and Taylor, J., Aspen pulping: A comparison of Stake explosion and conventional chemimechanical pulping processes, Pulp & Paper Canada, 91:12 (1990), pp. 142-151;

(2) Kokta, B.V., Steam Explosion Pulping, book: Focher, B., Marzetti, A. and Crescenzi, V.(ed.), Steam explosion techniques, Fundamentals and Industrial Applications, Gordon and Breach Science Publishers, 1991, pp. 163-206

10.3 Level of Detail of the Source Material: Additional information on the experimental procedures as well as pulp properties is available in the source material.

10.4 Industry/Program Contact and Address: Bohuslav V. Kokta, Dr., Universite du Quebec a Trois-Rivieres, Centre de recherche en pates et papiers, C.P.500, Trois-Rivieres, Qc G9A 5H7 CANADA, phone: (819)376-5075, fax: (819)376-5148

John Taylor, President, Stake Technology, 2838 HwY7, Norval, Ont, 2051KO, phone: 1-416 455 1990, fax: 1-416 455 2529

10.5 Abstractor Name and Address: Bohuslav V. Kokta, Dr., Universite du Quebec a Trois-Rivieres, Centre de recherche en pates et papiers, C.P.500, Trois-Rivieres, Qc G9A 5H7 CANADA, phone: (819)376-5075, fax: (819)376-5148

11.0 Keywords

11.1 Waste type: Pulp plant effluent

11.2 Process type/waste source: Chemimechanical pulping, Bleaching

11.3 Cleaner Production Technique: Steam Explosion Pulping, Ultra high yield, Vapor phase pulping process

11.4 Other Keywords: Explosion, Energy, Effluents, Hydrogen peroxide, Paper

11.5 Country Code: Canada.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulp plant effluent, Chemimechanical pulping, Bleaching, Steam Explosion Pulping, Ultra high yield, Vapor phase pulping process, Explosion, Energy, Effluents, Hydrogen peroxide, Paper

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Explosion pulping reduces energy consumption in high-yield pulping and produces pulp showing superior strength properties at a low sulfur content.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

The Swanboard Masonite AB plant at Rundvik, Sweden.

4.0 Cleaner Technology Category

Rising electrical power cost has intensified the search for power reduction methods for high-yield pulping. The explosion method of defibering wood, known since the 1920s, has been used mainly for building board manufacture. Renewed interest in this method has been reported for reducing power consumption and enhancing pulp quality.

5.0 Case Study Summary

5.1 Process and Waste Information: A modification of the explosion process preimpregnates chips with sodium carbonate, whereafter the chips are loaded in the gun and SO^2 gas is injected to convert sodium carbonate to sodium sulfite in situ. The released carbon dioxide remains in solution. Upon heating the chips with high pressure steam (50 bar), pressure builds up within the chips due to CO^2 formation. The contents of the gun are then blown to a cyclone kept at 5 bar. This sudden expansion of steam and CO^2 tears up the chips and produces a coarse fiber. The released steam is condensed in a reboiler to produce 4 bar of fresh steam.

Wood chips were put in an open container and presteamed for 15 min. The container was filled with cold impregnation liquor, and the chips were covered completely. The impregnation time was 10 min and the liquor was a sodium sulfite solution. The chelating agent DTPA was added to the liquor (0.5% on bone-dry wood). This DTPA (Kelatex 80) contained 1-5% sodium hydroxide, which resulted in a pH in the impregnation liquor of approximately 11.0.

After impregnation the pressure vessel was filled up with the chips. The amount of the chips in the vessel was 42 kg. The time in the vessel was divided into three sequences: degassing, steaming, and retention time before blowing.

Steam was introduced to heat the raw material and evacuate air. The pressure was raised to 5 bar (160°C) and kept at this temperature for 10 s.

After degassing, the steam pressure was raised to 30 bar instantaneously and maintained at this pressure for 30 s.

In the last sequence the pressure was raised to 50 bar and maintained at this level for 5, 15, or 30 s, depending on the sodium sulfite charges, 3.6%, 8.7%, and 14.8% on bone-dry wood respectively. The valve in the bottom of the vessel was then quickly opened and the chips blown out.

A sample of coarse fiber from each batch was refined in three or four stages to reach different CSF levels. Reference CTMPs were produced from the same raw material (spruce).

To estimate energy consumption, the pulps produced by explosion and refining and a reference pulp were beaten in a PFI-refiner. The pulps were beaten at 10% consistency and then hot disintegrated and tested for freeness (CSF).

Power consumption in a refiner and the PFI-mill revolutions are not exactly comparable. However, in absence of better methods this comparison is made to obtain an idea of the order of magnitude of power consumption. Conventional CTMP requires approximately 1600 kWh/ton when refined to 400 CSF. By explosion pulping, power can be reduced to 300-600 kWh/t.

5.2 Scale of Operation: Pilot-plant tests were conducted. Approximately 300 l of chips (45 kg) were the raw material to be pulped.

5.3 Stage of Development: These pilot-plant experiments were conducted to verify the feasibility of this process. The process merits further systematic investigation in pilot scale and testing of the pulp in papermaking. Further work is in progress to generate sodium sulfide in situ and more accurately estimate power consumption.

5.4 Level of Commercialization:

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs:

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

Pilot-plant test of spruce by chemical impregnation with sodium sulfite and steam explosion can produce a pulp with properties superior to CTMP. Electrical energy savings of 25% are possible. The sulfur content of the pulp is low.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article.

10.2 Citation: (1) Chaudhuri, P.B., Explosion pulping - exploratory trials, Tappi Journal, December 1989, pp. 196-200

10.3 Level of Detail of the Source Material: Additional information on pulp properties and pulping conditions is available in the source material.

10.4 Industry/Program Contact and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

10.5 Abstractor Name and Address: Same as in 10.4.

11.0 Keywords

11.1 Waste type:

11.2 Process type/waste source: CTMP, Sulfite impregnation, High yield pulping

11.3 Cleaner Production Technique: Explosion pulping, Energy saving

11.4 Other Keywords:

11.5 Country Code: Sweden.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: CTMP, Sulfite impregnation, High yield pulping, Explosion pulping, Energy saving

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Development of a chlorine-free bleaching sequence of eucalypt kraft pulp.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Aracruz Cellulose Technology Center, Caixa Postal 46, 29 190 Aracruz, ES, Brazil

4.0 Cleaner Technology Category

Pulp mills are improving the effluent treatment facilities and introducing process modifications to meet new chlorinated organics discharge limits. There is a clear trend to avoid the use of any chlorine compound in the bleaching the pulp.

This research work contains some preliminary results in the development of a chlorine-free bleaching sequence of eucalypt kraft pulp. The study was developed around a sequence involving only oxygen and hydrogen peroxide, and a key intermediary acid treatment.

5.0 Case Study Summary

5.1 Process and Waste Information: The chlorine-free bleaching sequence of eucalypt kraft pulp involves oxygen pre-bleaching, a patented acid pulp treatment, followed by an oxidative extraction stage with oxygen and hydrogen peroxide, and peroxide stages. An alternative bleaching sequence with ozone was also evaluated, and all results were compared with those obtained with the conventional chlorine-containing bleaching sequence. The alternative sequences were conducted aiming at 80% + ISO brightness.

Bleaching was performed on a kappa 20 eucalypt kraft pulp. Chlorination, oxygen and oxidative extraction stages were run in a QUANTUM MARK III high intensity mixer/reactor, while peroxide and chlorine dioxide stages were performed in plastic bags, at constant temperature. The ozone treatment was done in a plug flow reactor.

The results so far obtained are quite satisfactory. When starting from kappa 20 pulp, the alternative sequences produced pulps with brightness in the range of 80% ISO, with lower extractives and pentosans contents, acceptable brightness reversion but significantly changed paper properties relatively to a reference chlorine-bleached pulp.

The proposed sequence is OA(E+P+O)PP, where A stands for a key acid treatment, aimed at removal of metals from pulp, and increasing its reactivity in the following bleaching stages. HCl, SO^2, HNO^2/NO^2, and peracetic acid were studied as acid treatments, and the most promising results were found for HCl and peracetic acid.

Ozone was included as an alternative acid treatment, although also with a bleaching action. The results were quite different from obtained with acid treatment only, and comprise a separate line of development.

5.2 Scale of Operation: Full scale trials (500 air dry metric tons/day) in 1991 have led to implementation of a 760 air dry metric tons/day operation, with even better results.

5.3 Stage of Development: Fully implemented.

5.4 Level of Commercialization: The technology will be available to international market in November, 1992.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	confidential	confidential
Feedstock Use:	confidential	confidential
Water Use:	confidential	confidential
Energy Use: (low pressure steam)	326-817 kg/AD	(depending on sequence)

6.0 Economics* (items below are not to be disclosed at this time)

6.1 Investment Costs:

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

The results demonstrated the significant influence of acid treatments on metal removal and upon improvements in pulp reactivity in the additional alkaline stages. The brightness targets were achieved with extremely high chemicals consumption, and significant effects on pulp quality. Further improvements from optimization of the acid treatment and peroxide usage, combined with slight modifications in the pulping process have been achieved in industrial practice.

8.0 Obstacles, Problems and/or Known Constraints

There is still much to be studied and optimized, especially with regard to (E+P+O) bleaching, and the acid treatment conditions. Further combinations of such techniques and new developments in pulping, aiming at higher selectivity, should provide more opportunities for additional improvements in pulp quality, as well as savings in production costs. Some improvements are already observed, and this is part of a continuous development programme.

9.0 Date Case Study Was Performed: The results were presented in 1990.

10.0 Contacts and Citation

10.1 Type of Source Material: Conference proceedings.

10.2 Citation: Lima, M.M. de, Manfredi, V. and Claudio-da-Silva Jr, E., Total chlorine-free bleaching of eucalypt kraft pulp, Tappi Proceedings, 1990 Pulping Conference, pp. 799-807.

10.3 Level of Detail of the Source Material: Additional information on bleaching chemical consumption, bleaching conditions, pulp and paper properties is available.

10.4 Industry/Program Contact and Address: Claudio-da-Silva Jr, E., General Manager, Technology, Aracruz Celulose S.A., Caixa Postal 46, 29 190 - Aracruz, ES, Brazil.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O. Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Bleach plant effluent

11.2 Process type/waste source: Kraft pulp bleaching, Eucalypt kraft pulp bleaching

11.3 Cleaner Production Technique: Chlorine-free bleaching, Acid treatment, Oxygen bleaching, Hydrogen peroxide bleaching

11.4 Other Keywords: Ozone, Nitrogen dioxide, Peracetic acid, Hydrochloric Acid, Sulphur dioxide, Oxygen, Hydrogen peroxide

11.5 Country Code: Brasil.

12.0 Assumptions

13.0 Peer Review

Unknown.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleach plant effluent, Kraft pulp bleaching, Eucalypt kraft pulp bleaching, Chlorine-free bleaching, Acid treatment, Oxygen bleaching, Hydrogen peroxide bleaching, Ozone, Nitrogen dioxide, Peracetic acid, Hydrochloric Acid, Sulphur dioxide, Oxygen, Hydrogen peroxide

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The Lignox process produces pulp without chlorine or chlorine dioxide while eliminating AOX in effluent.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

The Aspa mill, Munksjõ Concern, Sverige.

4.0 Cleaner Technology Category

The Lignox process, a high-temperature peroxide bleaching process for lower-brightness pulp prebleaching, produces lower-brightness pulp of ISO 70 totally without elemental chlorine or chlorine dioxide. The AOX content of the effluent is totally eliminated.

5.0 Case Study Summary

5.1 Process and Waste Information: The bleaching is done in three stages after pulping in the Lignox process. The pulp has a kappa no of 32 after pulping and is then oxygen bleached. Delignification is further going on, and the lignin content is lowered by about 40%. The kappa number is 18 after the oxygen stage.

The pulp will next be treated with a so called complex building agent, EDTA (ethylenediamine tetra-acetic acid). The treatment is done instead of a conventional C/D-stage. The EDTA-treatment does not change the kappa number of the pulp.

The last stage of the bleaching is an extraction with hydrogen peroxide. A kappa number under 10 can be reached. The process conditions are highly alkaline, and consequently, a SO^2 treatment is needed to reach the right pH level before drying.

The most important point of the Lignox process is to implement the EDTA treatment in the right and narrow pH area.

5.2 Scale of Operation: The Lignox process has been implemented in full scale. The Aspa mill produces 120,000 tons pulp/year.

5.3 Stage of Development: The Lignox process has been fully implemented.

5.4 Level of Commercialization: The Lignox process is commercially available.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:		
AOX	100	0
COD	100	60-70
Feedstock Use:	N/A	N/A
Water Use:	100	100

Energy Use: 100 105-110

6.0 Economics*

6.1 Investment Costs: When changing to Lignox pulp the needed investments in Aspa have been piping and lining of some bleaching towers. The necessary oxygen delignification and other bleaching components were already installed.

6.2 Operational and Maintenance Costs: Chemical costs have increased about 100 SEK/ton (Swedish crowns, 1991) compared to the chlorine bleached pulp.

Maintenance costs have been nearly the same, but in the long run these will possibly be decreased.

Energy costs have, as mentioned in section 5.5, increased.

6.3 Payback Time:

7.0 Cleaner Production Benefits

The Lignox process produces lower-brightness pulp without AOX emissions.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed: The process development was done during 1988-90.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article.

10.2 Citation: Forsström, A., Aspa Bruk: Först med klorfri sulfatmassa, Svensk Papperstidning/Nordisk Cellulosa, Nr 3, 1992, pp. 20-21

10.3 Level of Detail of the Source Material: Additional detail information is not available in the source material.

10.4 Industry/Program Contact and Address: Hans Fasten, chief of the mill and Sam Wiklund, marketing director, Aspa Bruk, Munksjö koncern, 690 40 ASPABRUK, Sverige, fax: 46 583 504 55, phone: 46 583 50200.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O. Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Bleach plant effluent

11.2 Process type/waste source: Bleaching

11.3 Cleaner Production Technique: Peroxide bleaching, Lignox process

11.4 Other Keywords:

11.5 Country Code: Sweden.

12.0 Assumptions

13.0 Peer Review

Unknown.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleach plant effluent, Bleaching, Peroxide bleaching, Lignox process

1.0 Headline: Effluent-free bleach plant in kraft pulp mills.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Jaakko Pöyry Oy, P.O.Box 4, SF-01621 VANTAA, Finland, phone +358-0-89471

4.0 Cleaner Technology Category

Recycling of process water and mineralizing of waste material.

5.0 Case Study Summary

5.1 Process and Waste Information:

Process area: Kraft pulp mill bleach plant

Waste streams affected: Bleach plant waste liquors containing dissolved organic material, heavy metals, nutrients, and sodium used for bleaching purposes.

Process changes: No changes necessary in the bleaching process; however, economic considerations lead to equipment modifications and amendments.

Effect on wastes: Waste liquor discharges are eliminated, no AOX discharge, discharge of phosphor virtually eliminated, heavy metals captured from the discharge and transferred into a low-volume solid waste.

Production rate: Full scale application.

New waste stream: Low-volume solid waste as indicated above.

New raw materials: None.

Energy usage: Energy balance calculated case by case. Generally, no change in energy consumption.

Operating procedures:

The contaminated acidic wastewater is separated into a sufficiently small stream for immediate treatment in the bleach plant. The alkaline bleach plant waste liquor is used countercurrently as wash liquor for the oxygen delignified and unbleached pulp. The alkaline wastewater is recirculated into the chemicals recovery system.

The purification of the acid wastewater is done by evaporation in a specially designed evaporator utilizing vapour recompression. In principle, the device is a conventional falling-film evaporator. It operates at low pressure, typically corresponding to the steam pressure of boiling water at 40-50°C. A single-stage centrifugal fan can be used for vapour recompression.

The concentrate from the evaporator contains mainly hydrochloric acid, but also some organic matter. Moreover, it contains metal ions and phosphorus and nitrous compounds. The way to dispose this material is to incinerate the concentrate from the evaporator in controlled conditions

and to mineralise the non-combustible material into inert ash. The heavy metals content of the ash determines whether it could be dumped as landfill or should be treated in some other way.

5.2 Scale of Operation: Full-scale kraft mills have an annual output of 200,000-1,000,000 tons of pulp. Total annual world production of bleached kraft pulp is about 60 million tons. Today, all mills discharge their bleach plant waste liquors through external waste water treatment plants into lakes, rivers and the sea. This process makes it possible to eliminate this discharge.

5.3 Stage of Development: Pilot stage.

5.4 Level of Commercialization: The technology is not yet ready for commercialization. The equipment is available from other applications. The evaporator is commercial for seawater desalination.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: Large-scale economic figures are not available.

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

The discharge of the bleach plant waste liquor is the single remaining major pollution problem of kraft pulp mills. Recent development efforts have been focused on the elimination of chlorinated substances in the mill effluents. Closing up the bleach plant process water system would not only solve this problem, but eliminate the total discharge of organic material, of nutrients, currently non-recoverable sodium and colored substances as well.

The driving force for this development work is primarily environmental considerations. However, the technology would reduce the consumption of fresh water, and sodium now used as a once-through chemical in the bleach plant would be recirculated and reused. Thus there are economic incentives as well.

8.0 Obstacles, Problems and/or Known Constraints

The technical constraints that may emerge are on the material side; the environment is highly corrosive. Therefor a long-term test of the special evaporator is under way. No regulatory barriers can be anticipated, on the contrary, this technology may be classed as "best available technology economically achievable" and thus favoured for new mills and rebuilds of old mills.

9.0 Date Case Study Was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Organization report and personal contact.

10.2 Citation: Myreen, B., Closing up the bleach plant, Jaakko Põyry Client Magazine," Know-how Wire", 1/1991, pp. 8-11

10.3 Level of Detail of the Source Material: Professor Bertel Myreen, Jaakko Põyry Oy, P.O. Box 4, SF-01621 VANTAA, Finland, phone +358-0-89471

10.4 Industry/Program Contact and Address: Professor Bertel Myreen, Jaakko Põyry Oy, P.O.Box 4, SF-01621 VANTAA, Finland.

10.5 Abstractor Name and Address: Bertel Myreen, Jaakko Põyry Oy, P.O.Box 4, SF-01621 VANTAA, Finland, phone +358-0-89471

11.0 Keywords

11.1 Waste type: Bleach plant waste liquors, Organic material, Heavy metals, Nutrients, Sodium

11.2 Process type/waste source: Bleach plant, Kraft pulp bleaching

11.3 Cleaner Production Technique: Closed cycle mill

11.4 Other Keywords:

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleach plant waste liquors, Organic material, Heavy metals, Nutrients, Sodium, Bleach plant, Kraft pulp bleaching, Closed cycle mill

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The NCC-bleaching process uses oxidizing agents in place of chlorine compounds in pulp bleaching and allows savings in chlorine chemicals and low AOX discharge levels.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Metsä-Serla Oy, Äänekoski pulp mill, and Metsä-Botnia Oy, Kaskinen and Kemi mills, all in Finland.

4.0 Cleaner Technology Category

The inclusion of oxygen, peroxide, ozone and enzyme treatment is a step towards a bleaching process that has excellent performance and results in very low AOX levels in the bleaching discharge. Chlorine-free bleaching is the first step towards a substantial reduction in the amount of water used in pulp production.

5.0 Case Study Summary

5.1 Process and Waste Information: Although cooking to very low kappa numbers can be done the final yield is always affected. However, cooking to residual lignin content of 2-4% followed by optimized oxygen delignification to the target kappa number gives pulps with good initial strength properties and bleachability.

Under alkaline cooking conditions, xylan dissolves from the wood into the cooking liquor. Some of this xylan has been shown to precipitate back onto the surface of cellulose fibrils. This xylan is not easily broken down by either hot or cold alkali and therefore hinders the alkaline leaching of lignin from fibres.

The enzyme xylanase hydrolyses the precipitated xylan, at the same time making the fibres more permeable and assisting extraction of lignin. However, enzymes are not bleaching agents; they merely render alkaline bleaching stages more effective. The critical parameters in enzyme treatment are: selecting the right xylanase product; the conditions and the location of this step in the process and the enzyme dosage.

The following sequences have been recommended for bleaching:

Birch: O-e-A-P-P and
Pine: O-e-A-Z-e-P where
e means enzyme treatment and A means acidification + EDTA/DTPA treatment.
Several test runs have been conducted. The process is based on extended cooking and extended multi-stage oxygen-enzyme-peroxide treatment.

After the last sequence, peroxide bleaching, softwood pulp has reached a brightness of 75-80% ISO and birch pulp 80-85% ISO. The pulp properties are close to those of normal chlorine bleached pulps, except for brightness. Brightness stability is not comparable to that of fully bleached pulp, because of the residual lignin present in the pulp.

5.2 Scale of Operation: The successful experience of enzymatic bleaching at Metsä-Serla's Äänekoski mill was applied together with oxygen and peroxide chemicals at Metsä-Botnia's Kaskinen and Kemi mills.

Tests on the use of enzyme pretreatment were completed in 1990, and this technology is now in industrial use. Most recently, in 1991, smaller mill-scale trials were conducted with the aim of bleaching kraft pulp entirely without chlorine or chlorine compounds. To date, almost 50,000 tons

of both pine and birch pulps have been produced in this way, and Metsä-Serla plans to produce a further 80,000 tons this year (1992).

Metsä-Botnia is now able to produce chlorine-free softwood and hardwood pulps according to the demand at its mills at Kaskinen and Kemi. These mills have a total production capacity of 400 000 t/a of chlorine chemical free pulp grades.

5.3 Stage of Development: The technology is fully implemented.

5.4 Level of Commercialization: The technology is commercially available and the equipment needed is readily available. The enzymes were specifically developed for biological bleaching. Since September 1991 a rapid commercialization of various paper products produced of chlorine chemical free softwood and hardwood pulp has taken place.

5.5 Material/Energy Balances and Substitutions: Enzyme application

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	15% less total chlorine AOX
Feedstock Use:	N/A	1.0 kg/t pulp
Water Use:	N/A	N/A
Energy Use: water going to the evaporation plant (see 8.0)	8 m_3/t pulp	15-20 m_3/t pulp

6.0 Economics*

6.1 Investment Costs:

6.2 Operational and Maintenance Costs: The manufacturing costs are somewhat higher than those of conventional pulp. With 20% chlorine dioxide substitution the cost of bleaching chemicals is 10-15% higher than for conventional bleaching.

6.3 Payback Time:

7.0 Cleaner Production Benefits

Chlorine-free bleaching is the first step towards a substantial reduction in the amount of water used in pulp production. The most significant effect of NCC-bleaching has been to reduce bleaching plant discharge parameters, particularly organochlorine compounds (AOX).

8.0 Obstacles, Problems and/or Known Constraints

All stages mentioned in 5.1 can be carried out at medium consistency. As no chlorine chemicals are used, it should be possible to lead all white water from bleaching into the recovery system. However, at a normal kraft mill, this would increase the volume of water going to the evaporation plant from 8 m3/t pulp to 15-20 m3/t pulp. This poses new problems for both the recovery cycle and the white water circulation.

Further, if it were possible to raise the working range of the enzymes from the current level of below 55°C (and slightly acid conditions) to a 70-80°C range (and alkaline conditions), it would then be possible to send the dissolved hemicelluloses to the recovery cycle instead of to the effluent treatment. In addition, intermediate cooling of the pulp would no longer be required.

9.0 Date Case Study Was Performed: The foundations for the chlorine-free bleaching of pulp were laid back in the 1970s when development work in oxygen delignification, peroxide and biological bleaching were initiated. Six years ago VTT's (Technical Research Centre of Finland) Biotechnical Laboratory and the Finnish Pulp and Paper Research Institute (FPPRI) started a joint research project on biological bleaching. The mills of Metsä-Serla and Metsä-Botnia have been investigating the NCC-bleaching for a number of years. The processes have been commercialized in 1991 (oxygen and peroxide bleaching) and 1992 (enzymatic bleaching).

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles and unpublished material.

10.2 Citation:

(1) Trotter, P.C., Biotechnology in the pulp and paper industry: a review, Part 1: tree improvement, pulping and bleaching, and dissolving pulp applications, Tappi Journal, April 1990, pp. 198-204;

(2) Grant, R., Enzyme technology - First mill-scale trials get underway, PPI, June 1991, pp. 61-63;

(3) Breakthrough in pulp bleaching - Completely chlorine-free pulp from Finland, Views on Finnish technology, Technology development centre Finland, 1992, p. 16;

(4) NCC - non chlorine compound, Metsä-Botnia Oy brochure;

(5) Kekki, R., Chlorine-free bleaching: Technology and mill experience, Environmental technology from Finland for the Canadian forest industry, Vancouver, March 17, 1992, pp. 65-82;

(6) Malinen, R., Chlorine-free bleaching: State of the art in Scandinavia, , Environmental technology from Finland for the Canadian forest industry, Vancouver, March 17, 1992, pp. 8-18.

10.3 Level of Detail of the Source Material: Information on paper properties is available in the source material.

10.4 Industry/Program Contact and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O. Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

10.5 Abstractor Name and Address: Same as in 10.4.

11.0 Keywords

11.1 Waste type: Bleach plant waste water

11.2 Process type/waste source: Pulp bleaching

11.3 Cleaner Production Technique: Chlorine-free bleaching, Non chlorine compound bleaching, Enzymatic bleaching, Biobleaching

11.4 Other Keywords:

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

Yes (articles 1. and 2.), others unknown.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleach plant waste water, Pulp bleaching, Chlorine-free bleaching, Non chlorine compound bleaching, Enzymatic bleaching, Biobleaching

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The OxO prebleaching process yields a fully bleached pulp with a substantial decrease in AOX emissions.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

The Centre Technique du Papier, BP 7110, 38020 Grenoble, Cedex, France.

4.0 Cleaner Technology Category

With the optimized (OxO)DED sequence a fully bleached pulp was obtained. This process leads to a substantial decrease in the AOX (absorbable organic halogens) emission.

5.0 Case Study Summary

5.1 Process and Waste Information: It has been found that the use of Cl^2 or ClO^2 can improve the selectivity of lignin removal in oxygen bleaching. Since the effluent from the O^2 stage is usually recycled, the logical way to benefit from this activation is to apply it on an oxygen-bleached pulp to avoid introducing chlorides in the recovery system. This procedure leads to the OxO prebleaching sequence.

The OxO prebleaching sequence, where "x" stands for the activation treatment with halogens (chlorine, chlorine dioxide, or a mixture of both) is an oxygen delignification process, which leads to a high-brightness softwood kraft pulp with low AOX emissions. The OxO process was first optimized in the laboratory. The process is mainly characterized by the combination of low charges of chlorine and the use of harsh conditions in the subsequent oxygen stage. This concept could easily be retrofitted in a mill having an O(C+D)(EO)DED sequence. In an example, a softwood kraft pulp already oxygen-delignified to kappa no. 20 is submitted to a regular (C+D)(EO)DED bleaching sequence. The kappa number after O(C+D)(EO) is 1.6 and final brightness is 88.8.

The OxO concept has been applied in preparing this pulp. The results indicate:

- The chlorine multiple can be lowered to 0.15 while increasing the (EO) temperature from 65°C to 90°C.
- The process is sensitive to (EO) temperature.
- Chlorine is a better activation agent than chlorine dioxide.

The results show that using the best conditions, less than 2 kg/ton of TOCl could be reached. No clear evidence of a decrease in pulp strength or brightness could be noticed. These good results encouraged to check this process in a full-scale trial.

Plant trials were successful in confirming laboratory results. By running the (EO) stage in harder conditions, it has been possible to reduce the chlorine multiple down to 0.10 without impairing pulp characteristics. This process is a possible alternative in environmental control in that 1.5 kg/ton of AOX (before external treatment) was reached.

5.2 Scale of Operation: The full-scale tests of the OxO process were implemented in two mills. The capacity of one was 500 metric tons/day of softwood kraft pulp for internal use, the other mill produced 360 tons /day of softwood kraft pulp (market pulp).

5.3 Stage of Development: The technology was fully implemented and the quantitative figures were based on actual production.

5.4 Level of Commercialization: The OxO technology is commercially available. The equipment are readily available, extra equipment are not necessary.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	1.5 kg AOX/ton
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: Extra investments are not necessary.

6.2 Operational and Maintenance Costs: Taking into account steam and chemicals, costs increased by 25% from 130 SEK/ton (Swedish crowns) for the reference to 160-165 SEK/ton. Steam costs accounted for 40% of this increase. The addition of H^2O^2, although helpful in reducing kappa number, brought another 10% cost increase and was difficult to justify economically.

6.3 Payback Time:

7.0 Cleaner Production Benefits

With the optimized prebleaching sequence, it was possible to produce high-brightness softwood kraft pulp with AOX emission as low as 1.5 kg/ton before effluent treatment. A substantial decrease in effluent color was detected. The pulp viscosity and strength remained constant. Final brightness remained at a high level throughout the trial.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed: The tests were run in 1989-1990?

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article.

10.2 Citation: Muguet, M., Joly, P., Lachenal, D. and Bohman, G., Mill-scale implementation of the recycled oxygen process, Tappi Journal, December 1990, pp. 127-132

10.3 Level of Detail of the Source Material: Detail information on bleaching sequences as well as on pulp properties is available in the source material.

10.4 Industry/Program Contact and Address: Christian de Choudens, Centre Technique du Papier, Domaine Universitaire, B.P.251, 38044 Grenoble Cedex 9, France, tel: 76 44 82 36, fax: 76 44 71 38.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Bleach plant effluent, AOX

11.2 Process type/waste source: Bleaching, Kraft bleaching, Oxygen delignification

11.3 Cleaner Production Technique: Recycled oxygen process, OxO process, Oxygen prebleaching

11.4 Other Keywords:

11.5 Country Code: France.

12.0 Assumptions

13.0 Peer Review

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleach plant effluent, AOX, Bleaching, Kraft bleaching, Oxygen delignification, Recycled oxygen process, OxO process, Oxygen prebleaching

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: A short sequence delignification and bleaching process for dissolving pulps from mixed tropical hardwoods has potential for cost reduction, quality improvement and mill-adaptability as compared to the present C E H E D sequence.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Pilot Plant Study: The Research Institute of Grasim Industries Ltd, Kumarapatnam 581 123, Karnataka, India.

Plant Scale: Harihar Polyfibers, Kumarapatnam 581 123, Karnataka, India.

4.0 Cleaner Technology Category

The short sequence E/O C E/O D has potential for cost reduction, quality improvement and mill-adaptability as compared to the present C E H E D sequence. By proper use of this sequence, it is possible to achieve 40-60% reduction in COD and BOD and 65-75% reduction in colour of the combined load of wash and bleach effluents.

5.0 Case Study Summary

5.1 Process and Waste Information: In view of the advantages of oxygen delignification technique with respect to effluent load reduction and bleaching cost savings, an investigation was carried out. Various sequences were studied employing oxygen and oxidative extraction stages in the following combinations: O H E D, C E/O H D, E/O C E/O H D, E/O C E/O D.

Since medium consistency oxygen systems are believed to offer more selective delignification reactions, as well as ease of retrofitting in existing mill installation with small capital investment, it was further decided to keep pulp consistency at 8% and the reaction pressure not in excess of 3.5 kg/cm2 for all the trials. A parallel run with C E H E D sequence was also carried out simulating plant conditions for comparison.

A number of trials were conducted on mill unbleached pulp for each of the above sequences by varying the chemical charges, time and temperature to match the brightness and viscosity level with conventional C E H E D sequence.

The E/O C E/O D, while being a short sequence not only gave the desired final pulp brightness (89% ISO) within acceptable viscosity range (14 cP), but also the additional advantage of significant effluent load reduction. Final adjustment of viscosity could be done by varying the alkali charge in the E/O-2 stage.

The analysis of oxygen bleached kraft dissolving pulp from an admixture of Eucalyptus and mixed tropical hardwoods is superior to both mill and laboratory bleached pulps obtained with conventional C E H E D sequence except for the high ash components.

5.2 Scale of Operation: The E/O C E/O D short sequence study was on pilot plant scale, whereas C E/O H D sequence was adopted for mill scale in 1980. The mill experience after installing E/O stage is as under:

The C E/O H D was adopted for mill scale operation in view of low investment and easy adaptability. The E/O stage was introduced in May 1990, and since then, it is running continuously.

5.3 Stage of Development: E/O C E/O D - Laboratory Scale; C E/O H D - Plant Scale

5.4 Level of Commercialization: E/O C E/O D - Not commercialized; C E/O H D - Commercialized

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
	C E H E D	C E/O H D
Waste Generation:	12 000 m3/day	12 000 m3/day
COD	16.12 t/day	12.0 t/day
BOD	4.40 t/day	4.32 t/day
colour	35.55 t/day	24.00 t/day
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs (May 1990):

Summary of investment		Rs. in Lacs.
6.1.1	MC Pump with vacuum pump by Kamyr (imported) Capacity - 20 lps. Cy - 12% Kead - 75 M	29.00
6.1.2	Boughtout & Manufacture items Stand pipe Size - 1900 mm dia x 16,500 mm Ht. Material of construction - MS & SS 316 lined	11.90
6.1.3	Electrical	2.50
6.1.4	Instrument	2.75
6.1 5	Civil & Misc.	0.90
6.1.6	Total	47.05
6.1.7	Current Value	64.00

6.2 Operational and Maintenance Costs:

6.2.1 Savings in Chemicals

		Per ton pulp tons	Per year for 66,000 AD
			Rs. Lacs
a)	Caustic	4 kg	37.05
b)	Chlorine	5 kg	8.35
c)	Chlorate	0.5 kg	5.72
		Total Savings	49.12

6.2.2 Recurring Costs

a) Oxygen	4.5 kg	23.73
b) Power	5.5 kWh	5.44
c) Manpower	4 operators	1.32
d) Maintenance Cost		0.80
	Total Cost	31.29

6.2.3 Net Savings per Annum: Rs. 17.83 lacs

6.3 Payback Time: Investment Rs. 64 lacs, Savings Rs.17.83 lacs, Pay Back Period 64/17.83 = 3.6 Years

7.0 Cleaner Production Benefits

As compared to the conventional C E H E D sequence such bleaching process offers following advantages:

1. Reduced chemical cost
2. Substantial reduction in effluent load
3. Ease and retrofitting in the existing mill installations with small investment
4. Improved pulp quality in terms of brightness, degree of polymerisation (D.P.) distribution and better processability in fibre plant

8.0 Obstacles, Problems and/or Known Constraints

No technical constraints.

9.0 Date Case Study Was Performed: May 1990.

10.0 Contacts and Citation

10.1 Type of Source Material: Conference proceedings, Mill experience.

10.2 Citation: Jain, S.K. and Maru, S.S., A short sequence delignification and bleaching process for dissolving pulps from mixed tropical hardwoods, Tappi proceedings, International Oxygen Delignification Conference, 1987, pp. 75-80.

10.3 Level of Detail of the Source Material: Additional information on bleaching conditions and pulp analysis is available in the source material.

10.4 Industry/Program Contact and Address: S.S. Maru, Joint Executive President (Technical), Harihar Polyfibers, Kumarapatnam 581 123, Karnataka, India.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Bleach plant effluent

11.2 Process type/waste source: Pulp bleaching

11.3 Cleaner Production Technique: Oxygen delignification, Oxidative extraction

11.4 Other Keywords:

11.5 Country Code: India.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleach plant effluent, Pulp bleaching, Oxygen delignification, Oxidative extraction

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The Prenox (TM) process, pretreating pulps prior to oxygen-delignification with NO^2, reported to remove a substantial lignin and reduce TOCl level.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

The Prenox process has been developed by the Swedish companies AGA, KemaNord, MoDo and Sunds Defibrator.

4.0 Cleaner Technology Category

The Prenox process increases the selectivity of the oxygen toward lignin in the oxygen delignification stage. The amount of the bleaching chemicals needed is reduced and the environmental effect of the bleach plant effluent decreased.

5.0 Case Study Summary

5.1 Process and Waste Information: A research effort has been made in order to find ways of delignification to still lower kappa numbers. Special attention has been paid to the ability of nitrogen oxides to activate the lignin degradation. In the Prenox process, the softwood pulp can be treated with nitrogen dioxide in acid conditions prior to oxygen delignification. In laboratory conditions, it is possible to extend the delignification down to the kappa number 7 without severely impairing the papermaking properties of the pulp. On a pilot scale, the practical kappa number limit is about 10.

The tests have been made using a normally cooked softwood pulp with an initial kappa number of about 30. The test figures show that at low charges (5 and 6 kgs per ton respectively) NO^2 is as efficient as molecular chlorine. At increased concentrations molecular chlorine shows a more selective delignification.

Laboratory pretreatment tests using already oxygen delignified softwood pulp have also been made. With a nitrogen dioxide pretreatment at 10% consistency and subsequent delignification in a pressurized (EO) stage, an acceptable pulp with the kappa number 7 has been obtained.

5.2 Scale of Operation: Pilot plant scale.

5.3 Stage of Development: Pilot stage.

5.4 Level of Commercialization: The Prenox process is not yet commercially available.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	1.5 kg/t
Feed Stock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs:

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

See 4.0.

8.0 Obstacles, Problems and/or Known Constraints

All effective pretreatments occur in acidic conditions, which is a drawback, because the pulp is alkaline after the cook.

If nitrous compounds are used, the NOx emissions from the recovery boiler are likely to increase.

Using nitrogen dioxide would pose serious questions related to health and safety at work.

9.0 Date Case Study Was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles and an environment report.

10.2 Citation:

(1) Bowen, I.J. and Hsu, J.C.L., Overview of emerging technologies in pulping and bleaching, Tappi Journal, September 1990, pp. 205-217;

(2) Pride, D., Old pulps for new, Paper, November 990, pp. 26-29;

(3) Ahlgren, L., Kraft pulp: Cleaner still by year 2000, PPI, April 1991, pp. 59-61;

(4) Heimburger, S.A., Blevins, D.S., Bostwick, J.H. and Donnini, G.P., Kraft mill bleach plant effluents: recent developments aimed at decreasing their environmental impact, part 1, Tappi Journal, October 1988, pp. 51-60;

(5) Reduction of Chloro-organic Discharge in the Nordic Pulp Industry, Environment Report 1989:6E, Prepared by Jaakko Pöyry for The Nordic Council of Ministers, April 1989, 103 p.

10.3 Level of Detail of the Source Material: Additional information is not available in the source material.

10.4 Industry/Program Contact and Address: Christian de Choudens, Centre Technique du Papier, Boite postale 251, F - 38044 Grenoble Cedex 9, France, tel: 76 44 82 36, fax: 76 44 71 38.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Tel. +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Bleach plant effluent

11.2 Process type/waste source: Pulp bleaching

11.3 Cleaner Production Technique: Cleaner Production Technique

11.4 Other Keywords:

11.5 Country Code: France.

12.0 Assumptions

13.0 Peer Review

Yes (1-4 in 10.2) and unknown (5).

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleach plant effluent, Pulp bleaching, Cleaner Production Technique

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Papricycle bleaching process saves each plant caustic and steam.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Weyerhaeuser Canada Ltd., P.O.Box 800, Kamloops, B.C., Canada V2C 5M7.

4.0 Cleaner Technology Category

One method of lessening the demand for caustic is to ensure that the alkaline streams within the mill are used efficiently. The Papricycle process makes better use of one of these alkaline streams. The process provides a savings of 35% in caustic usage.

Recycling of hot filtrate has the potential to decrease steam usage by 0.43 GJ/ton of pulp.

5.0 Case Study Summary

5.1 Process and Waste Information: The comparison of E-stage procedures, no recycle, conventional recycle, and recycle followed by washing was done in the laboratory. The results were obtained with a laboratory-cooked black spruce kraft pulp of kappa no. 27.5. The pulp was chlorinated conventionally and then thoroughly washed with deionized water.

In the "recycle followed by washing" runs, the chlorinated pulp was brought to 20% consistency and diluted to 10% consistency with the effluent from a conventional extraction stage. The extraction effluent, at 60°C, was again allowed to be in contact with the pulp for 5 min. In these runs, however, the pulp was washed before the conventional extraction stage. Recycle followed by washing allowed a target kappa number or a target brightness to be obtained with only 2.0% NaOH in the E1 stage, compared to the 3.0% NaOH required to reach the same kappa number or brightness level in the other examples. This process of E1-stage effluent recycle followed by washing to decrease the chemical requirements in the E1 stage has been called "Papricycle".

There are several ways in which a bleach plant can be modified to use Papricycle. The simplest modification is that applied to a mill which has a six-stage bleach plant and which, by adding oxygen to the extraction stage, has eliminated the hypochlorite stage. As a result of these changes, the original H-stage washer can be repiped for use as the "Papricycle washer." In effect, it will be operating as if it were between the C-stage washer and the E-stage steam mixer.

The first full mill application in Canada required the simplest of the available modifications.

5.2 Scale of Operation: The Kamloops mill is divided into two lines; the first of which, referred to as "A" mill, produces 330 air dry metric tons/day of pulp. The second and larger line, "B" mill, produces 920 air dry metric tons/day of pulp.

5.3 Stage of Development: Fully implemented.

5.4 Level of Commercialization: The Papricycle process is commercially available. The operation of the bleach plant is only minimally altered by the introduction of the process.

5.5 Material/Energy Balances and Substitutions: Combined mill effluent properties:

Material Category	Quantity Before	Quantity After
Waste Generation:		
colour	244 kg/t	274 kg/t
clarifier pH	9.7	8.8
BOD_5	2.3 kg/t	2.9 kg/t
CaO	2.3 kg/t	2.9 kg/t
Water Use:	123 m_3/d	132 m_3/d
Energy Use: steam	saving 0.43	GJ/t pulp

6.0 Economics*

6.1 Investment Costs: The total cost of installing the new process was $23,000 (Canadian dollars 1989) for the "A" mill and $ 2,130,000 for the "B" mill.

6.2 Operational and Maintenance Costs: The chemical cost savings attributed to Papricycle at the Kamloops mill are $525,000/year for the "A" mill and $2,830,000/year for the "B" mill.

6.3 Payback Time: The costs in 6.1 and 6.2 represent a savings of $4-5/ton of pulp produced, with a payback time of 15 days.

7.0 Cleaner Production Benefits

The process provides a saving of 35% in caustic usage. Recycling of hot filtrate has the potential to decrease steam usage by 0.43 GJ/ton of pulp. The bleach plant effluent properties have been improved.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed: The first mill scale trial was run during July 1987.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles and Conference proceedings.

10.2 Citation: (1) Berry, R.M., Fleming, B.I., Berndt, G. and Williams, G., Papricycle - a mill proven process for saving bleach plant caustic and steam, Tappi Journal, February 1989, pp. 109-113; (2) Advances in pulping, Tappi Journal, November 1988, pp. 16-20; (3) Berndt, G. and Williams, G., Maintaining the caustic chlorine balance in a bleached kraft pulp mill, CPPA Pacific & Western Branch Meeting, Jasper, B.C., May 1990, 7 p.

10.3 Level of Detail of the Source Material: Additional information on the changes made in the existing process and pulp properties is available in the source material.

10.4 Industry/Program Contact and Address: R.M. Berry, scientist and B.I.Fleming, senior scientist, PAPRICAN, 570 Blvd. St.Jean, Pointe Claire, Que., Canada H9R 3J9. G. Berndt, technical superintendent and G. Williams, process superintendent, Weyerhaeuser Canada Ltd., P.O.Box 800, Kamloops, B.C., Canada V2C 5M7.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Bleach plant effluent

11.2 Process type/waste source: Pulp bleaching

11.3 Cleaner Production Technique: Papricycle process, E-stage effluent recycling

11.4 Other Keywords: Caustic, Steam

11.5 Country Code: Canada.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleach plant effluent, Pulp bleaching, Papricycle process, E-stage effluent recycling, Caustic, Steam

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The effect of enzyme pre-treatment on the bleachability of kraft pulps.

2.0 SIC/ISIC Code: I3411.

3.0 Name and Location of Company:

Genencor International Europe Ltd, SF-02460 Kantvik, Finland.

4.0 Cleaner Technology Category

Better bleachability means possibilities to use lower amounts of bleaching chemicals, and thus, the AOX and TOCl levels are substantially lowered both in the end product and in the bleachplant waste waters. A lower toxicity of bleachplant effluents will have a long term positive effect on the mill's biological treatment. On the other hand, higher brightness levels can be reached without changing the chlorination factor.

5.0 Case Study Summary

5.1 Process and Waste Information: Albazyme is an enzyme blend specially designed to improve the bleachability of softwood and hardwood kraft pulps. The performance of Albazyme is a result of synergistic effects of all the main and side activities and cannot be evaluated only on the basis of declared activity. The main component is commonly referred to as xylanase activity.

The Albazyme treatment will be ideally performed in the high density brown stock tower under the following conditions: temperature 40-60°C, pH 5-7, and reaction time 0.5-3 hours. No additional washing is needed after Albazyme treatment. Acidification of the brown stock can be achieved with various acids, including C-stage filtrate or ClO^2 generator's waste acid.

Albazyme is effective on both conventional and oxygen delignified pulps. Under suggested process conditions and with appropriate dosage no negative effect on pulp strength or cleanliness will be noted. Albazyme is compatible with oxygen and peroxide boosted extraction stages.

5.2 Scale of Operation: Mill-scale application.

5.3 Stage of Development: Fully implemented.

5.4 Level of Commercialization: The technology as well as equipment is commercially available.

5.5 Material/Energy Balances and Substitutions

Material Category	Quantity Before	Quantity After
Waste Generation:		positive effect
Feedstock Use:	100	75-85
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics

6.1 Investment Costs: Albazyme will be used without any major change in the bleachplant. The only additional equipments needed are a dosage system and a pH control loop.

6.2 Operational and Maintenance Costs: Maintenance cost is about zero. Operational cost varies case by case, but in most cases it is about the same as the cost savings of chemicals.

6.3 Payback Time: Short, but varies case by case.

7.0 Cleaner Production Benefits

The benefits of using Albazyme as a prebleaching agent are clearly measured in several perspectives. Lower dosage of Cl^2, ClO^2, NaOH etc. is needed, leading to savings in chemical cost. Albazyme will be particularly attractive to pulp mills with regulatory pressure on AOX/TOCl levels, with limited capital investment possibilities and with a plan for higher ClO^2 substitution level or ClO^2 generator capacity limitations.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study was Performed

10.0 Contacts and Citation

10.1 Type of Source Material: A brochure.

10.2 Citation: ALBAZYME, Pulp and Paper enzymes, Biopulp International, brochure, 4 p.

10.3 Level of Detail of the Source Material: Additional information on the enzyme properties is available in the source material.

10.4 Industry/Program Contact and Address: Olli Jokinen, Product Manager, Pulp & Paper Enzymes, Genencor International, SF-02460 Kantvik, Finland, phone: +358 0 297 4660, fax: +358 0 298 2203, telex: 121076 supo sf

10.5 Abstractor Name and Address: Olli Jokinen, Product Manager, Pulp & Paper Enzymes, Genencor International, SF-02460 Kantvik, Finland, phone: +358 0 297 4660, fax: +358 0 298 2203, telex: 121076 supo sf.

11.0 Keywords

11.1 Waste type: Bleach plant effluent.

11.2 Process type/waste source: Kraft pulp bleaching.

11.3 Cleaner Production Technique: Enzyme pretreatment.

11.4 Other Keywords: Albazyme, Kraft pulp.

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Kraft pulp bleaching, Enzyme pretreatment, Albazyme, Kraft pulp.

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The economic effect of enzymatic treatment on kraft pulp bleaching.

2.0 SIC/ISIC Code: I3411.

3.0 Name and Location of Company:

PI Process Consulting Ltd., Myyrmäenraitti 2, P.O.Box 31, SF-016101 Vantaa, Finland, phone +358 0 530 91, telex 122905 pihki sf, telefax +358 0 563 2003.

4.0 Cleaner Technology Category

The enzymatic treatment reduces the need of active chlorine in kraft pulp bleaching and the AOX load of the effluents will be decreased.

5.0 Case Study Summary

5.1 Process and Waste Information: The investment and operating costs were compared when an enzyme treatment stage or an oxygen delignification stage was added to a reference process. As a reference mill, a new mill with annual average production of 400,000 ADt/a (400-mill) and an old mill with annual average production of 200,000 ADt/a (200-mill) fully bleached kraft pulp were used.

The operating and investment cost calculations are based on specific consumption values from material and energy balance calculations using the RAMI simulation program developed by PI Process Consulting Ltd. The balance calculations cover the whole pulp mill process.

5.2 Scale of Operation: See 5.1. The addition of the enzyme stage to the reference mill causes changes in the dimensioning of the chlorine dioxide plant and chemical recovery system. The additional capacity requirement in the chemical recovery line is about 15%. The capacity of the chlorine dioxide plant can be reduced from 34.5 t/d to 27.5 t/d.

The addition of an oxygen delignification stage to the reference mill causes changes in the chemical recovery line capacity by about 1.5%. The capacity of the chlorine dioxide plant can be reduced from 34.5 t/d to 21.0 t/d.

5.3 Stage of Development: The calculations are based on results of a simulation program.

5.4 Level of Commercialization:

5.5 Material/Energy Balances and Substitutions

Material Category	Quantity Before	Quantity After
Waste Generation:	15-25% less AOX	
Feedstock Use:	20-30% less active chlorine in prebleaching	
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics

6.1 Investment Costs: The total investment costs for a Scandinavian kraft pulp mill producing 400,000 ADt/a has been estimated to 2,400 million FIM in spring 1991. The total investment costs for the mill, including enzyme treatment, are only 0.3 million FIM more expensive than the costs for the reference mill.

The addition of the oxygen delignification stage makes the total investment costs 5.8% more expensive than the investment costs for the reference mill.

When an enzyme stage is added to the "old" 200,000 ADt/a mill, the investments are estimated to cost 1.4 million FIM. The additional cost for the oxygen stage is estimated to be 85.0 million FIM.

6.2 Operational and Maintenance Costs: With present enzyme prices and charges, the operating costs for the enzyme treatment are 16-17 FIM/ADt higher than the operating costs for the reference mill (400-mill). Oxygen delignification gives a clear chemical cost saving.

The inclusion of an enzyme stage or an oxygen stage to the 200-mill causes changes in the operating costs that are in the same range as for the 400-mill.

6.3 Payback Time:

7.0 Cleaner Production Benefits

See 4.0

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study was Performed: The work was reported in June 1991 and it is a part of SYTYKE, the Environmental Research and Development Programme for the Finnish Forest Industry.

10.0 Contacts and Citation

10.1 Type of Source Material: A research programme report.

10.2 Citation: Sannholm, G., Pusa, R. and Söderström, M., The effect of enzymatic treatment on kraft pulp bleaching, A SYTYKE research programme report, 65 p. (English abstract only)

10.3 Level of Detail of the Source Material: Additional information on the material balances and more detailed costs is available in the source material.

10.4 Industry/Program Contact and Address: Gun Sannholm, Project Manager, PI Process Consulting Ltd., Myyrmäenraitti 2, P.O.Box 31, SF-016101 Vantaa, Finland, phone +358 0 530 91, telex 122905 pihki sf, telefax +358 0 563 2003.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Tel. +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf.

11.0 Keywords

11.1 Waste type: Bleach plant effluent.

11.2 Process type/waste source: Kraft pulping, Pulp bleaching.

11.3 Cleaner Production Technique: Oxygen delignification, Enzyme treatment.

11.4 Other Keywords: Enzymes, Operating costs, Investment costs, Simulation.

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Bleach plant effluent, Kraft pulping, Pulp bleaching, Oxygen delignification, Enzyme treatment, Enzymes, Operating costs, Investment costs, Simulation.

****** DOCNO: 400-005-A-196 ******

HEADLINE:	Closed-cycle technology in bleached kraft pulp mill reduces wastewater generation through materials and recovery substitution and countercurrent washing.
INDUSTRY/SIC CODE:	Manufacture of Pulp, Paper and Paper Board; Bleached Kraft Process/SIC 2611
NAME/CONTACT:	U.S. Environmental Protection Agency
TECHNOLOGY DESCRIPTION:	The company runs a 725 ton/day ERCO Envirotech (Rapson-Reeve) closed-cycle technology for bleached kraft pulp mills. Chlorine dioxide replaced 70 percent of the chlorine normally used in the first-stage chlorination. This stage is followed by conventional caustic extraction, chlorine dioxide regeneration. Countercurrent washing is employed by the bleach plant, and bleach plant effluent is re-used in pulp mill in countercurrent brown-stock washers. Sodium chloride is recovered from white liquor by evaporation and filtration and is used in chlorine dioxide generator. Saltcake (sodium sulphate) in chlorine dioxide generator can be dried and sold. Salt (sodium chloride) from salt removal process can be re-used in the generation of bleaching chemical such as ClO_2, NaOH-Cl_2 and $NaClO_3$.
FEEDSTOCKS:	Wood, $NaClO_3$, Cl_2, H_2, SO_2, NaOH, Lime
WASTES:	Aqueous Na_2SO_4 and solid sodium sulfate
MEDIUM:	Low-level contaminated water
COST:	(1975 Dollars)
CAPITAL COST:	4.5 million
OPERATION/MAINTENANCE:	1.0 million
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	2.2 million/year
FEEDSTOCK REDUCTION:	Fresh process water requirement reduced from 104 m^3/ton to about 15m^3/ton.
WASTE PRODUCTION:	Total flow of 117 m^3/ton
IMPACT:	Reduced wastewater and wastewater contamination in bleached kraft process.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Closed Cycle Technology for Bleached Kraft Pulp Mills," Monograph ENV/WP.2/5/Add.5).
KEYWORDS:	Bleached Kraft Pulp, Paper, Wastewater, SIC 2611

***** DOCNO: 450-003-A-363***** <x>

HEADLINE:	Northwood Pulp and Paper modernizes bleaching system and particulate removal system and reduces bleaching effluent and particulate emissions.
INDUSTRY/SIC CODE:	Paper and Allied Products/SIC 26
NAME/CONTACT:	Northwood & Paper, Ltd. Prince George, British Columbia
POLLUTION PREVENTION OPTIONS SUMMARY:	A 680 ton/day bleached sulfite pulp mill installed equipment supplied by Kamyr to reduce the volume of effluent. Four separate bleaching stages occur in a single tower. Bleaching chemicals are displaced through the mat of pulp as it moves upwards. A Munters particulate removal unit was installed to reduce particulate emissions from the smelt dissolving stack. The unit comprises a number of multiangular components arranged in parallel for form modules that act as mist eliminators through impaction. The particulates in the gas stream are wetted and captured and the collected water droplets are directed back down the stack.
FEEDSTOCKS:	Emissions
WASTES:	Bleaching effluent
MEDIUM:	Air
COST:	
CAPITAL COST:	Munters unit - $40,000 compared to the Venturi unit - $230,000.
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Dollar values not reported.
FEEDSTOCK REDUCTION:	No energy requirements for the Munters unit, compared to $15,000/year for Venturi scrubber, with 90% the removal efficiency.
WASTE PRODUCTION:	Bleaching effluent reduced to 15 m^3/ton of pulp, particulate emissions reduced to 0.2 kg/ton.
IMPACT:	Waste management was improved at this pulp mill with the dynamic bleaching process which reduces effluent, and with the Munters particulate removal unit which reduces emissions.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects," Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 65.
KEYWORDS:	Pulp and Paper, Bleached Kraft Pulp, Scrubber Effluent, Process Change, SIC 26

***** DOCNO: 450-003-A-364*****

HEADLINE:	Installation of continuous sulfonated chemi-mechanical pulp (SCMP) plant and scrubber system reduces particulate emissions and increases plant yields.
INDUSTRY/SIC CODE:	Paper and Allied Products/SIC 26
NAME/CONTACT:	Abitibi-Price, Inc. Fort Williams Division Thunder Bay, Ontario
POLLUTION PREVENTION OPTIONS SUMMARY:	A batch sulfite pulp operation was replaced by a continuous sulfonated chemi-mechanical pulp (SCMP) plant to reduce sulfite effluent. A scrubber system was installed that contains an alkaline liquid suspension of powdered activated carbon which trickles downwards through packing, ensuring gas/liquid contact. Hydrogen sulfide is absorbed by the alkaline solution and then reacts with caustic and oxygen to produce sodium thiosulfate. Sulfur dioxide is recovered in the form of sodium sulfate, and the scrubbing liquor is recycled to the scrubber. The gas is then washed and heat is recovered through direct contact with water.
FEEDSTOCKS:	Wood chips, sodium sulfate
WASTES:	Sulfide wastes, emissions
MEDIUM:	Water, air
COST:	
CAPITAL COST:	SCMP plant - $30 million.
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	36
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Dollar values not reported.
FEEDSTOCK REDUCTION:	Reduced energy consumption.
WASTE PRODUCTION:	Scrubber removes 96.4% of the hydrogen sulfide and all the sulfur dioxide. Particulate emissions reduced from a range of 200-500 $\mu g/m^3$ to 126 $\mu g/m^3$.
IMPACT:	The new SCMP process complies with Ontario provincial controls on the amount of effluent entering Lake Superior. Plant yield has been increased from 70% to 90%, and particulate emissions have been reduced by 37-75%.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects," Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 66.
KEYWORDS:	Pulp and Paper, Hydrogen Sulfide, Scrubber Effluent, Process Change, Heat Recovery, SIC 26

***** DOCNO: 401-006-A-000 *****

1.0 Headline: Reduction of multimedia wastes in Finnish pulp and paper factories

2.0 SIC Code: 26 Paper and Allied Products, 2611 Pulp Mills, 2621 Paper Mills.

3.0 Name & Location of Company: 53 mill sites located throughout Finland. Mill sites include: Kemi, Oulu, Kajaani, Jamsankoski and Jamsa, Varkaus, Aanekoski, Tampere area. Southern lake Saimaa and the River Kymijoki. Examples of mill sites established since 1950 include Kemijarvi in the north, Uimaharju in the east, Kaskinen in the west and Kirkniemi in the south of Finland.

4.0 Clean Technology Category: This case study provides an overview of waste reduction in Finland's pulp and paper industry involving environmental legislative action, administration, improved processes and equipment and recycling.

5.0 Case Study Summary

5.1 Process and Waste Information: The Finnish pulp and paper industry has seen a trend of replacement of sulfite pulping processes with mechanical and sulfate pulping processes. This trend coupled with the development of loads and pollution control measures as well as increased administration and legislation has brought about a promotion of both industrial development and environmental achievement in the form of multimedia waste reduction.

The development of effluent loads and pollution control measures have lead to decreases in wastewater discharge quality and volume in Finland for the following reasons: 1. Considerable structural change in the industry with a shift from sulfite mills to sulfate and mechanical pulp mills; 2. Improved process internal measures which have lowered chemical losses; including the improvement of control systems, reduction of water consumption by closing some water circulation systems; and the improvement of production processes and equipments (i.e., dry debarking, increasing the recovery rate of spent liquor, stripping of condensates, changes in pulp cooling systems and changes in bleaching and chemical ad conditions).

Malodorous gases from chemical pulp mills are a problem in Finland. The structural development of the pulp industry has promoted air pollution control, because sophisticated chemical circulation systems in sulfate mills have eliminated emissions of sulfur compound. It is expected that as facilities are modernized total emissions of malodorous sulfur compounds by the pulp industry will be reduced to 3000-7000 tons per year (Sulfur dioxide emissions in the 1970's totalled about 600,000 tons per year.).

The total quantity of wastes accumulated in Finland each year attributed to the pulp and paper industry is approximately 70-80 million tons. (10 million tons are wood wastes and 815,000 tons are paper and cardboard). Only 35-40% of paper and cardboard are recovered in Finland due to limited capacity of the paper industry to receive paper from households due to export orientation and competition on quality. The degree to which wastes are used in the future will depend on the development of raw material and energy prices. The standard of waste management will depend on the state of development of utilization technology and methods.

5.2 Scale of Operation: Approximately 53 mills in Finland are subject to and participate in the combined efforts of the government to reduce wastes and emissions from pulp and paper manufacture.

5.3 State of Development: In Finland, environmental legislation and administration has not developed in parallel. There is a differentiation of the control mechanisms in administration and in environmental protection in legislation. Finland must make an effort to harmonize the licensing and notification system.

5.4 Level of Commercialization: All of the strategies discussed have originated in or have been implemented in the pulp and paper facilities in Finland.

5.5 Balances and Substitutions: The industry has trended towards the replacement of sulfite pulping processes to mechanical or sulfate pulping processes. This trend coupled with tighter discharge limits and control mechanisms have resulted in a reduction of pollution. In wastewaters, the suspended solids and biological oxygen demand have decreased in the years 1980-1984 by 23 % and 15 % respectively. However, the load of nutrients has increased with the increase in production. Air emissions of sulfur dioxide totalled about 600, 000 tons per year in the 1970s. It is expected that modernized total emissions of the pulp and paper industry will be reduced to 3000-7000 tons a year depending on the effectiveness of air pollution control. The installation of a new deinking facility is expected to increase the capacity of Finland to recover paper and cardboard thereby reducing the amount of solid wastes generated in Finland (about 300 000 tons per year).

6.0 Economics:

6.1 Investment Costs: Although costs were not specifically discussed, there was indication that sulfite mills have been converted to mechanical or sulfate pulping mills for reasons of profit. It was also stated that the recovery of energy and raw materials brought about by Finland's program is economically beneficial.

6.2 Operational and Maintenance Costs: Costs were not discussed. However, it was mentioned that an industrial plant with sound production costs is also sound from the point of view of environmental protection. This suggests that the saving of environment, energy, and raw material has become a factor that promotes industrial development in Finland.

6.3 Payback Time: Environmental benefits are recognized immediately. Individual facilities and specific costs and paybacks were not discussed.

7.0 Cleaner Production Benefits

The new sulfate and mechanical pulping processes are more profitable than the older sulfite pulping processes and also produce lowered air emissions and improved wastewater quality.

8.0 Obstacles, Problems and/or Known Constraints

Finland has not harmonized licensing and notification systems. This has resulted in a differentiation of the control mechanisms in administration and in environmental protection in legislation.

9.0 Date case study was performed: This case study was developed from proceedings of the Finland/UNEP International Seminar on Sound Environmental Management in the Pulp and Paper Industry in Helsinki held May 14-17, 1986.

10.0 Contacts and Citation

10.1 Type of Source Material: Proceedings of the 1986 Finland/UNEP International Seminar on Sound Environmental Management in the Pulp and Paper Industry.

10.2 Citation: Ruonala, Seppo, "Environmental Mangement in the Finnish Pulp and Paper Industry." Sound Environmental management in the Pulp and Paper Industry, Seminar Papers and Documents (May 14-17 1986): 65-75.

10.3 Level of Detail of Source Material: More detailed information on water discharge loads are available. This document is an overview of improvements in Finland's pulp and paper industry and does not provide facility specific data.

10.4 Industry/Program Contact and Address: Mr. Seppo Ruonala, National Board of Waters, Finland.

10.5 Abstractor and Address: Susan Wojnarowski, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, VA 22043.

11.0 Keywords:

11.1 Waste Type: Sulfur dioxide emissions, Sulfide wastes, Wastewater, Wood fiber, Organic sludges, Liquors.

11.2 Process Type/Waste Source: Pulping operations, paper manufacture, SIC code 2611, Pulp Mills, and SIC Code 2621, Paper Mills.

11.3 Waste Reduction Technique: Process redesign, air pollution control, equipment modification, chemical use review, wastewater reduction, waste segregation.

11.4 Other Keywords: Finland.

Keywords: Equipment Modification, Process Redesign, Pulp and Paper Mills, Sulfur Dioxide Emissions, Wastewater

***** DOCNO: 450-003-A-365*****

HEADLINE:	Tembec converts coal fired boiler to use waste sulfite liquor as fuel substitute.
INDUSTRY/SIC CODE:	Paper and Allied Products/SIC 26
NAME/CONTACT:	Tembec, Inc. Temiscaming, Quebec
POLLUTION PREVENTION OPTIONS SUMMARY:	A coal-fired boiler at a pulp mill was converted to use waste sulfite liquor. The liquor from the batch digesters is taken to a blow-pit, and then drawn off to a storage tank. Vapor compression evaporators increase the concentration to 49-50% solids, and the liquor is ready for use in the boiler.
FEEDSTOCKS:	Waste sulfite liquor
WASTES:	Emissions
MEDIUM:	Air
COST:	
CAPITAL COST:	$32 million
OPERATION/MAINTENANCE:	Less than costs of coal-firing boiler
MONTHS TO RECOVER:	38
SAVINGS:	
DISPOSAL & FEEDSTOCK:	$10 million/year.
FEEDSTOCK REDUCTION:	Reduced costs for fuel.
WASTE PRODUCTION:	Improved quality of emissions.
IMPACT:	Conversion of a coal-fired furnace to one that burns plant waste reduces fuel costs by eliminating coal purchases, and reduces hazardous emissions that are emitted from coal furnaces.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects," Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 67.
KEYWORDS:	Pulp and Paper, SIC 26

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The PUNEC pulping process produces bleached pulp from agricultural residue (e.g., bagasse or rice straw) and selectively separates lignin and hemicellulose with minimal water use and no release of soluble waste or noxious gas.

2.0 SIC/ISIC Code: I3411, I3511

3.0 Name and Location of Company:

Pudumjee Pulp & Paper Mills Ltd., Thergaon, Pune 411 033, India.

4.0 Cleaner Technology Category

The process involves delignification of lignocellulosic material in the absence of environmentally polluting sulphur and chlorine compounds, using solvent ethanol and oxygen in bleaching, refining lignocellulosics into pulp, lignin and hemicelluloses. These products form environmentally friendly natural polymers and animal feeds. The simplicity of pulping makes it possible, to establish mini mills.

5.0 Case Study Summary

5.1 Process and Waste Information: The PUNEC pulping process provides a cleaner production technique involving use of an ethanol-water mixture as solvent, in presence of catalytic amount of caustic soda so as to obtain a near neutral pH at the end of the delignification reaction and also providing as environment for selective removal of lignin with high yield of pulp. The solvent is recovered by flashing and distillation to recycle the same in the process. Lignin is precipitated in the form of chocolate brown coloured solids by proper acidification and dilution and amounts to about 15% of the dry weight of fibre processed. The remaining aqueous extract after the solvent recovery is rich in hemicelluloses concentrated to a syrup to use it in animal feed.

Thus, the process refines lignocellulosic material into three products named above and lets no dissolved organic waste or polluting chemicals to environment. Therefore, the objective of environmentally benign process is truly met with the advent of this pulping process.

Pulp consumes about 30% lower bleaching chemicals and responds well with the chlorine free bleaching chemicals, such as oxygen and peroxide.

Products or production rates resulting from the applications:

- 172 MT O.D. (oven-dry) deputhed bagasse upon PUNEC pulping process yields 110 MT O.D. of unbleached pulp of kappa number 30 + 3, which upon screening and bleaching by ODP sequence yields 100 MT O.D. bleached pulp at 80+1% ISO brightness.
- About 26.0 T lignin and an equal amount of hemicellulose concentrate on dry basis are obtained while the solvent recovery is 99% on the charge.

5.2 Scale of Operation: Tested at pilot plant level producing 15 kg pulp per day at Pudumjee Mills.

5.3 Stage of Development: Pilot plant scale.

5.4 Level of Commercialization: One hundred tonnes per day plant will be established by M/s. Pudumjee Pulp & Paper Mills by 1994.

5.5 Material/Energy Balances and Substitutions: See 5.1 and 7.0.

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: To be established.

6.2 Operational and Maintenance Costs: To be established.

6.3 Payback Time: To be established.

7.0 Cleaner Production Benefits

The PUNEC pulping process has the following benefits:

- the process invites conservation of raw materials by producing higher yields of pulp.
- the process also provides means of recovering the chemicals used therein and their reuse in the process thereby economizing the method of delignification of agricultural residues.
- the solvent used in the process is a renevable organic material benign to the environment.
- the recovery of useful by-products such as lignin and hemicelluloses, which are normally lost to the effluent, makes the process to operate at lower cost.
- no generation of AOX and process is free from TRS and lime grits.
- requires far less water than conventional pulping.
- lower capital cost than in the conventional pulping.

8.0 Obstacles, Problems and/or Known Constraints

- a special washing arrangement needs to be done to prevent lignin reprecipitation.
- leakages and spillages of pulping chemicals cannot be tolerated both for environmental and economical reasons. However, this is a standard procedure for any petrochemical type operation and the necessary design features should be incorporated whilst planning.
- difficulty of pulping of mixed species of wood could lead to less homogeneous pulps. This fear has proven to be unfounded in the various trials taken so far in Canada.

9.0 Date Case Study Was Performed: In the early 1985, Pudumjee Mills started work on a laboratory scale. Over last five years the process went through several tests and trials on a pilot plant scale.

10.0 Contacts and Citation

10.1 Type of Source Material: Unpublished material provided by contact person, see 10.4.

10.2 Citation: Indian Patent No. 167296 dated 6th October, 1990. International Classification - D2IC-3100, 3/02, 11/100.

10.3 Level of Detail of the Source Material: Additional information on the laboratory tests conducted is available in the source material.

10.4 Industry/Program Contact and Address: K.D. Pudumjee, Technical Director, Pudumjee Pulp & Paper Mills Limited, Thergaon, Pune 411 033, India.

10.5 Abstractor Name and Address: Dr. R.G. Nayak, Pudumjee Pulp & Paper Mills Ltd, Thergaon, Pune 411033, India, tel: 86032/33/34, 86488, fax: (0212) 86294, telex: 146-215 GPGL IN

11.0 Keywords

11.1 Waste type: Agricultural residues, Lignin, Hemicelluloses

11.2 Process type/waste source: Pulping process, Delignification, Alcohol, Depithed bagasse

11.3 Cleaner Production Technique: PUNEC pulping process, Solvents, Alcohol

11.4 Other Keywords:

11.5 Country Code: India.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Agricultural residues, Lignin, Hemicelluloses, Pulping process, Delignification, Alcohol, Depithed bagasse, PUNEC pulping process, Solvents, Alcohol

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Effluent-free and potassium-based sulphite pulping of flax straw with reuse of spent pulping liquor and bleaching effluent as saleable fertilizer product..

2.0 SIC/ISIC Code: I3411, I3512

3.0 Name and Location of Company:

Canadian Flax Pulp Ltd. (Arbokem Inc.), Surrey, British Columbia.

4.0 Cleaner Technology Category

Virtually effluent-free mill as all pulping liquor, bleaching effluent, and fibrous rejects will be collected for subsequent processing into value-added potassium fertilizer. No burning of spent pulping or bleaching liquor. Thus, there will be no emission of odorous sulphur compounds and excess carbon dioxide to the atmosphere.

5.0 Case Study Summary

5.1 Process and Waste Information: The process line includes rotary digesters, pulp washers, beaters/refiners, screens/cleaners, a two-stage bleachery, pulp dryer, evaporator and activated sludge system for evaporator condensates.

Arbokem proposes to use its new patented process for producing pulp from flax straw and for disposing of spent pulping liquor. A potassium alkaline sulphite process will be used to produce the brown flax pulp. The alkaline/neutral sulphite pulp will be bleached to 80-points brightness using an oxygen-hydrogen peroxide process sequence. The spent pulping liquor as well as the bleaching effluent is to be collected and evaporated to a saleable liquid fertilizer product. All of the evaporator condensate and excess white water is to be treated biologically in a small activated sludge system. Ninety-five percent of the bio-treated effluent is to be recycled for use within the pulping and bleaching processes. The remaining 5% of the bio-treated effluent will be discharged into the municipal sanitary sewer.

In the event of potassium-base supply interruption and to diversify the market for concentrated pulp mill liquor, Arbokem states that a secondary use of the concentrated spent pulping liquor could be for road construction. A patented new road construction technology, known as "BC Stabilizer", requires lignosulphonate. The effluent produced in the flax pulping process can be used as the lignosulphonate component of the BC Stabilizer.

5.2 Scale of Operation: The pulp mill is designed to produce 7,000 air-dried metric tonnes of bleached flax pulp annually, at full capacity, primarily for the export market. The flax pulp mill will also co-produce 13,000 tonnes (as 50% dissolved solids and 50% water) of potassium-based liquid fertilizer.

5.3 Stage of Development: A small-scale mill will be fully operational in late 1992.

5.4 Level of Commercialization: The technology is commercially available.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:		
BOD	N/A	<0.5 kg/d
COD	N/A	2.5 kg/d
TSS	N/A	1.0 kg/d
SO_2	N/A	<2.0 kg/t pulp
CO_2	N/A	18 t/d
Feedstock Use:		
flax fibre	N/A	12,000 t/y
potassium sulphite	12.7 t/d	
potassium hydroxide	1.32 t/d	
oxygen	0.55 t/d	
hydrogen peroxide	1.32 t/d	
epsom salt	0.22 t/d	
DTMPA (chelate)	0.22 t/d	
Water Use:	N/A	100 m^3/d
Energy Use:		
electrical	N/A	760 kWh/admt pulp
low press. steam		13 GJ/admt pulp

6.0 Economics*

6.1 Investment Costs: The proposed bleached flax pulp mill is estimated to cost $8 million Canadian (April 1991) to construct.

6.2 Operational and Maintenance Costs: The proposed mill would employ 23 full-time workers, with an estimated annual payroll of $900,000 Canadian.

6.3 Payback Time:

7.0 Cleaner Production Benefits

See 4.0.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed: Arbokem filed its Prospectus document with the Major Project steering Committee on October 25, 1990.

10.0 Contacts and Citation

10.1 Type of Source Material: Reviews of the project

10.2 Citations:

(1) Review of prospectus for Arbokem Inc. flax pulp mill, Prepared by: The Steering Committee of the Major Project Review Process, February 1991, Ministry of Regional and Economic Development & Ministry of Environment, 21 p.

(2) Bleached flax pulp mill, Prospectus, October 1990, Arbokem Inc., 25 p.

10.3 Level of Detail of the Source Material: Additional information on the environmental and socio-economic impacts of the project is available.

10.4 Industry/Program Contact and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

10.5 Abstractor Name and Address: Same as in 10.4.

11.0 Keywords

11.1 Waste type: Pulp mill effluent

11.2 Process type/waste source: Sulphite pulping

11.3 Cleaner Production Technique: Potassium based sulphite pulping

11.4 Other Keywords: Flax pulp mill, effluent-free, potassium, fertilizer, road construction

11.5 Country Code: Canada.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulp mill effluent, sulphite pulping, potassium-based sulphite pulping, flax pulp mill, effluent-free, potassium, fertilizer, road construction

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Organosolv Pulping of Sugarcane Bagasse

2.0 SIC/ISIC Code: I3411, I3122.

3.0 Name and Location of Company:

ICAITI (Instituto Centroamericano de Investigacion y Tecnologia Industrial), Guatemala.

4.0 Cleaner Technology Category

This organosolv pulping process uses sugarcane bagasse as raw material and ethanol-water and sodium hydroxide as cooking liquor, adding anthraquinone (AQ) as catalyst. The process has a closed circulation of effluents, uses the raw material totally and process residues can be used as raw material in biochemical processes due to their high content of hexoses and pentoses.

This technology is suitable for modification of old pulping processes. Very important aspects are the total use of raw material and closed circulation of effluents. The process residues are valuable raw materials for biochemical processes.

5.0 Case Study Summary

5.1 Process and Waste Information: One of the experiments carried out was as the following:

The cooks were carried out in six, two-liter unit reactors heated in an oil bath and rotating on a shaft at six rpm. The cooking liquor consisted of a mixture of 60-40% ethanol-water by weight and small quantities of sodium hydroxide. The amount of AQ was 0.05%.

The following factors were held constant:
- time to operating temperature, 140 min.
- cooking temperature, 175°C.
- solid to liquid ratio, 1:6.

Once the cooking cycle was concluded, each unit was quickly cooled by immersion in water. The cooked material was separated from the cooking liquor and thoroughly washed with fresh water; successively, the material was fiberized in a two-liter blender and screened on a flat screen. The pulps were then refined at different oSR freenes in a PFI refiner. Sheet making and testing was done according to TAPPI test methods.

The results of the cooks show that the AQ increases the selectivity of the system toward the lignin removal and reduces cellulose and hemicellulose degradation effect. The influence of the AQ also reflected on the physico-mechanical properties of the pulps. In a general way, most properties improved their values, mainly the tensile and tear index, with the exception of the folding endurance which showed an important decrease in its values for all the pulps.

5.2 Scale of Operation: The scale of operation is versatile. Already small scale production is economically feasible and existing pulp mills can be modified for this process.

5.3 Stage of Development: Organosolv pulp process has been theoretically studied since the 1030's. New development work for the use of tropical wood species, sugar cane and banana leaves as raw material has been done by the Central American Research Institute for Industry (ICAITI).

5.4 Level of Commercialization: The process consists of conversion of existing technology. Large scale commercialization has not been done.

5.5 Material/Energy Balances and Substitutions: A material balance of the process referred to a 50 t/day plant:

IN (t/day)		OUT (t/day)	
Bagasse (60% H_2O)	227.79	Pulp	50.00
H_2O	53.29	EtOH (regenerated)	295.22
EtOH (190° proof)	354.91	EtOH (dissipated)	32.80
Anthraquinone	0.05	Lignin	18.22
NaOH (50% H_2O)	3.64	Sugars (90.6% H_2O)	243.44

6.0 Economics*

6.1 Investment Costs: The investment cost for a 50 t/day plant capacity is $CA 21.5 million (1988).

6.2 Operational and Maintenance Costs: The operational costs are $CA 370 per ton of pulp and the by-product credits $CA 141 per ton of pulp.

6.3 Payback Time: The payback period will be three years (pulp cost $CA 500/t).

7.0 Cleaner Production Benefits

Use of new raw material, which can be biomass wastes existing already in large quantities like sugar cane bagasse.

Totally integrated use of raw material.

Decrease of waste effluents due to recirculation of effluents and replacement of chemical additives used in conventional pulp mill.

The pulp mill can be installed locally in small scale close to an area where non conventional raw materials are available. The socio-economical benefits of a small scale production are superior to those of centralized production.

8.0 Obstacles, Problems and/or Known Constraints

Due to the volatility of the pulping chemicals no leaks and spills can be tolerated, both for environmental and economic reasons.

9.0 Date Case Study Was Performed: This case study has been reported by ICAITI during 1984-89.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles.

10.2 Citations:

(1) Valladares, J., Rolz, C., Bermudez, M.E., Batres, F.R. and custodio, M.A., Pulping os sugarcane bagasse with a mixture of ethanol-water solution in presence of sodium hydroxide and anthraquinone, Tappi Nonwood Plant Fiber Pulping Program, Report no 15:23-28, Nov. 1984.

(2) Dominduez, J.L. and Valladares, J.L., Obtencion de pulpas a partir de tres variedades de eucaliptus utilizando como licor de coccion mezclas de etanol-aqua-sosa en presencia de antraquinona, pp. 143-146.

(3) Valladares, J. and Cruz, E.C., Obtencion de pulpas quimicas a partir de bagazo de cana de azucar, utilizando mezclas de metanol-aqua y etanol-aqua, IV Latinoamerican Congress on Cellulose abd Paper, Proceedings, Mexico 1986, pp.134-142.

(4) Valladares, J.L., Duarte, F.C., Rolz, C.A. and Perez, E.H.G., Especies arboreas de rapido crecimiento como fuentes potentiales de celulosa y papel, V Latinoamerican Congress on Cellulose and Paper, Proceedings, Santiago 1989, pp. 71-88.

(5) Valladares, J.L., Rolz, C. and Perez, E.H., Residuos fibrosos del cultivo del banano como fuentes potenciales de celulosa y papel, Augura Ano, 14, No. 1, 1988, pp. 65-72.

(6) Valladares, J., Salguero, R., Rolz, C. and Perez, E., Obtencion de pulpas quimicas a partir de bagazo de cana de azucar utilizando mezclas de etanol, aqua y amoniaco, paper to be presented in Torremolinos in June 1992, 10 p.

10.3 Level of Detail of the Source Material: Additional information on the pulping conditions is available in the source material.

10.4 Industry/Program Contact and Address: Valladares, Jaime, Head of the Pulp and Paper Section of the Applied Research Division Of ICAITI, Avenida La Reforma 4-47, Zona 10-01010, Guatemala.

10.5 Abstractor Name and Address: Mrs. Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type:

11.2 Process type/waste source: Chemical pulping, Organosolv lignins, Delignification, Bagasse pulping

11.3 Cleaner Production Technique: Organosolv pulping, Alcohols, Methanol, Anthraquinone

11.4 Other Keywords:

11.5 Country Code: Guatemala.

12.0 Assumptions

13.0 Peer Review

Unknown.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Chemical pulping, Organosolv lignins, Delignification, Bagasse pulping, Organosolv pulping, Alcohols, Methanol, Anthraquinone

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Production of higher value paper products from depithed sugarcane bagasse.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

4.0 Cleaner Technology Category

Production of high-yield pulp from depithed sugarcane bagasse.

5.0 Case Study Summary

5.1 Process and Waste Information:

Process Area: Pulping.

Base Process: Cold soda semichemical process. The conventional process requires that the sugarcane bagasse undergoes a depithing process followed by pulping of the fraction rich in fibres in a cold soda process (10-12% of NaOH over dry matter; 120-140°C during 20-30 minutes). The pulp produced is normally used to manufacture liners and corrugating medium. This pulp can be bleached and used to produce, in mixture with secondary fibres, printing and writing papers.

Process Changes: The equipment lay-out is the same, but the chemicals applied are less, and the pre-steaming time and the temperature of the steam are lower.

New Waste Stream: The same as in regular sugarcane cold soda process, but with lower content in pollutants.

Raw Materials: Sugarcane bagasse.

Energy Usage: Somewhat higher, between 300-500 kWh/t of drymatter.

Operating Procedures: Normal procedures for the operations already described.

5.2 Scale of Operation: The same as used in the sugarcane semichemical process, between 50-100 ADMT/day.

5.3 Stage of Development: Pilot plant trials.

5.4 Level of Commercialization: The basic conditions are established, but additional research is necessary.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: Between 150-200 thousands US$/ADMT/day.

6.2 Operational and Maintenance Costs: Depend on the case.

6.3 Payback Time: Depend on the case.

7.0 Cleaner Production Benefits

Substitute a polluting process for another less polluting.

8.0 Obstacles, Problems and/or Known Constraints

None.

9.0 Date Case Study Was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article, personal contacts, conference proceedings, unpublished material.

10.2 Citations:

(1) Neves, J.M., Pastas quimitermomecanicas de bagaco de cana-de-acucar. O Papel 46(12): 127-140(1985).

(2) Neves, J.M. e Souza, A., Pastas quimitermome canicas obtidas a partir de bagaco desmedulados. 8 Encontro de PAR: Materias-primas alternativas. Realizado pela Sub Comissao de PAR de Comissao Permanente de Celulose, ABTCP, Sao Paulo, 1991.

10.3 Level of Detail of the Source Material: Well detailed.

10.4 Industry/Program Contact and Address: Dr. Jose Mangolini Neves, Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

10.5 Abstractor Name and Address: Dr. Jose Mangolini Neves, Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

11.0 Keywords

11.1 Waste type: Liquor

11.2 Process type/waste source: CTM Pulping, Waste liquor

11.3 Cleaner Production Technique: Process substitution

11.4 Other Keywords:

11.5 Country Code: Brasil.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Liquor, CTM Pulping, Waste liquor, Process substitution

1.0 Headline: Enzymatic post-treatment of TMP obtained from depithed sugarcane bagasse to produce reducing sugars for ethanol production.

2.0 SIC/ISIC Code: I3511.

3.0 Name and Location of Company:

Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

4.0 Cleaner Technology Category

An alternative method for the use of sugarcane bagasse that permits production more ethanol in the regular process, instead of bagasse burning. This kind of process is of great importance in regions where only ethanol is produced instead of sugar.

5.0 Case Study Summary

5.1 Process and Waste Information: Base Process: The literature shows that in the PEADCO process, the sugarcane bagasse is depithed by the dry wash and the wet methods. In some mills, one, two or the three methods are used consecutively producing the depithed bagasse that contains approximately 19% of pith and 81% of fibres. This raw material feeds the cold soda process for corrugated liner pulp production.

Process Changes: This alternative takes the depithed bagasse, passes it through a pressurized refiner, as in the first step of a TMP process (thermomechanical), only applying less energy. This results in some solubilization of hemicelluloses and waxes and makes the cellulose more accessible to future enzymatic attack. The pulp produced in the TMP process is then squeezed into a screw and treated with the enzymatic liquor containing Trichoderma reese. During 3-4 hours, the treated material is saccharified; the sugar liquor is removed through filtration and sent to the ethanol mill in the fermentation area. The solid residue, containing the micelium, is partly removed and partly reutilized in the process. The rest can be compressed into pellets for burning in the furnace.

New Waste Stream: When the sugarcane bagasse is depithed, a big volume of the pith is separated. This is a material rich in starch that can be hydrolized into sugar through acid or enzymatic methods and then also converted to ethanol.

Raw Materials: Sugarcane bagasse.

Energy Usage: About 200-300 kWh/t of dry bagasse are needed for the TMP operations.

Operating Procedures: Same as described in "Process changes".

5.2 Scale of Operation: In full-scale production, an ethanol mill has a modular output of 1,200,000 litres per day. This output can be increased with enzymatic production.

5.3 Stage of Development: Bench scale.

5.4 Level of Commercialization: This technology is not yet ready for commercialization. A technical and economic evaluation of the process is being carried out.

5.5 Material/Energy Balances and Substitutions

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics

6.1 Investment Costs: Between US$ 200-300 thousand/BDT of pulp processed per day.

6.2 Operational and Maintenance Costs: Variable in each case.

6.3 Payback Time: Not available.

7.0 Cleaner Production Benefits

The increase in production capacity of a regular ethanol mill, by using bagasse to produce ethanol instead of burning.

8.0 Obstacles, Problems and/or Known Constraints

Price and availability of the sugarcane bagasse.

9.0 Date Case Study was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Personal contact, conference proceedings and unpublished material.

10.2 Citations:

(1) Neves, J.M., Pastas quimitermomecanicas de bagaco de cana, O Papel 46 (12):127-140, Sao Paulo, 1985.

(2) Peres, C.S., Schimidell, W., Lima, A.F., Neves, J.M., Villen, R.A. and Sanros, T.W., Hidrolise enzimatica de bagaco de cana-de-acucar, i Simposio Interamericano sobre Biotecnologia de Enzima, OEA/Conselho de Investigaciones Biomedicas Univ. Nacional do Mexico, 10-12 Dez. 1981, In: Mutton, C., ed., Biotecnologia de Enzimas, UNAN, 1983, p. 297-308.

10.3 Level of Detail of the Source Material: Fairly well detailed.

10.4 Industry/Program Contact and Address: Dr. Jose Mangolini Neves, Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

10.5 Abstractor Name and Address: Dr. Jose Mangolini Neves, Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

11.0 Keywords

11.1 Waste type: Sugarcane bagasse.

11.2 Process type/waste source: Recycling of sugarcane bagasse.

11.3 Cleaner Production Technique: Alternative method to use sugarcane bagasse, Ethanol.

11.4 Other Keywords:

11.5 Country Code: Brasil.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Recycling of sugarcane bagasse, Alternative method to use sugarcane bagasse, Ethanol.

1.0 Headline: Recovery of by-products and pulping chemicals from industrial soda bagasse spent liquors.

2.0 SIC/ISIC Code: I3411, I3529

3.0 Name and Location of Company:

The Division for Processing and Chemical Manufacturing Technology, CSIR, P.O.Box 395, Pretoria, 0001 South Africa

4.0 Cleaner Technology Category

A serious environmental problem can be solved by the recovery and use of lignin and hemicellulose and the recycling of chemicals from spent liquors from bagasse pulping.

5.0 Case Study Summary

5.1 Process and Waste Information: Soda bagasse spent liquor contains three useful products - lignin, hemicellulose, and the spent pulping chemicals. There are various avenues by which these components can be separated.

In this study, the spent liquor from industrial bagasse soda pulping was subjected to a series of treatments to separate the valuable components. The concentrated liquor was mixed with an equal quantity of methanol, resulting in the precipitation of the hemicellulose. Filtration, washing with 50% aqueous methanol, and drying (105°C) gave a hemicellulose precipitate in a 30% yield. The methanol and part of the water were removed under reduced pressure from the filtrate to give a lignin solution with a solids content of 33%. The concentrated solution was acidified with CO_2 to pH 9.5, resulting in precipitation of the lignin. This precipitate was filtered and dried. The lignin yield obtained by this treatment is influenced by the concentration of the liquor.

The results show that the main portion of the silica is removed from the spent liquor by the hemicellulose precipitate. This leads to various exciting possibilities of recovery.

The removal of the silica results in an almost silica-free liquor, eliminating the recovery restrictions previously imposed by the silica in the recovery of soda bagasse pulping chemicals. The liquor remaining after the removal of the lignin can now be burnt via standard recovery procedures, if enough energy is present in the form of unrecovered organic material. Another approach is to remove only the hemicellulose and burn the lignin filtrate for recovering the pulping chemicals.

Soda bagasse hemicellulose has found use as a paper strengthener, a corrugated board adhesive, and a briquette binder, whereas soda bagasse lignin is an excellent substitute for phenol and urea formaldehyde adhesive.

5.2 Scale of Operation: In the experimental procedures, the amount of the industrial spent liquor obtained from the soda pulping of bagasse was 100 g (solids content 30.8 %) and the mixed methanol amount 100 g.

5.3 Stage of Development: Laboratory stage. Industrial pilot plant evaluations are under way.

5.4 Level of Commercialization: The technology is not commercially available. The equipment and materials are readily available.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs:

6.2 Operational and Maintenance Costs:

6.3 Payback Time: Reclaiming the lignin and hemicellulose as by-products can increase the profitability of bagasse pulp mills because the values of these products are estimated to be much more than their reclamation costs. In addition, the major portion of the sodium can be recovered for the recycling by a process that is potentially inexpensive in terms of capital investment.

7.0 Cleaner Production Benefits

See 4.0.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed: The experimental procedures were presented in 1987.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article.

10.2 Citation: Venter, J.S.M. and Van der Klashorst, G.H., The recovery of by-products and pulping chemicals from industrial soda bagasse spent liquors, Tappi Journal, March 1989, pp. 127-132

10.3 Level of Detail of the Source Material: Additional information on the uses of by-products is available.

10.4 Industry/Program Contact and Address: J.S.M. Venter and G.H. Van der Klashorst, program managers, Division for Processing And Chemical Manufacturing Technology, CSIR, P.O.Box 395, Pretoria, 0001 South Africa.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Pulp plant effluent

11.2 Process type/waste source: Soda pulping, Chemical pulping

11.3 Cleaner Production Technique: Desilication, Recovery

11.4 Other Keywords: Spent liquors, Bagasse, By-products, Adhesive, Binder

11.5 Country Code: South Africa.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulp plant effluent, Soda pulping, Chemical pulping, Desilication, Recovery , Spent liquors, Bagasse, By-products, Adhesive, Binder

***** DOCNO: 400-110-A-325*****

HEADLINE:	Application of the black liquor disilication technology increases efficiency and eliminates environmental pollution of alkaline non-wood plant fibre pulping.
INDUSTRY/SIC CODE:	Manufacture of Pulp, Paper and Paperboard/ISIC 3411
POLLUTION PREVENTION OPTIONS SUMMARY:	Removal of silica from spent liquors of alkaline non-wood plant fibre pulping. When using non-wood annual plant as raw material for pulping, a considerable amount of silica (SiO_2) is carried into the process, which prohibits recycling of the quick lime to the causticizing process. The desilication of the black liquor requires steam boiler flue gas as the only reagent. Precipitated matter is separated from the liquor by means of conventional mechanical systems (centrifuging, sedimentation, etc.)
FEEDSTOCKS:	Steam boiler flue gas, black liquor containing dissolved silica
WASTES:	Precipitated silica, clarified black liquor recovered in the process.
MEDIUM:	Solid, liquid
COST:	Not reported
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Not reported
FEEDSTOCK REDUCTION:	Low waste technology allows for recycling of quicklime
WASTE PRODUCTION:	Current technology generates 250-300 kg $CaCO_3$ solids as lime mud per ton of dissolved black liquor solids. Low waste technology produces 15-125 kg SiO_2 solids per ton.
IMPACT:	Many pulp mills processing straw species with extremely high silica content are still running without any chemical recovery system due to silica problems. They are draining their spent liquor into the effluent system and are forced to cover their demand on pulping chemicals by purchases from the market. Application of the black liquor desilication technology would allow them to operate with a chemical recovery system, increasing their efficiency and eliminating environmental pollution.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Desilication of Spent Liquors Derived from Aldaline Pulping of Non-wood Fibres," Monograph ENV/WP.2/5/Add.110.
KEYWORDS:	Pulp, Paper, Recycling, Solid Waste Recovery, Silica, ISIC 3411

1.0 Headline: Chemicals recovery and disilication of rice straw black liquor.

2.0 SIC/ISIC Code: I3411, I3511

3.0 Name and Location of Company:

The Rakta General Co. of Alexandria, Egypt.

4.0 Cleaner Technology Category

The process described allows chemicals to be recovered from rice straw black liquor and an efficient desilication is attained.

5.0 Case Study Summary

5.1 Process and Waste Information: In general, the quantity of chemicals needed for the digestion of non-wood materials ranges between 20-50 weight percent of the pulp produced. For the economical reason, and also to prevent environmental pollution, the chemicals should be recovered from the spent black liquor.

With chemical pulp produced from rice straw, about half the quantity of silica contained in the plant substance is dissolved in black liquor (rice straw contains 8-14% SiO_2). This causes problems in all stages of the chemical recovery process.

For a pulp mill that depends on nonwood fiber, silica must be eliminated from black liquor to produce pulp economically and to meet environmental restrictions.

In the proposed chemicals recovery and desilication process, black liquor coming from the washing unit is filtered in a drum-filter. The outcoming black liquor is fed via a buffering tank, to the four-effect evaporation plant. For low concentrations, evaporation takes place in three long-tube falling film evaporators. Higher concentrations are attained in a forced circulation evaporator, which pre-concentrates the black liquor to a DS content of between 8 and 14% - the optimum for effective desilication. The forced-circulation stage further concentrates the desilicated black liquor.

Next, a stream of preconcentrated black liquor is fed to a draft-tube reactor equipped with stirrer and foam breaker, where it is brought into intimate contact with a continuous stream of flue gas from the power station stack. Here, soluble sodium silicates are converted into sodium carbonate and largely insoluble SiO_2. This two-phase mixture is routed via an intermediate tank to a decanter that separates the precipitates from the clean liquor. For final clarification, the liquor is passed through a separator, where the residual insoluble particles are removed. Subsequently, this desilicated black liquor is then burned in the conventional way.

The silica extracted from the black liquor together with some alkali and organic matter forms a sludge that is discharged from the decanter at a DS content of 30-40% and burned in a fuel oil-fired incinerator. Elution of the alkali from the ash with water, followed by filtering and drying, yields an almost white silica granulate, which can be used as a filler in papermaking.

The optimum pH is between 9 and 10. The corresponding specific flue gas rate at a CO_2 concentration of 6-8% is in the range 50-150 m^3 gas (at NTP) per m^3 of black liquor.

Irrespective of the silica content of the incoming black liquor, which typically is in the range of 1% (by weight), total silica contents of 0.05% weight were attained downstream of the separator.

5.2 Scale of Operation: The research work was carried out in a pilot plant installed at the Rakta Mill, the largest pulp mill based on rice straw in the world. All process stages were studied in detail, with researchers carrying out 95 test runs.

In the pilot drum-filter throughput is 30 m^3/h and the evaporation capacity is 18.5 tons/hour. Rakta's pilot plant successfully handles 50 tons/day of pre-concentrated black liquor.

5.3 Stage of Development: Pilot plant stage.

5.4 Level of Commercialization: The technology is not commercially available. One of the major aims of the research project was to find the most suitable equipment available on the market to meet the various process requirements.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: Cost calculations made for some actual projects show that the desilication plant accounts for only 12% of the total investment cost of a conventional recovery plant.

6.2 Operational and Maintenance Costs: See 6.1. Likewise, labor and utility costs are in the same, relatively low range. A calculation made for a 200-ton/day pulp mill resulted in total operating costs for a caustic-soda recovery plant including desilication of $80/ton pulp (1986). Without recovery, the mill has to spend $140/ton to buy caustic soda on the market. In this case, annual savings by chemicals recovery amount to $3.6 million, or 13.3% of the international market value of the pulp.

6.3 Payback Time:

7.0 Cleaner Production Benefits

Among the advantages of the new recovery system are:

Only small losses of alkali and lime by purging out last traces of SiO_2 and less waste in the form of Ca silicates.

8.0 Obstacles, Problems and/or Known Constraints

If improved dewatering properties of silica sludge could be achieved on a commercial scale, even higher sludge concentrations would be obtained, which in turn would reduce chemical and organic losses correspondingly.

Disposal of silica sludge is still another area for study. In addition to the silica uses in the papermaking, bricks can be made with a mixture of 70% sludge (untreated, dry content 10%), 15% gravel, 5% sand, and 10% cement with a quality that met approved standards.

9.0 Date Case Study Was Performed: The investigation of desilication of rice straw black liquor started in the 1970s. The pilot plant started in 1985.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles.

10.2 Citations:

(1) Marcks, R. and Schildhauer, G., Trials prove black liquor system, PPI, November 1986, pp. 48-49.

(2) Kopfmann, K. and Hudeczek, W., Desilication of black liquor: pilot plant tests, Tappi journal, October 1988, pp. 139-147.

10.3 Level of Detail of the Source Material: Additional information on the individual process stages is available in the source material.

10.4 Industry/Program Contact and Address: L. Ehling, Kraftanlagen Aktiengesellschaft, Warngauer Str. 47, P.O,Box 900465, 8000 Munchen 90, Germany, Tel. (0049) 89-6237326, Fax. (0049) 89-6237335.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Pulp mill effluent

11.2 Process type/waste source: Recovery

11.3 Cleaner Production Technique: Desilication

11.4 Other Keywords: Rice straw, Black liquor

11.5 Country Code: Germany, Egypt.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulp mill effluent, Recovery, Desilication, Rice straw, Black liquor

1.0 Headline: Chemicals recovery of wheat/rice straw pulping waste liquor

Experiences on chemical recovery of 50 t/d bleached wheat/rice straw pulping waste liquor.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Shanghai Xin Hua Paper Mill, 3520 Yi Xian Road, Bao Shan District, Shanghai 200940, P.R.China, tel: 6673455.

4.0 Cleaner Technology Category

Based upon many years efforts, some characteristics of straw pulping black liquor can be modified to a certain extent, so as to conform to the requirement of alkaline recovery. Meanwhile, the design and operation of the equipment must accommodate the straw black liquor as possible. As a result of many efforts, the alkali recovery system of straw pulping black liquor can run regularly nowadays.

5.0 Case Study Summary

5.1 Process and Waste Information: Long-term practice reveals that applying conventional wood pulping alkaline recovery system to treat that of straw pulp is unsuitable. Wheat (as well as rice) straw pulping black liquor is characterized by high silica content and high viscosity, which cause evaporating problems, as well as low heat value which calls for much more supplementary heat energy. Moreover, as a result of high silica content of the liquor, impermeability on the ignite char bed of furnace bottom arises more easily, and the ash build-up phenomenon on the heated surface is severe.

According to the statistics in 1990, the annual commercial caustic soda consumption of Chinese pulp and paper industry reached 1,200,000 tons and only 350,000 tons were recovered. Lots of commercial NaOH were consumed by numerous small and straw pulp mills. The key problems hampered the regularly alkali recovery of straw black liquor are:

- High silica content of the black liquor, which causes scale problems not only in the evaporators, but also in the washing wires.
- High viscosity of the black liquor, especially the concentrated liquor (TS > 40%), which hampers the further concentration of the liquor to desired concentration (> 50%).
- High silica content of the liquor results difficulties in the recovery furnace (lower volumetric isothermal expansivity V.I.E.) as well as the recovery of lime.

In Chinese paper industry, long-term alkali recovery rate of straw pulp waste liquor in most mills is about 50-55%. Few of them reached 60% or more. The report of Xin Hua Paper Mill represents the experiences of efforts made by the industry.

Original manufacturing process:

- wheat straw: NaOH 17%; Pentosan of the B.L. 10.15%; SiO_2 in TS 1.86%; Viscosity Pa.S of B.L. 0.72

- rice straw: NaOH 11%; Pentosan of the B.L. 10.55%; SiO_2 in TS 3,57%; Viscosity Pa.S of B.L. 2.07

Black liquor extraction: no consistency adjusting device; lower extraction rate and concentration of the liquor.

Evaporation: long-tube rising film evaporators, serious scaling problem.

Furnace: flying ash and ash building up problems.

5.2 Scale of Operation: 50 t/d straw (wheat straw takes main part) alkaline pulping waste liquor recovery system.

5.3 Stage of Development: Full productional scale application, and certain improvements are undertaken.

5.4 Level of Commercialization: The technology can be commercialized.

5.5 Material/Energy Balances and Substitutions: Cooking conditions

	NaOH	Na_2SO_3	Pentosan of the B.L.	SiO_2 in TS	Viscosity Pa.s of B.L.
Wheat straw	13%	3%	7.44%	1.19%	0.36%
Rice straw	7%	3%	8.55%	1.83%	0.39%

Black liquor extraction: consistency adjusting device added.

Evaporation: Short-tube evaporators with circulation, suitable operation schedule established.

Furnace: many improvements were achieved to obtain better operation, such as the diameter and height of spray nozzle, the enough height of furnace, etc.

Caustization: chute-type clarifier, horizontal belt vacuum filter, etc.

Lime mud producer: is planned to be converted to CaCO3 for paper filler and coating materials with the successful experience of Yuan Jiang Paper Mill,Hunan Province.

Black liquor extraction rate: >85% (TS 10.5%).

Evaporating effect (concentration of B.L. 43-45%): evaporation intensity 10-12 kg/m2h, evaporation efficiency 3 kg water/kg steam.

Furnace/Boiler (model WGZ-13/9-1, made by Wu Han Boiler Factory, Hubei Province): heat efficiency reaches 70%.

Long-term alkali recovery rate: about 60%, and is further improved to 75% recently.

6.0 Economics*

6.1 Investment Costs: Not available.

6.2 Operational and Maintenance Costs: Not available, but in comparison with the price of commercial caustic soda, the recovered alkali may be save the production costs by about 15-20%.

6.3 Payback Time: Not available, but according to other feasibility studies for new alkali recovery systems in China, the payback time would be 7-9 years for 30-50 t/d straw waste liquor recovery systems.

7.0 Cleaner Production Benefits

For a 50 t/d straw pulping mill, the annual recovery of alkali reaches about 4000 tons which is a attractive economic and social benefit. On the other hand, according to the environmental legislation of China, if the serious pollution caused by the black liquor could not be reduced, the mill should be closed at the end of 1995.

8.0 Obstacles, Problems and/or Known Constraints

Though the alkali recovery rate reaches about 60%, nevertheless, this mill has not finished its rebuild project yet. The spent liquor occurred from a 15 t/d straw pulp workshop at an old area has not been reclaimed, which causes underload running of the recovery system, and thus influences the recovery rate. Moreover, the process technique, equipments and operation skills should be further improved. Through a series of efforts, the alkali recovery rate may reach 75%.

9.0 Date Case Study Was Performed: May 2, 1992.

10.0 Contacts and Citation

10.1 Type of Source Material: Conference proceedings and unpublished material.

10.2 Citation: Zou, Pei Cheng, The Alkali Recovery System for Black Liquor based on 50 t/d Bleached Straw Pulp, Proceedings of 2nd International Non-wood Fibre Pulping and Papermaking Conference, April 6-9, 1992, Shanghai, China, Vol.II, pp. 895-913.

10.3 Level of Detail of the Source Material:

10.4 Industry/Program Contact and Address: Prof. Ke Zhang, China Technical Association of the Paper Industry, No. 11 Fucheng Road (Beijing Institute of Light Industry), 100037 Beijing, P.R.China, tel: 890571-476.

10.5 Abstractor Name and Address: Prof. Ke Zhang, China Technical Association of the Paper Industry, No. 11 Fucheng Road (Beijing Institute of Light Industry), 100037 Beijing, P.R.China, tel: 890571-476.

11.0 Keywords

11.1 Waste type: Pulping waste liquor, Cooking waste liquor

11.2 Process type/waste source: Alkaline wheat/rice straw pulping

11.3 Cleaner Production Technique: Chemical recovery, Alkali recovery

11.4 Other Keywords:

11.5 Country Code: China.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulping waste liquor, Cooking waste liquor, Alkaline wheat/rice straw pulping, Chemical recovery, Alkali recovery

1.0 Headline: Pilot plant trial of desilication for alkaline wheat straw pulping black liquor by flue gas treatment to improve the evaporating and lime recovering efficiencies.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Paper Industry Research Institute, Ministry of Light Industry, No. 12 Guanghua Road, Beijing 10020, P.R.China. Tel: 5022561; Cable: 0061.

4.0 Cleaner Technology Category

Silica disturbance is well known as a troublesome question in the recovery of alkaline straw pulping black liquor, because large quantity of SiO_2 contained in the black liquor precipitated and plugged the separating wire and scaled in the evaporators. This obviously decreased the separating and evaporating efficiencies of the recovery process. The principles of this case study are: (1) to develop desilication process by CO_2 of flue gas and to obtain related parameters; (2) to develop specially designed separator for silica sludge separation.

5.0 Case Study Summary

5.1 Process and Waste Information: In normal alkali recovery process, the black liquor contained in the digester pulp is: (1) extracted by vacuum filters etc.; (2) the extracted black liquor is evaporated and concentrated by multi-evaporators; (3) the concentrated black liquor is burned in the recovery boiler and (4) the melted sludge mainly Na_2CO_3 is caustisized by CaO to form NaOH for reuse and lime mud can be recovered. Due to silica disturbance as showed in 4.0, a desilication process for treating alkali wheat straw pulping black liquor by flue gas was investigated through pilot plant trials. The main operating procedures are: (1) to mix the black liquor with flue gas from the boiler in an especially designed venturi absorber ((1 - 3):1000 v/v); (2) to control the pH of black liquor dropped from 11.1 - 11.85 to 10.3; (3) after reaction, the liquor is settled in a clarification tank; (4) the silica sludge is separated by a uniquely designed separator to a concentration of 40% and the total black liquor loss is below 1%. And then, the desilicated black liquor is pumped to the evaporation station as normal.

The main parameters obtained by this study could be summarized as followed:

Test capacity	3 m^3 extracted black liquor/h
SiO2 in original liquor	6 -8 g/l
SiO2 in clarified liquor	1.0 - 2.3 g/l
Dilute sludge volume	20%
Desilication efficiency	83 - 88%
Black liquor loss	< 1%
Bone dry sludge	3.5 - 4.1 kg/m^3 liquor
Power consumption	< 10 kWh/m^3 liquor

In discussion of the study, the authors pointed out:" The pH value of desilicated liquor is reduced, and also the evaporation efficiency, the ultimate concentration of the liquor. So white liquor or alkali must be added to increase the pH value of liquor as to satisfy the requirement of evaporation." Adding white liquor or alkali to satisfy the requirement of evaporation would be a drawback of this process which calls for further investigation.

5.2 Scale of Operation: Pilot plant trial on a capacity of 1-3 m^3 extracted black liquor/h, which roughly corresponding to 3 tons pulp/day.

5.3 Stage of Development: Pilot plant stage, the quantitative figures showed in 5.1 are estimated based on pilot test.

5.4 Level of Commercialization: It is far from commercialization as it was only a small scale pilot trial.

5.5 Material/Energy Balances and Substitutions: Please see 5.1, it is only a reference balance obtained in pilot trial.

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: It is difficult to estimate the actual economics from this pilot study. The key point is whether the evaporating efficiency would be improved, which could not be answered by the study.

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

Theoretically, the desilication of straw pulp waste liquor can decrease the scaling problem and thus obviously improves the evaporation efficiency, and at the same time the silica problem caused in lime recovery may decreased. But it must be proved in productional scale.

8.0 Obstacles, Problems and/or Known Constraints

Many efforts have been made by numerous researchers by different ways, such as flue gas, biological or precipitating method (adding Ca, Mg, Al precipitants). None of these have been successful in commercial scale. As for the CO_2 flue gas method, the investment and maintenance cost would be high due to a large gas-liquor reactor, fan and separator. Furthermore, the flue gas absorbed by the liquor will be liberated in the evaporators and thus foam problem would occur which will influence the evaporating efficiency in a negative way.

9.0 Date Case Study Was Performed: Paper presented at the Workshop on Environmental Aspects of Non-Wood Fibre Pulp and Paper Manufacture, in Hangzhou, China, Nov. 24-28, 1986.

10.0 Contacts and Citation

10.1 Type of Source Material: Conference proceedings.

10.2 Citation: Fu-ting Ma, Fa-bin Jiao, Pilot plant test run of desilication for alkaline wheat straw pulping black liquor, Proceedings of the Workshop on Environmental Aspects of Non-Wood Fibre Pulp and Paper Manufacture, Vol. II, UNEP Regional Office for Asia and the Pacific, September 1987, pp. 478-487

10.3 Level of Detail of the Source Material: A further productional scale test was published by the same first author of the pilot test in the title:"Production Scale Desilication Experiment from Alkaline Straw Pulp Black Liquor." The test scale was 250-500 m^3 black liquor/day. The silica content in desilicated clean black liquor was about 0.37 g/l, silica removal rate about 90% and electric energy consumption was about 5 kWh/m^3 black liquor, loss of black liquor < 4%. This report was published in "China Pulp and Paper" vol. 5, 1991, with English abstract. According to the discussion of this report, some shortcoming still existed as the foam problem of treated black liquor occurred in evaporation must be further overcome and the practical benefits of desilication for evaporation, combustion, as well as the character of lime mud etc. have to be proved in further practice yet.

10.4 Industry/Program Contact and Address: Fu-ting Ma and Fa-bin Jiao, Paper Industry Research Institute, Ministry of Light Industry, P.R.China, No. 12 Guanghua Road, Beijing 10020, P.R.China. Tel: 5022561; Cable: 0061.

10.5 Abstractor Name and Address: Professor Ke Zhang, China Technical Association of Paper Industry, CTAPI, 11 Fucheng Road, 100037 BEIJING, P.R.CHINA, tel. (01)890571-476.

11.0 Keywords

11.1 Waste type: Black liquor, Waste liquor, Spent liquor, Silica content

11.2 Process type/waste source: Alkaline straw pulping, Wheat straw pulping, Desilication, Silica removal

11.3 Cleaner Production Technique: Silica removal, Desilicate, Desilication, Flue gas (CO_2) treatment

11.4 Other Keywords:

11.5 Country Code: China.

12.0 Assumptions

Type and operating parameter of the evaporator used in the pilot test were not given, so it is difficult to evaluate the variation of the test data about evaporation.

Two consequences would be caused by the CO_2 flue gas in contact and reaction with black liquor: (1) viscosity of straw pulp black liquor would change which do influence the evaporation efficiency, and (2) flue gas dissolved in black liquor would cause foam problem during evaporation. Both of these factors must be further studied for successful application.

The addition of white liquor or alkali to the desilicated black liquor could improve the evaporation efficiency by decreasing the viscosity of the liquor, but the recovery rate of alkali will decrease due to incomplete extraction rate of alkali in the causticization process.

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Black liquor, Waste liquor, Spent liquor, Silica content, Alkaline straw pulping, Wheat straw pulping, Desilication, Silica removal, Silica removal, Desilicate, Desilication, Flue gas (CO_2) treatment

1.0 Headline: Development of a technology for desilication of bamboo black liquor.

2.0 SIC/ISIC Code: I3411.

3.0 Name and Location of Company:

The Hindustan Newsprint Ltd (HNL) mill in Nagar, Kerala, India.

4.0 Cleaner Technology Category

The bamboo black liquor desilication technology reduces the BOD and COD discharge loads of a chemical pulp mill. The desilication technology will benefit many developing countries and will contribute to shift emerging industrial growth in those countries from an ecologically degrading to an ecologically sustainable pattern.

5.0 Case Study Summary

5.1 Process and Waste Information: Non-wood fibrous raw materials normally have a higher ash and silica content than wood. Most of the silica gets dissolved during cooking and remains as an undesirable constituent of the black liquor. The silica causes many problems as washing is difficult owing to the poor drainability of the pulp and high viscosity of black liquor. The outcome is scale-formation in evaporator tubes; deposits on the furnace walls of recovery boilers, slow setting rate of caustizing white liquor and lime sludge unsuitable for reburning.

The presence of silica is a major technical obstacle to the efficient chemical recovery of non-wood black liquor. Together with the economic barriers, this is one of the reasons why most small- and medium-sized non-wood pulp mills in developing countries do not have any chemical recovery systems and thus severely pollute rivers and other water-courses.

Some mills using non-wood raw materials have chemical recovery systems in order to reduce pollutant loads and recovery pulping chemicals. However, as the lime sludge is unsuitable for reburning it is not recovered and large amount of solid waste is discharged in the soil. A mill producing 120 tpd of bleached pulp and paper from bamboo, generates roughly 16,000 t/year of lime that need to be dumped outside the mill.

Bearing in mind the problems faced by non-wood based pulp mills, a project was designed to develop, demonstrate and disseminate a technology for desilication of bamboo black liquor. The conclusions drawn from the study of available publications on the subject led the project management to select, as the most promising approach, the pH reduction of dilute or semi-concentrated black liquor (10-24% TS) using hot recovery furnace gas. The demonstration plant results were satisfactory and the process is technically feasible.

5.2 Scale of Operation: A full-size demonstration desilication plant was erected.

5.3 Stage of Development: The bamboo black liquor desilication process has been fully implemented.

5.4 Level of Commercialization: Unknown.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	60-70% reduction of both the solid and liquid waste
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: The Hindustan Newsprint Ltd (HNL) mill is in the process to install a lime kiln and only after the installation it will be possible to have cost figures to prepare an accurate economical evaluation of the process.

6.2 Operational and Maintenance Costs: See 6.1.

6.3 Payback Time:

7.0 Cleaner Production Benefits

The desilication technology will enable many mills with chemical recovery to install lime sludge reburning, with a reduction of 60-70% of their solid waste disposal. It also will reduce the operational difficulties in the recovery cycle and will enable a number of mills without chemical recovery to install it, including lime reburning, with a reduction of 60-70% of the liquid waste disposal.

8.0 Obstacles, Problems and/or Known Constraints

The project faced the normal problems to be overcome in any development of a technology. There are still some problems to be solved in the demonstration plant such as correct type of filter cloth and instrument sensors. These however are non-technical problems that are being handled by HNL and CPPRI and is expected to be solved.

9.0 Date Case Study Was Performed: The UNIDO/SIDA (Swedish Industrial Development Authority) assignment was to develop a desilication technology for black liquors suitable for use in tropical developing countries. The work has been funded by SIDA, the government of India and the cooperating pulp mills.

In 1984 the pilot desilication plant was ready to be scaled up to a full-size industrial demonstration plant and this was erected in the recovery department of an Indian kraft bamboo pulp mill by end 1985.

This effort is still going on for operational fine tune improvements and identification of operational costs after optimization.

10.0 Contacts and Citation

10.1 Type of Source Material: Unpublished material.

10.2 Citation: An abstract provided by UNIDO.

10.3 Level of Detail of the Source Material: General information on discharge loads is available.

10.4 Industry/Program Contact and Address: Ralph Luken, Environment Coordination Unit, UNIDO, Vienna International Centre, P.O.Box 300, A-1400 Vienna, Austria, Telephone: 211 310, telex: 135612 uno a, fax: 232 156.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Pulp mill solid waste, pulp mill liquid waste

11.2 Process type/waste source: Recovery, Black liquor recovery

11.3 Cleaner Production Technique: Desilication of black liquor

11.4 Other Keywords: Bamboo, Bamboo black liquor, Non-wood black liquor

11.5 Country Code: India.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulp mill solid waste, pulp mill liquid waste, Recovery, Black liquor recovery, Desilication of black liquor, Bamboo, Bamboo black liquor, Non-wood black liquor

****** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The Lignin Removal Process (LRP) provides an approach to effluent treatment for pulp and paper mill effluents with possible reuse of organic matter recovered from waste liquors.

2.0 SIC/ISIC Code: I3411, I3412

3.0 Name and Location of Company:

Central Pulp and Paper Research Institute, Saharanpur, India (non-wood materials, laboratory scale), Veitsiluoto Oy, Oulu mill and Suomen Kuitulevy Oy, Pihlava mill, both in Finland (pilot scale).

4.0 Cleaner Technology Category

LRP fits well as a complement to mechanical and biological effluent treatment in that it efficiently removes biologically slowly decomposing organic material of high molecular mass, as well as, effluent colour.

5.0 Case Study Summary

5.1 Process and Waste Information: The LRP can be used for treating bleach plant, wet barking, fibre board, TMP and CTMP plant effluent. The pulp mills especially making non-wood pulps are discussed here.

LRP is a method for removing organic matter from pulp and paper mill effluents and other waste waters with high organic contents. The process is based on the ability of acidified fibre sludge to precipitate organic matter from effluents. The zeta potential of the sludge/water suspension used is reduced almost to zero prior to precipitation with acidic effluent or mineral acid. The presence in the fibre sludge of acid soluble salts like aluminum, iron and calcium makes precipitation more effective. The results achieved with the LRP for treatment are similar to those obtained with aluminum sulphate.

Acidified sludge is mixed with the effluent during mixing, causing precipitation of dissolved organic material from the effluent. The insoluble material formed binds with the sludge to give solid that can be removed by sedimentation. The solids are separated from water in a clarifier or, when the sludge content is high, in a centrifuge. Some of the sludge obtained is recycled and the remainder dried or used for making products like board.

To protect the separation equipment against corrosion and improve subsequent dewatering, the water/sludge suspension is neutralized with lime and a suitable polymer, usually cationic, is added.

Sludge recycling is not normally required when the process is used to treat paper and board mill effluents. The fibre sludge used in these cases is disintegrated waste pulp, which is recycled to paper or board machine after being used for precipitation of organic material from circulating water.

The method has given the best results when effluents from non-wood pulp mills have been treated. The reuse of the recovered organic matter is then possible.

5.2 Scale of Operation: The scale of the laboratory equipment was about 5 l and the pilot equipment treated 1-6 m^3/hour (2 m^3) of effluent

5.3 Stage of Development: Pilot stage.

5.4 Level of Commercialization: The technology is ready for commercialization.

5.5 Material/Energy Balances and Substitutions: Non-wood pulp and paper mill. Raw materials are wheat straw and waste paper 50/50.

Material Category	Quantity Before	Quantity After
Waste Generation:		
COD	400 kg/t product	140 kg/t product
colour reduction		85%
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

The effluent volume should be as low as possible (organic matter content 2-10 g/l). Normally no new raw materials are needed, if some acidic effluent is available. If not, acid and lime will be needed. The energy balance is calculated case by case. Generally there is no change in energy consumption.

6.0 Economics*

6.1 Investment Costs: Investment cost for a non-wood based pulp mill in India was 2.5 million FIM (date February 1992), (effluent flow 1,600 m^3/day). There are also other examples but the investment cost must be calculated case by case due to the high impact of local conditions.

6.2 Operational and Maintenance Costs: Total operating cost (without the benefit from the recovered fibers and organic matter) was for the above mentioned plant 200 FIM/ton pulp.

6.3 Payback Time: Payback time mainly depends on the value of the recovered fibers and organic matter. For a possible price, 600 FIM/ton, the payback time is three years.

7.0 Cleaner Production Benefits

The biggest environmental problem for a non-wood pulp mill is the lack of recovery of cooking waste liquor. The main problem is techno-economical. The raw material contains large amounts of silica, and evaporation of the waste liquor is impossible in most cases. LRP-method offers an economic measure to recover the organic matter from the waste liquors.

The COD and colour removal has also been important for developing this method. The biological purification methods can remove smaller molecules (molecular weight less than 700-800 dalton), but larger molecules will not be removed. For removal of those compounds, the LRP-method gives new possibilities.

8.0 Obstacles, Problems and/or Known Constraints

There are no technical constraints to foresee. The economy is the most important question, and it mainly depends on the reuse of the recovered fibers.

9.0 Date Case Study Was Performed: The tests were run in the first quarter of 1992.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles.

10.2 Citations:

(1) Hynninen, P., Pilot plant trials for LRP, a new process for precipitating organic material, Tappi Journal, February 1989, pp. 167-170.

(2) Hynninen, P., A mathematical model of the lignin removal process (LRP), Paperi ja Puu - Paper and Timber, No 10, 1989, pp. 1114-1118.

10.3 Level of Detail of the Source Material:

10.4 Industry/Program Contact and Address: Pertti Hynninen, Enviro Data Oy, P.O.Box 328, 02151 Espoo, Finland, tel. +358-0-4354 2093, fax. +358-0-465 250.

10.5 Abstractor Name and Address: Pertti Hynninen, Enviro Data Oy, P.O.Box 328, 02151 Espoo, Finland, tel. +358-0-4354 2093, fax. +358-0-465 250.

11.0 Keywords

11.1 Waste type: Pulp and paper mill effluents, Non-wood pulping effluents, Organic matter, COD, Colour

11.2 Process type/waste source: Non-wood pulping, Paper and board mills, Fiberboard mills

11.3 Cleaner Production Technique: Waste liquor recovery, Lignin removal process

11.4 Other Keywords: Effluent treatment, Sludge handling, Fiber recovery

11.5 Country Code: Finland, India.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulp and paper mill effluents, Non-wood pulping effluents, Organic matter, COD, Colour, Non-wood pulping, Paper and board mills, Fiberboard mills, Waste liquor recovery, Lignin removal process, Effluent treatment, Sludge handling, Fiber recovery

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Eucalypt or other wood pulping with the oil tar fraction from wood dry pyrolysis uses less energy and affords recovery and reuse of tar oil and lignin residue.

2.0 SIC/ISIC Code: I3411.

3.0 Name and Location of Company:

Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

4.0 Cleaner Technology Category

Eucalypt wood pulping with oil tar.

5.0 Case Study Summary

5.1 Process and Waste Information:

Process Area: Waste recycling.

Base Process: The standard process of production of soluble cellulose, used in the rayon and viscose manufacture, is the kraft process with prehydrolysis. This case represents an alternative to the standard process, in the same line as the organosolv process.

Process Changes: Pulping occurs through dissolution of lignin in the wood tar, which is used as cooking liquor.

New Waste Stream: The oil and lignin become a new waste stream, but the lignin can be recovered by distillation of the tar oil, and returns to the main process. The solid lignin residue can be used as raw-material for the production of plastics.

Raw Materials: The tar oil can be obtained by dry pyrolysis of the fine chips, separated in the wood screening area.

Energy Usage: In the pulping operation, less energy is used when compared to the conventional process. Some energy is necessary to recover the cooking liquor.

Operating Procedures: Same as described in Base Process and Process Changes.

5.2 Scale of Operation: Applied in standard kraft process operations, but in full-scale mills with an output in the order of 100-150 ADMT/d.

5.3 Stage of Development: Partly bench scale and partly pilot scale.

5.4 Level of Commercialization: The basic technology is ready for use; some adjustment is necessary before commercialization.

5.5 Material/Energy Balances and Substitutions

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics

6.1 Investment Costs: Detailed economic figures have not yet been prepared, but the equipment suggested in this alternative is of regular use in the areas of pulping and crude oil distillation.

6.2 Operational and Maintenance Costs: Not available.

6.3 Payback Time: Not available.

7.0 Cleaner Production Benefits

Reduction of waste generation in the pulping area when compared with the conventional process.

8.0 Obstacles, Problems and/or Known Constraints

None.

9.0 Date Case Study was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Personal contact and doctoral thesis.

10.2 Citation: Jordao, M.C.S., Uso de alcatrao vegetal como agente deslignificante de madeira de eucalipto, Tese de Doutoramento, EPUSP-Depto Eng. Quimica.

10.3 Level of Detail of the Source Material: Fairly well detailed.

10.4 Industry/Program Contact and Address: Dr. Jose Mangolini Neves, Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

10.5 Abstractor Name and Address: Dr. Jose Mangolini Neves, Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

11.0 Keywords

11.1 Waste type: Wood tar, Lignin.

11.2 Process type/waste source: Pulping liquor.

11.3 Cleaner Production Technique: Alternative kraft process.

11.4 Other Keywords:

11.5 Country Code: Brasil.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wood tar, Lignin, Pulping liquor, Alternative kraft process.

1.0 Headline: Chemicals and energy consumption reduced and upgraded effluent treatment plant based on extended aeration activated sludge process added in a pulp plant.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Harihar Polyfibers, Kumarapatnam, Dharwar, India.

4.0 Cleaner Technology Category

A significant reduction to the tune of 60% in consumption of chemicals and energy was achieved through several innovative modifications in the Rayon Grade Pulp Plant. This resulted in 50-55% reduction in influent load to the Effluent Treatment Plant in terms of BOD and suspended solids. For treating the waste water generated in the process, the Effluent Treatment Plant was upgraded by installing a biological reactor employing extended aeration activated sludge process.

5.0 Case Study Summary

5.1 Process and Waste Information: The effluents from the plant are segregated into the following four main streams: prehydrolysate liquor, pulp mill effluent, bleach plant effluent, and recovery effluent.

Presently, the total installation consists of two primary clarifiers, three anaerobic lagoons, a biological reactor and two secondary clarifiers with sludge recirculation systems. In addition to this, there is a separate treatment system for the prehydrolysate liquor. This system consists of lime milk addition device, two settling tanks, one cooling pond, two anaerobic lagoons, two aerated lagoons and a settling pond.

The prehydrolysate liquor is obtained from the prehydrolysis of the wood chips. The stream is having the BOD in concentrated form and hence, it is given a separate preliminary treatment before mixing it with the rest of the effluent for the secondary treatment in the biological reactor.

The combined effluent (i.e., the treated prehydrolysate liquor, primary clarifiers' overflow, bleaching effluent, and the settled recovery effluent) is jointly led into the three anaerobic lagoons operating in parallel. Urea and diammonium phosphate are added as nutrients required for the anaerobic bacteria. The overflow of these lagoons is directed to the biological reactor.

In the aeration tank, the waste liquor is aerated with 17 surface aerators of 40 hp each. Urea and diammonium phosphate are added. The biomass generated is flocculent and quick settling. It is separated from the aerated effluent in two secondary clarifiers and the settled bottom sludge is recycled continuously to the aeration tank as an essential feature of the process. The clear overflow from the secondary clarifier with a BOD of below 30 mg/l is discharged to the river. Continuous bio-monitoring is being done and fish survive comfortably.

5.2 Scale of Operation: Harihar Polyfibers produces 66,000 t/a rayon grade pulp from plantation crops of eucalyptus, casurina, etc. The effluent treatment plant has been built over an area of 90 acres.

5.3 Stage of Development: Fully implemented.

5.4 Level of Commercialization: The plant was designed and installed by integrating equipments and know-how available from different sources tp meet our specific requirement of quality of final treated effluent parameters suitable for river discharge.

5.5 Material/Energy Balances and Substitutions: Quality of treated effluent before and after installation of biological reactor employing extended aeration activated sludge process.

Material Category	Quantity Before	Quantity After
Waste Generation:		
BOD, mg/l	300	20
COD, mg/l	500	250
TSS, mg/l	350	80
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: Investment costs Rs. 150 lacs (as in the year 1983).

6.2 Operational and Maintenance Costs:

	Rs./day	Rs.in lacs/annum
a) Chemical	8,210	29.6
b) Manpower	1,000	3.6
c) Power	17,188	61.9
d) Maintenance	4,200	15.1
	30,598	110.2

6.3 Payback Time:

7.0 Cleaner Production Benefits

With the upgradation of the effluent treatment plant by installing Biological Reactor employing Extended Aeration Activated Sludge Process, the Quality of effluent discharged from the mill improved drastically. Reduction in BOD was 93% and in Suspended Solids 68%. COD value also came down below the stipulated limit of 250 mg/l. The downstream river water quality improved considerably and the wholesomeness of the water quality was maintained. Plenty of fish are available both in the treated effluent channel leading to the river and also in the downstream river. Fish catch is flourishing.

8.0 Obstacles, Problems and/or Known Constraints

No technical constraints.

9.0 Date Case Study Was Performed: The installation of Biological Reactor employing extended aeration activated sludge process was completed in December 1983.

10.0 Contacts and Citation

10.1 Type of Source Material: Unpublished material provided by the contact person.

10.2 Citation: Rajan, T.V.S. and Betkerur, S.N., Environmental management in Harihar Polyfibers, 17 p.

10.3 Level of Detail of the Source Material: Additional information on the waste streams treated and on the development of the reduction in chemical and energy consumption is available.

10.4 Industry/Program Contact and Address: Mr. S.S. Maru, Grasim Industries Ltd., Kumarapatnam 581 123, Karnataka, India, phone: 08197-2171, fax: 08197-2875, telex: 0834-221 & 224

Shailendra K. Jain, Senior Executive President, Harihar Polyfibers, Grasim Industries Ltd., Kumarapatnam 581 123, Dharwar, India, phone: 2271-2175, fax: 08197-2875

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Pulping effluent, Prehydrolysate liquor, Bleaching effluent, Recovery effluent

11.2 Process type/waste source: Chemical pulping

11.3 Cleaner Production Technique: Activated sludge, Anaerobic lagoons, Biological reactor

11.4 Other Keywords:

11.5 Country Code: India.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Pulping effluent, Prehydrolysate liquor, Bleaching effluent, Recovery effluent, Chemical pulping, Activated sludge, Anaerobic lagoons, Biological reactor

1.0 Headline: Heat recovery in dissolving-grade pulp plant captures heat from digesters for reuse in bleach plant.

2.0 SIC Code: 2299, Textile Goods, NEC

3.0 Name & Location of Company: Harihar Polyfibers, GRASIM, Karnataka, India.

4.0 Clean Technology Category

Technology Principle: This technology involves a heat recovery system which incorporated cyclone separators for eliminating liquor carry-over in vent vapors.

5.0 Case Study Summary

5.1 Process and Waste Information: This plant is a dissolving-grade pulp plant where the pulp is produced by employing a pre-hydrolysis sulphate process using mixed tropical hard wood by a two-stage cooking process. The first stage is called pre-hydrolysis, where in the pentosal, contents of wood are dissolved in water at high temperatures and acidic conditions. After the cooking is completed, the digester is vented and the liquor content is drained out. A considerable amount of heat was being wasted to the atmosphere by way of vent vapors and hot poly-hydrolysate (PH) liquor.

To avoid this heat wastage, a properly designed heat recovery system was introduced, incorporating suitable cyclone separators for eliminating liquor carry-over in vent vapors. The vent vapors are passed through two-stage cyclone separators and condensed in a shell and tube condenser using mill water. The water is heated from 40 Degrees C to 85 Degrees C. The poly-hydrolysate (PH) liquor from the draining operation is also flashed in a cyclone and the flash vapors are condensed, thus recovering maximum possible heat without allowing the liquor to form resinous deposit.

5.2 Scale of Operation: Not reported

5.3 State of Development: The clean technology is fully implemented.

5.4 Level of Commercialization: The clean technology is fully commercialized.

5.5 Balances and Substitutions: Use of live steam was reduced by about 48 T/day.

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Not reported

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

The heat recovery is in the form of hot water which is used in the bleach plant, and has resulted in reduction in use of live steam of about 48 ton/day. This is equivalent to about Rs. 62/ton pulp and savings of Rs. 3.9 million/year.

8.0 Obstacles, Problems and/or Known Constraints

The liquor has a typical characteristic of forming resinoces deposits but this problem was rectified.

9.0 Date case study was performed: Not reported

10.0 Contacts and Citation

10.1 Types of Source Material: Unpublished

10.2 Citation: Mr. Shailendra Jain, Senior Executive President, Harihar Polyfibers (GRASIM), Karnataka, India.

10.3 Level of Detail of Source Material: Additional information is available in the source document.

10.4 Industry/Program Contact and Address: Mr. Shailendra Jain, Harihar Polyfibers (GRASIM), Karnataka, India.

10.5 Abstractor and Address: UNEP Workgroup, Paris. Reformatted: Lynn L. Curry, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Thermal waste

11.2 Process Type/Waste Source: Pulp, sulphate process, textile industry, SIC 2299

11.3 Waste Reduction Technique: Heat recovery, cyclone separators

11.4 Other Keywords: India

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Thermal Waste, Pulp, Sulphate Process, Textile Industry, SIC 2299, Heat Recovery, Cyclone Separators, India

1.0 Headline: Installation of dewatering booster presses reduces oil consumption during manufacture of dissolving grade paper and improves pulp quality by avoiding "burnouts."

2.0 SIC Code: 2299, Textile Goods, NEC

3.0 Name & Location of Company: Harihar Polyfibers, GRASIM, Karnataka, India.

4.0 Clean Technology Category:

Technology Principle: This technology involves equipment modification to reduce oil consumption and hot air temperature.

5.0 Case Study Summary

5.1 Process and Waste Information: In the finishing steps of manufacture of dissolving grade pulp, at Harihar Polyfiber, the pulp is dewatered, flash dried, baled and packed. The mechanical dewatering was done to about 38% of dry content, then the pulp was dried further to 70% of dry content using hot air at 300 Degrees C, generated by burning fuel oil.

In order to reduce the oil consumption and temperature of the hot air, two dewatering booster presses were installed in series after the existing dewatering presses running in parallel. This improved the dryness of pulp to +50% and the temperature of the hot air could be brought down to 200 Degrees C.

5.2 Scale of Operation: Not reported

5.3 State of Development: The clean technology is fully implemented.

5.4 Level of Commercialization: The clean technology is fully commercialized.

5.5 Balances and Substitutions: Improvement in dryness content of pulp by 50% and temperature of hot air is reduced from 300 Degrees C to 200 Degrees C.

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Not reported

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Economic benefits were a savings of Rs. 3.5 million/year by reducing fuel oil consumption by about 14 kg/tonne of pulp. Furthermore, an improvement in pulp quality resulted by avoiding the "burnouts" due to higher temperatures of hot air.

Environmental benefits include reduction in fuel oil consumption.

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date case study was performed: Not reported

10.0 Contacts and Citation

10.1 Types of Source Material: Unpublished

10.2 Citation: Mr. Shailendra Jain, Senior Executive President, Harihar Polyfibers (GRASIM), Karnataka, India.

10.3 Level of Detail of Source Material: Additional information is available in the source document.

10.4 Industry/Program Contact and Address: Mr. Shailendra Jain, Senior Executive President, Harihar Polyfibers (GRASIM), Karnataka, India.

10.5 Abstractor and Address: UNEP Workgroup, Paris. Reformatted: Lynn L. Curry, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Not reported.

11.2 Process Type/Waste Source: Textile industry, SIC 2299

11.3 Waste Reduction Technique: Energy conservation

11.4 Other Keywords: India

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Textile Industry, SIC 2299, Energy Conservation, India

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Improved washing equipment for pollution load reduction in a synthetic fiber mill results in reduced steam and chemical requirements.

2.0 SIC Code: 2299, Textile Goods, NEC

3.0 Name & Location of Company: Harihar Polyfibers, GRASIM, Karnataka, India

4.0 Clean Technology Category

Technology Principle: Process/equipment modifications to reduce energy and chemical consumption.

5.0 Case Study Summary

5.1 Process and Waste Information: Use of a three-stage counter-current brown stock pressure washer at a pulp mill resulted in high alkali loss with the brown pulp stock, carry-over of liquid impurities with the pulp, and high chlorine consumption in the bleach stage. This contributed to the effluent load by way of discharge of chlorinated organic compounds, color, COD, etc. The spent liquor recovered from the washing plant was dilute, requiring more steam for evaporation. The introduction of a fourth-stage pressure wash in series with the previous three resulted in reduction in steam requirements and in chemical requirements, and in alleviation of problems caused by alkali loss and carry-over of lignin compound along with the pulp.

5.2 Scale of Operation: Not reported

5.3 State of Development: Technology is fully implemented

5.4 Level of Commercialization: Not reported

5.5 Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:		
Color	N/A	40% reduction
Chlorinated organic compounds	N/A	14% reduction
COD	N/A	22% reduction
Feedstock Use:		
Chlorine	N/A	6.5 kg/ton reduction
Alkali	N/A	3.0 kg/ton reduction
Water Use:	N/A	N/A
Energy Use:		
Steam	N/A	0.2 ton/ton reduction

6.0 Economics

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Not reported

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Reduction in steam requirements for evaporators, resulting in savings of Rs. 3.0 million/year. Reduction in chemical requirements resulted in savings of Rs. 0.8 milliom/year for chlorine and Rs. 19 million/year for make-up alkali.

8.0 Obstacles, Problems and/or Known Constraints

Not reported.

9.0 Date case study was performed: Not reported

10.0 Contacts and Citation

10.1 Type of Source Material: Unpublished material

10.2 Citation: Mr. Shailendra Jain, Senior Executive President, Harihar Polyfibers (GRASIM), Karnataka, India

10.3 Level of Detail of Source Material: Additional information is available in source document.

10.4 Industry/Program Contact and Address: Mr. Shailendra Jain, Senior Executive President, Harihar Polyfibers (GRASIM), Karnataka, India

10.5 Abstractor and Address: UNEP Workgroup, Paris. Reformatted: Isaac Diwan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Wastewater

11.2 Process Type/Waste Source: Synthetic fiber mill

11.3 Waste Reduction Technique: Equipment modification

Keywords: Textiles, Wastewater, SIC 2299, Synthetic Fiber Mill, Equipment Modification

***** DOCNO: 450-003-A-362*****

HEADLINE:	Kruger Inc. recovers whitewater at their newsprint mill and reduces wastewater discharge and energy costs.
INDUSTRY/SIC CODE:	Paper and Allied Products/SIC 2621
NAME/CONTACT:	Kruger, Inc. Bromptonville, Quebec
POLLUTION PREVENTION OPTIONS SUMMARY:	A series of modest modifications to a newsprint mill have achieved recovery of significant amounts of lean and clear wastewaters that had been discharging to the sewer. Lean whitewater from the company's three paper machine presses are collected by gravity flow in a reservoir beneath the machines. It is then pumped through a Sweco filter, where 90% is used for dilution of stock and 10% is sent to the clarifier. Clear whitewater is now used instead of heated freshwater on the paper machine showers.
FEEDSTOCKS:	Whitewater from newsprint mill
WASTES:	Wastewater
MEDIUM:	Water
COST:	Not reported
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	$580,000/year
FEEDSTOCK REDUCTION:	1.8 tons/day fiber recovered, which represents $80,000/year. Recovered lean whitewater led to $500,000/year savings.
WASTE PRODUCTION:	Discharges to sewer significantly reduced.
IMPACT:	Efforts to recycle wastewaters, previously discharged to the sewer, have greatly reduced the volume of waste generated, and allow for recycling of fiber feed material.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects," Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 64.
KEYWORDS:	Paper and Pulp, Filtration, Wastewater, Recycling, Recovery, SIC 2621

1.0 Headline: The effluent-free newsprint mill achieved through treatment and inplant reuse.

2.0 SIC/ISIC Code: I3411.

3.0 Name and Location of Company:

PI-Consulting Ltd, Myyrmäenraitti 2, P.O.Box 31, SF-016101 Vantaa, Finland, phone +358 0 530 91, telex 122905 pihki sf, telefax +358 0 563 2003.

4.0 Cleaner Technology Category

Paper mill process water is treated and reused. No effluent is discharged from the mill. Some water is driven off in the flue gases from the bark fired boiler and in the drying air from the paper machine hood like in all existing mills.

5.0 Case Study Summary

5.1 Process and Waste Information: A typical newsprint mill using mechanical pulp as raw material consumes 5-15 m^3 of water per tonne of paper. Effluent is normally treated biologically before being sewered into the recipient.

A newsprint mill with no process effluent has been designed by using the PI-Consulting's RAMI simulation program. In the designed paper mill, 7 m^3 of water per tonne of paper will be treated and reused. Three water treatment methods were employed: evaporation, ultrafiltration and reverse osmosis.

Raw materials and production of the paper mill are conventional. Process water is treated by evaporation and ultrafiltration and used again, no effluent is discharged from the mill.

Concentrates from evaporation and ultrafiltration are burned along with bark in the bark boiler. Inorganic salts will dissolve in the flue gas scrubbing water. This water is then treated first by ultrafiltration and then by reverse osmosis. The salts are finally concentrated and taken away from the mill.

The production at the pulp mill and the paper mill take place as normal. To balance the water circulation to the output of the pulp lines and the paper machine, storage tanks of a total volume of 17,000 m^3 are needed.

5.2 Scale of Operation: The capacity of a new newsprint mill is 250,000 tonnes per year. The total amount of effluent water treated biologically is about 12,000 m^3 of water per day. In the designed mill 2,600 m^3 of process water are treated by evaporation and stripping. Another 2,400 m^3 of water are treated by ultrafiltration. Some 160 m^3/d of the flue gas scrubbing water is treated by reversed osmosis.

5.3 Stage of Development: All three water treatment methods are today implemented in other uses. The quantities of water to be treated are estimated from experience and calculated from the process simulation program.

The study work is continued with pilot scale equipment in a Finnish pulp and paper mill. The work is sponsored by the Technology Development Centre Finland, EUREKA status for the project has been requested. The project title is: Improved water reuse in paper industry.

5.4 Level of Commercialization: Equipments for all three water treatment methods are commercially available. Pilot scale studies are under way for paper mill applications.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	5-15 m^3 water/t paper Boiler ash	None Boiler ash+some salt
Feedstock Use:	N/A	N/A
Water Use:	5-15 m^3/t paper	0.6 m^3/t paper
Energy Use:	3-4 MWh/t paper	3.1-4.1 MWh/t paper

6.0 Economics*

6.1 Investment Costs: The estimation shows that an effluent-free greenfield paper mill would cost USD 390 million, making it only about 1% more expensive than a conventional greenfield paper mill with a modern external treatment plant for effluent.

Evaporation plant for 2,600 m^3/d costs USD 4 million, ultrafiltration plant for 2,400 m^3/d costs USD 1 million and reversed osmosis plant for 160 m^3/d costs USD 1 million.

6.2 Operational and Maintenance Costs: The difference in operating costs arises from differences in water treatment costs. The operating costs for the conventional mill having a biological treatment plant are about USD 3 lower per tonne of paper. It is assumed that the steam required for evaporation is produced by burning oil.

6.3 Payback Time:

7.0 Cleaner Production Benefits

An effluent-free paper mill benefits from the small quantity of fresh water needed allowing the mill to be built even in forest areas. A mill without any effluent could also be built near big cities where recycled fibre can be used as raw material.

8.0 Obstacles, Problems and/or Known Constraints

There are still some questions to be answered before the water circulation in a paper mill can be totally closed. Investigations should be done with pilot scale equipment in existing mills. The questions are: What is the most economical way of treating the water before evaporation and ultrafiltration? How should cleaner waters be treated? What kind of concentrates are formed in evaporation and ultrafiltration and what is the best way of burning them?

9.0 Date Case Study Was Performed: The case study was performed as a part of SYTYKE, the Environmental Research and Development Programme for the Finnish Forest Industry and reported June 11th 1991.

10.0 Contacts and Citation

10.1 Type of Source Material: A research programme report and an article.

10.2 Citation: (1) A SYTYKE research programme report, will be published in 1993, in Finnish, summaries in English, German and Swedish; (2) Jantunen, E., Lindholm, G., Lindroos, C., Paavola, A., Parkkonen, U., Pusa, R. and Söderström, M., The effluent-free newsprint mill, Paperi ja Puu - Paper and Timber, Vol. 74, No.1, 1992, pp. 41-44.

10.3 Level of Detail of the Source Material: Companies manufacturing evaporation and ultrafiltration units are providing more information.

The investigation was conducted using the RAMI process simulation program developed by PI Consulting Ltd. More information about the possibilities of simulating all pulp and paper processes is available.

10.4 Industry/Program Contact and Address: PI-Consulting Ltd, Myyrmäenraitti 2, P.O.Box 31, SF-016101 Vantaa, Finland, phone +358 0 530 91, telex 122905 pihki sf, telefax +358 0 563 2003.

10.5 Abstractor Name and Address: Esko Jantunen, PI-Consulting Ltd, Myyrmäenraitti 2, P.O.Box 31, SF-016101 Vantaa, Finland, phone +358 0 530 91, telex 122905 pihki sf, telefax +358 0 563 2003.

11.0 Keywords

11.1 Waste type: Effluent water.

11.2 Process type/waste source: Mechanical pulp, Paper mill.

11.3 Cleaner Production Technique: Evaporation, Ultrafiltration, Reversed osmosis.

11.4 Other Keywords: Newsprint mills, Pulp washing, Process simulation.

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

Unknown.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Effluent water, Mechanical pulp, Paper mill, Evaporation, Ultrafiltration, Reversed osmosis, Newsprint mills, Pulp washing, Process simulation.

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Enzymatic pitch control in the papermaking process.

2.0 SIC/ISIC Code: I3411.

3.0 Name and Location of Company:

Jujo Paper's Ishinomaki mill, Japan; Jujo Paper's Yarsushiro mill, Japan; other companie's mills.

4.0 Cleaner Technology Category

Enzyme is introduced in the papermaking process to solve pitch problems. The enzymatic pitch reduction reduces the side effects of conventional pitch reduction by seasoning during storage. Those are yield loss and brightness reduction.

5.0 Case Study Summary

5.1 Process and Waste Information: Jujo Paper's Ishinomaki mill uses 10-30% red pine groundwood to produce newsprint and telephone directory paper. In controlled trials, employing 50% unseasoned wood, Resinase A 2X was added prior to the disk refiners located before the mixing chest. Most of the effect is believed to occur in the first of two intermediate chests located between the refiners and the mixing chest, where conditions were controlled at 4% consistency, 40-50°C and a pH value of 6.5-7.0.

For newsprint, the Resinase A 2X addition level was 0.5 kg/bone-dry ton pulp and a residence time of 30 minutes was allowed. For YTD (Yellow telephone directory), enzyme dosage was reduced to 0.38 kg/bone-dry ton of pulp and the residence time increased to three hours.

The results show that the produced paper, which has been treated with the enzyme, contains less pitch and that the number of spots and holes in the paper is reduced. These improvements were achieved while cutting the amount of fine talc added by one third. Fine talc is usually added as a control agent to eliminate the pitch problems.

5.2 Scale of Operation: Industrial scale.

5.3 Stage of Development: This technology is used in the actual papermaking process.

5.4 Level of Commercialization: The technology is commercially available. The Novo Nordisk's enzyme Resinase A 2X was used.

5.5 Material/Energy Balances and Substitutions: The enzyme is mixed with mechanical pulp slurry in the conventional mill fiber line. Therefore, no additional fresh water is required. Energy requirement increase is just for mixing and very small. Pitch is hydrolyzed to fatty acids that are retained on pulp fiber. Therefore, no waste material is generated. These characteristics are summarized below.

Material Category	Quantity Before	Quantity After
Waste Generation:	none	
Water Use:	no increase	
Energy Use:	very small increase	

6.0 Economics

6.1 Investment Costs: The investment of a blending tank and a mixer.

6.2 Operational and Maintenance Costs: Resinase A 2X costs 3800 yen/kg and the dosage of the Resinase A 2X is 0.3-0.5 kg/bone-dry pulp ton.

6.3 Payback Time: The costs are paid back by improved paper machine operation and product quality with higher fresh log ratio in wood supply, which means less cost in wood yard operation.

7.0 Cleaner Production Benefits

See 4.0.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study was Performed:

1987-88	Laboratory research
1989 March	First mill trial in Ishinomaki mill
1989 May-July	Long run mill trial in Ishinomaki mill
1990 March-July	Long run mill trial in Yatsushiro mill

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles and conference proceedings.

10.2 Citations:

(1) Grant, R., Enzyme technology - First mill-scale trials get underway, PPI, June 1991, pp. 61-63.
(2) Irie, Y., Matsukura, M., Usui, M. and Hata, K., 1990 Papermakers Conference: 1-10(1190).
(3) Hata, K. et al., 1992 Papermakers Conference: (1)73-79(1992).
(4) Hata, K. et al., JAPAN TAPPI Journal: 905-921 Aug. 1992.
(5) Hata, K. et al., TAPPI Journal, vol.74, no.4, 117-122, April 1992.

10.3 Level of Detail of the Source Material:

10.4 Industry/Program Contact and Address: Kunio Hata, Managing Director, R & D, Jujo Paper Co., Ltd., Shin-Yurakucho Bldg., 12-1, Yurakucho 1-chome, Chiyoda-ku, Tokyo, Japan.

Tokue Iwatsu, President, Jujo Research Co. Ltd., Jukkai Bldg., 5-24, Oji, 5-chome, Kitaku, Tokyo, 114, Japan.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Tel. +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf.

11.0 Keywords

11.1 Waste type:

11.2 Process type/waste source: Newsprint mill, Mechanical pulp containing paper.

11.3 Cleaner Production Technique: Pitch reduction, Enzymatic pitch control.

11.4 Other Keywords: Biotechnology, Enzyme.

11.5 Country Code: Japan.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Newsprint mill, Mechanical pulp containing paper, Pitch reduction, Enzymatic pitch control, Biotechnology, Enzyme.

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Dry forming of paper web

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

United Paper Mills Ltd, Walkisoft factory, Kotka, P.O.Box 81, SF-48101 KOTKA, Finland, tel. +358-52-15440, telex 53132 UPMWF SF.

4.0 Cleaner Technology Category

The process is non-polluting, there are no wastewater problems, and therefore, the mill can be located either close to consumers in an urban location or near the sources of raw material.

5.0 Case Study Summary

5.1 Process and Waste Information: The dry forming method can in principle be divided into the following phases: defibration of raw material, forming, binder application, curing, and finishing.

The main raw material, mostly wood pulp, is defiberized in a hammer mill. After this, the fibres are transported by means of a fan to the forming section.

Each former consists of two perforated drums rotating inside the forming head. The fibres circulate horizontally between the drums. The accepted fibre material is formed onto the moving forming wire by suction. After forming, the web is led through heated compactor and embosser rolls.

In the third phase, a binder solution is sprayed onto the web. The application is made separately on both sides of the web, each application being followed by through-drying.

Full strength is achieved during the curing as the binder is cross-linked. The curing is also performed in a through-dryer. To improve the final properties, the web is led through a finishing calender.

In the conventional process, most of the water that is drained from the sheet in the wire section and pressed off in the press section is recycled. Some of it is extracted from the process and led back into the watercourse. The evaporated water has to be replaced by fresh water.

In the dry forming process, the fresh water demand is only 0.8 litres per one kilogram produced material (air dry). It is totally used to dilute the binder. The dry forming process creates neither wastewater nor effluent gases.

5.2 Scale of Operation: The work has progressed from a semicommercial pilot machine to a full scale production unit.

5.3 Stage of Development: Fully implemented.

5.4 Level of Commercialization: The technology is commercially available.

5.5 Material/Energy Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	0.8 l/kg AD product
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: Investment cost of a dry forming machine is rather low and the economically profitable size of the production plant is small. The capacity of the plant can be enlarged gradually according to market demand.

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

Dry formed materials have unique absorption and wet strength properties. They are nonabrasive, soft and feel like textiles. The products are suitable for different kinds of towelling and wiping, in health-care, hygiene and for table settings.

The dry forming machine can be located either near consumers or near raw material sources. It does not emit waste water or stack gases.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed: United Paper Mills Ltd has been actively involved in the development of the dry forming process since the late 1970's. The first production unit at the Kotka mill started up at the beginning of 1985.

10.0 Contacts and Citation

10.1 Type of Source Material: A report on technologies from Finland.

10.2 Citation: Environmental high-technology from Finland, Prepared by Mexpert Consulting Engineers Ltd. for the Ministry of the Environment, Helsinki 1987, pp. 33- 36.

10.3 Level of Detail of the Source Material: Additional information on the paper properties is available in the source material.

10.4 Industry/Program Contact and Address: Material Business: United Paper Mills Ltd, Walkisoft factory, Kotka, P.O.Box 81, SF-48101 KOTKA, Finland, tel. +358-52-15440, telex 53132 upmwf sf, telefax +358-52-84360.

Machinery: United Paper Mills Ltd, Walkisoft Engineering, Valkeakoski, P.O.Box 40, SF-37601 VALKEAKOSKI, Finland, tel. +358-37-7111, telex 22316 ypkot sf, telefax +358-37-43814.

10.5 Abstractor Name and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

11.0 Keywords

11.1 Waste type: Paper mill effluent

11.2 Process type/waste source: Paper production

11.3 Cleaner Production Technique: Dry forming, Effluent-free paper mill

11.4 Other Keywords:

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Paper mill effluent, Paper production, Dry forming, Effluent-free paper mill,

***** DOCNO: 400-028-A-217 *****

HEADLINE:	Wastewater treatment and recycling reduces discharge of pollutants and requirements for virgin chemicals.
INDUSTRY/SIC CODE:	Manufacturing of Paper and Paper Products/ISIC 3411
NAME/CONTACT:	Ministere de l'Environment et du Cadre de Vie Direction de la Prevention des Pollutions 14 Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	The company manufactures paper with the recovery and valorization of manufacturing effluents. The manufacturing effluents are separated two distinct ways. There is a physical chemistry treatment and a coagulation-flotation with the introduction of pressurized water and poly-electrolyte. The recovered raw materials are in part immediately re-integrated into the paper production process, the rest being held for later use or sale. Purified effluents are discharged into the river by way of a sewer.
FEEDSTOCKS:	Wastewater
WASTES:	The manufacturing water is purified before being discharged into the river. Pollution results solely from cooling water. There are 3 kg of suspended and oxidizable matter per ton of paper manufactured, against 18.1 kg in the standard treatment technique.
MEDIUM:	Water
COST:	(1980 Francs)
CAPITAL COST:	F 800,000
OPERATION/MAINTENANCE:	F 1.8/ton paper produced
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	Reduces requirements for virgin chemicals.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Water Closure System in Paper Mills," Monograph ENV/WP.2/5/Add 28.
KEYWORDS:	Paper, ISIC 3411, Closed-Loop Wastewater

***** DOCNO: 400-089-A-256*****

HEADLINE:	Closed-water system eliminates wastewater generation from paper-board facility.
INDUSTRY/SIC CODE:	Manufacture of Pulp, Paper and Paper-board/ISIC 3411
TECHNOLOGY DESCRIPTION:	Paper-board making with closed water systems. Water consumption in a hypothetical mill practicing no recycling of water would be 200 - 300 m^3/ton paper produced. Conventional processes recycle a portion of their process waters, but also introduce freshwater in some process areas. A closed system blends in freshwater only as a make-up or in order to dilute some component that might otherwise restrict recycling.
FEEDSTOCKS:	Primary pulps and/or secondary fibers, process additives, product quality additives (clay, chalk), water, 30 GJ energy for each ton of paper generated
WASTES:	Steam, no liquid or solid effluent discharge
MEDIUM:	Water vapor
COST:	
CAPITAL COST:	$457,000
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	7.5 months excluding additional operating costs
SAVINGS:	
DISPOSAL & FEEDSTOCK:	10 British Pounds/ton primarily in waste treatment
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Wastewater production is eliminated. The amount of solid residuals generated is decreased from 6% (64 kg/ton) to 1 percent of waste production.
IMPACT:	Recycling of process waters and recovery of additional 5% of suspended solids is the benefit offered by this technology. Practical problems, including product quality, were incurred during closing-up of the water system and are therefore a significant deterrent to a mill considering implementation.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Paper/board Making With Closed Water Systems," Monograph ENV/WP.2/5/Add89.
KEYWORDS:	Pulp, Paper, Wastewater Recovery, Recycling, ISIC 3411

**** DOCNO: 400-091-A-258*****

HEADLINE:	ZIMPRO process recovers filler clay for reuse in paper production.
INDUSTRY/SIC CODE:	Pulp Paper and Paper Board/ISIC 3411
TECHNOLOGY DESCRIPTION:	The ZIMPRO process for disposal of wastewater treatment sludge in the paper and board industry recovers the filler clay by wet air oxidation of the sludge. The sludge is mixed with biological sludge and continuously oxidized by compressed air at 250-350 degrees centigrade and 120-150 bar. After the reaction, the filler clay (kaolin) is separated and cleaned for reuse in paper production.
FEEDSTOCKS:	Sludge from treatment plant, electrical energy, fuel oil, flocculant, water
WASTES:	Wastewater from the settling tanks containing small amounts of acetic acid and other organics are added to the biological water treatment plant. The filler clay which is re-used in the paper production.
MEDIUM:	Water
COST:	(For Oxidizing 16.5 ton/dry sludge in 1977)
CAPITAL COST:	750,000 Swiss francs
OPERATION/MAINTENANCE:	560,000 fr/year
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	430,000 fr/year operating savings over incineration, 110,000 increase over lagooning
FEEDSTOCK:	Not reported
WASTE PRODUCTION:	400,000 fr/year savings due to kaolin recovery
IMPACT:	The recovered filler clay can be re-used in paper production, paying for the operating cost of the plant. The disposal of the sludge via incineration or lagooning is eliminated.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Filler Clay Recovery by Wet Air Oxidation of Sludge (Zimpro Process)," Monograph ENV/WP.2/5/Add91.
KEYWORDS:	Pulp, Paper, Waste Recovery, ISIC 3411, Wet Air Oxidation, ZIMPRO, Kaolin Clay

***** DOCNO: 400-075-A-249*****

HEADLINE:	CSM-Biothane process treats wastewater to reduce sludge generation and produce methane gas for input to the production process.
INDUSTRY/SIC CODE:	Manufacture of Food, Beverages and Tobacco/ISIC 31 Manufacture of Paper and Paper Products/ISIC 34
TECHNOLOGY DESCRIPTION:	The CSM-Biothane U.A.S.B. process for anaerobic wastewater treatment treats organic wastewater generated during processing of food and paper related materials. This new technology consists of a digester where settling occurs under anaerobic conditions. Methane gas is produced as a by-product and can be used as energy for input to the production process.
FEEDSTOCKS:	Organic wastewater, sludge
WASTES:	Anaerobic wastewater sludge consisting of 2 to 20% carbon compounds, all nitrogen as ammonia
MEDIUM:	Organic wastewater sludge
COST:	
CAPITAL COST:	125,000 to 250,000 Dutch guilders
OPERATION/MAINTENANCE:	0 to 500 Dutch guilders (20% of investment costs)
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	375,000 to 1,250,000 Dutch guilders
FEEDSTOCK REDUCTION:	25 to 50% reduction in need for additional nutrients (P and N)
WASTE PRODUCTION:	Reduces production of surplus sludge by 80 to 90%
IMPACT:	The CSM-Biothane process for anaerobic wastewater treatment reduces the quantity of sludge generated by 80% to 90%, and also produces methane gas which can be used as a substitute for energy in a production process.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "CSM-Biothane U.A.S.B. Process for Anaerobic Waste Water Treatment," Monograph ENV/WP.2/5/Add75.
KEYWORDS:	Food Processing, Paper, Energy Recovery, Sludge, Wastewater Treatment, ISIC 31, ISIC 34

TEXTILE

Synthetic Textiles
Wool Manufacturing
Cotton Production
General Textile

***** DOCNO: 450-003-A-378*****

HEADLINE:	Recycling spent nylon hosiery dyebaths reduce disposal costs and raw material purchases.
INDUSTRY/SIC CODE:	Rubber and Plastics/ISIC 15, ISIC 16
NAME/CONTACT:	Dominion Textiles, Inc. Valleyfield, Quebec
POLLUTION PREVENTION OPTIONS SUMMARY:	A pilot operation was established to recycle spent nylon hosiery dyebaths containing disperse dyes and chemical auxiliaries (scouring, levelling and wetting agents). The dyebaths are pumped from the rotary drum dying machine to a holding tank for analysis and reconstitution with dyestuff. An average of 30 batches can be dyed before discharge.
FEEDSTOCKS:	Dyes, chemical auxiliaries
WASTES:	Spent dyes and chemicals
MEDIUM:	Liquid
COST:	
CAPITAL COST:	$28,441 for conversion and analytical equipment (1980)
OPERATION/MAINTENANCE:	Wet processing costs decreased by $0.044/kg
MONTHS TO RECOVER:	Not reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	$12,240/year
FEEDSTOCK REDUCTION:	19% reduction in dye consumption, 35% in auxiliaries and 57% in energy.
WASTE PRODUCTION:	Spent dyes and chemicals no longer require disposal.
IMPACT:	Contaminated dyes and chemicals are being recycled, reducing the volumes disposed, in addition to raw material and disposal costs.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects," Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 91.
KEYWORDS:	Textiles, Dye, Recycling, Recovery, Nylon, ISIC 15, ISIC 16

***** DOCNO: 400-121-A *****

1.0 Headline: Zinc recovery in the rayon industry in Netherlands.

2.0 SIC Code: 22, Textile Mill Products

3.0 Name and Location of Company: Enka B.V., Velperweg, Kleefsewaard at Arnheim, Netherlands

4.0 Clean Technology Category: This case study addresses recovery of zinc

5.0 Case Study Summary:

5.1 Process and Waste Information: The main production steps in the rayon industry are (1) the reaction of cellulose with sodium hydroxide, followed by pressing and grinding; (2) the reaction of sodium-cellulose with carbon disulfide; (3) the creation of a solution of reaction product in water, called viscose; (4) the spinning of viscose by injection through a spinning head into a spinning bath, where the viscose is transformed into cellulose yarn by coagulation; and (5) finishing of rayon tire cord by washing, lubrication, and drying.

During the spinning process, zinc sulphate is used to slow down the formation of the yarn. This is necessary in order to obtain the desired strength and elongation of the yarn. The wastewater from the spinning process contains mainly sulfuric acid, sodium sulphate, and zinc salts. This wastewater is treated in the biological wastewater treatment plant. Removal of $zinc^{++}$ is effected by precipitating it to form inert zinc sulfides. The biological sludge containing this zinc sulfide is dumped on the land. For the wastewater, the discharge draft standard for zinc in some areas of the Netherlands is 20 kg/day. The maximum allowable amount of zinc in any given sample of wastewater effluent is 3 mg/liter. Over a 24-hour period the maximum allowable zinc content in the wastewater effluent is 2 mg/liter.

The low-waste technology concerns the recovery and recycling of zinc from the acid effluent of the rayon spinning process. The $zinc^{++}$ containing acid effluent is treated with a mixture of D.E.H.P.A. (10%) and solvesso 150 (90%). The ratio of acid effluent to organic solvent is generally less than one. Treatment occurs in a tank fitted with agitators. The dispersed water and organic solvent is transported to a separation tank in order to obtain separation between water and the organic phase. The extraction process is carried out in three steps with counter-flow of the effluent and the organic solvent. The reaction product of $zinc^{++}$ and D.E.H.P.A. dissolves in the organic phase. This organic phase has to be stripped in order to recover the $zinc^{++}$.

In order to obtain high efficiency of $zinc^{++}$ removal, the pH of the water phase must be controlled by addition of sodium hydroxide. During the first extraction step the pH is greater than 2.8 and afterwards it is greater than 3.0. The $zinc^{++}$ removal efficiency is generally more than 98%. The zinc-free water phase is neutralized and charged together with 10 times the amount of caustic wastewater in the wastewater treatment plant. The effluent from the wastewater treatment plant is dumped together with three times the amount of other wastewater into open water.

To recover the $zinc^{++}$ from the organic extraction solvent, the solvent is stripped with a water-based solution of sulfuric acid (20%) and a flocculent. This is, however, a one-step process. During stripping, the $zinc^{++}$ is re-worked as zinc sulphate. It dissolves in the waster phase. This solution is used again in the spinning process. The addition of a flocculent is essential in order to obtain high efficiency of $zinc^{++}$ recovery and to prevent large losses or organic solvent. This flocculent neutralizes the cation-active substances. The $zinc^{++}$ recovery efficiency is about 100%.

5.2 Scale of Operation: The plant maximum capacity for treatment is 40 cubic meters of effluent per hour.

5.3 Stage of Development: The technology is fully implemented.

5.4 Level of Commercialization: Unknown

5.5 Material/Energy Balances and Substitutions: Figures based on tone of rayon tire cord production in the effluent discharge.

6.0 Economics*

6.1 Investments Costs: While the total investment for the conventional process is 2,000,000 F1, the investment for the low-waste technology is 5,600,000 F1. The cost of rayon tire cord per year increases from 70 F1 for the conventional method to 85 F1 for the low-waste technology. Zinc recovery results in savings of 225,000 F1 per year.

6.2 Operational & Maintenance Costs: Unknown

6.3 Payback Time: Unknown

7.0 Cleaner Production Benefits: Because the zinc removal efficiency is high, there are economic benefits as well as regulatory benefits.

8.0 Obstacles, Problems, and/or Known Constraints: Not available.

9.0 Date Case Study Was Performed: 1982

10.0 Contacts and Citation

10.1 Type of Source Material: United Nations document.

10.2 Citation: United Nations Economic and Social Council, Economic Commission for Europe, Compendium on Low- or Non-Waste Technology, Monograph ENV/WP.2/5/Add.121, May 1985.

10.3 Level of Detail of Source Material: Unknown

10.4 Industry/Program Contact and Address: Unknown

10.5 Abstractor Name and Address: The information in this case study was derived from abstracts provided by the United Nations Environment Program (Paris). This abstract was prepared directly from the abstract without access to the document cited. Mary L. Wolfe, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Wastewater

11.2 Process Type/Waste Source: Textile Mill Products, SIC 22

11.3 Waste Reduction Technique: Wastewater reduction, reuse, recovery

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Wastewater, Textile Mill Products, SIC 22, Wastewater Reduction, Reuse, Recovery

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Wastewater reuse in a synthetic textile mill in Bombay, India.

2.0 SIC Code: 2299, Textile Goods, NEC

3.0 Name & Location of Company: Orkay Textile Processors, Saki Naka, Andheri (East), Bombay, India

4.0 Clean Technology Category

Technology Principle: This technology involves treated wastewater reuse at a textile unit where the entire volume was reused.

5.0 Case Study Summary

5.1 Process and Waste Information: Wastewater reuse was implemented at a textile unit in Bombay processing 30,000 meters/day of polyester and polyviscose piece dyed shirting and suiting. The total quantity of wastewater discharged including floor washing was about 900 cubic meters per day.

The wastewater was treated in the scheme such as equalization and neutralization, chemical assist (using alum) sedimentation, pressure sand filter and a fluidized polishing reactor based on activated carbon. The entire volume of treated wastewater was reused in the process.

5.2 Scale of Operation: Daily production of 30,000 meters/day of polyester and polyviscose piece and fiber dyed shirting and suiting.

5.3 State of Development: This clean technology is fully implemented.

5.4 Level of Commercialization: This clean technology is fully commercialized.

5.5 Balances and Substitutions: Entire quantity of wastewater was recycled.

6.0 Economics*

6.1 Investment Costs: Civil capital costs (Rs. 200,000) plus mechanical capital costs (Rs. 700,000) totalled Rs. 900,000 for investment costs.

6.2 Operational and Maintenance Costs: Costs of chemicals per day (Rs. 1,700) plus power costs per day (Rs. 300) plus manpower costs per day (Rs. 100) brought the total O & M costs to Rs. 2,100 per day.

6.3 Payback Time: For 300 working days in a year, the pay back period was calculated to be 9 months.

7.0 Cleaner Production Benefits

Environmental and economic benefits include reduced consumption of fresh water and a net savings of Rs. 4,300 per day since there was a reduction in costs for purchase of 800 cubic meters of fresh water at Rs. 8 per cubic meter.

8.0 Obstacles, Problems and/or Known Constraints

The plant was commissioned in 1983-84. Recently operational problems were found in the fluidized column if activated carbon.

9.0 Date case study was performed: 1984

10.0 Contacts and Citation

10.1 Types of Source Material: Conference proceeding.

10.2 Citation: Handa, B.K. "Wastewater Management in a Synthetic Textile Industry," All India Workshop on Environmental Management of Small Scale Industries, July 22-23, 1989, Nagpur.

10.3 Level of Detail of Source Material: Additional information is available in the source document.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor and Address: UNEP Workgroup, Paris. Reformatted: Lynn L. Curry, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Wastewater

11.2 Process Type/Waste Source: Textile industry, SIC 2299

11.3 Waste Reduction Technique: Wastewater reuse

11.4 Other Keywords: Water reuse, fresh water

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Textile Industry, SIC 2299, Wastewater Reuse, Treated Wastewater, Fresh Water

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Recovery and reuse of solid waste from a synthetic textile industry.

2.0 SIC Code: 2299, Textile Goods, NEC

3.0 Name & Location of Company: Harihar Polyfiber, GRASIM, Karnataka, India

4.0 Clean Technology Category

Technology Principle: This technology involves recovery of solids in the effluent and selling the recovered material.

5.0 Case Study Summary

5.1 Process and Waste Information: At this facility the rejects from the last centri-cleaner stage were sent to the sewer. This resulted in the jamming of the primary clarifier sludge screen and higher suspended solids in the effluent as well as fiber loss. Also, the underflow sludge from the primary effluent clarifier was very dilute and the disposal of the same was very difficult. In the new process the solids were slurryied and passed through a vibrating screen and finally dewatering to 35% dry content. This was then bagged and sold to board and cellulose powder manufacturers.

To alleviate the problem of the dilute underflow sludge, the sludge was dewatered to 35% dry content by passing it through a vibrating screen and screw press and then bagged and sold to board manufacturers and for packing purposes.

5.2 Scale of Operation: Not reported

5.3 State of Development: The clean technology is fully implemented.

5.4 Level of Commercialization: The clean technology is fully commercialized.

5.5 Balances and Substitutions: Not reported

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Savings of 0.3 million Rs./year were realized from the sale of the water.

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Economic benefits were estimated to be Rs. 0.3 million/year from the wastes sales.

8.0 Obstacles, Problems and/or Known Constraints

Not reported

9.0 Date Case Study Was Performed: Not reported

10.0 Contacts and Citation

10.1 Types of Source Material: Unpublished

10.2 Citation: Mr. Shailendra Jain, Senior Executive President, Harihar Polyfibers (GRASIM), Karnataka, India.

10.3 Level of Detail of Source Material: Additional information is available in the source document.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor and Address: UNEP Workgroup, Paris. Reformatted: Lynn L. Curry, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Textile solid wastes, sludge

11.2 Process Type/Waste Source: Textile Industry, SIC 2299

11.3 Waste Reduction Technique: By-product recovery, reuse

11.4 Other Keywords: India

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Textile Solid Wastes, Sludge, Textile Industry, SIC 2299, By-Product Recovery, Reuse, India

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Recycling of process waste to reduce chemical requirements in a synthetic fiber industry.

2.0 SIC Code: 2299, Textile Goods, NEC

3.0 Name & Location of Company: Harihar Polyfibers, GRASIM, Karnataka, India.

4.0 Clean Technology Category

Technology Principal: This technology involves recycling of HCl and caustic soda.

5.0 Case Study Summary

5.1 Process and Waste Information: At this facility, the cation units were regenerated with HCl and the back wash and rinse water were being drained to the effluent plant. The anion unit was regenerated with alkali (NaOH) and the spent waste was also being drained to the effluent plant.

To recover and recycle HCL and caustic soda, the cation back wash was analyzed and checked for content of acid and other impurities. This was deemed suitable for neutralizing the effluent from the staple fiber plant, which was neutralized earlier in the process by addition of fresh HCl. The anion back wash containing alkali was used for effluent treatment where fresh soda had been used earlier.

5.2 Scale of Operation: Not reported

5.3 State of Development: The clean technology is fully implemented.

5.4 Level of Commercialization: The clean technology is fully commercialized.

5.5 Balances and Substitutions: Not reported

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Savings of 1.5 million Rs./year in chemical purchases were realized.

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Reduced mineral acid and alkali (i.e., fresh HCl and caustic to effluent resulted in a savings of Rs. 1.5 million/year.

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date case study was performed: Not reported

10.0 Contacts and Citation

10.1 Types of Source Material: Unpublished.

10.2 Citation: Mr. Shailendra Jain, Senior Executive President, Harihar Polyfibers, GRASIM, Karnataka, India.

10.3 Level of Detail of Source Material: Additional information on technical aspects of the industrial process and cleaner production benefits is provided.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor and Address: UNEP Workgroup, Paris. Reformatted: Lynn L. Curry, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Ion exchange back wash

11.2 Process Type/Waste Source: Ion exchange regeneration, textile industry, SIC 2299

11.3 Waste Reduction Technique: Recycling, reuse

11.4 Other Keywords: Ion exchange, hydrochloric acid, caustic soda

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Ion Exchange Backwash, Ion Exchange Regeneration, Textile Industry, SIC 2299, Recycling, Reuse, Ion Exchange, Hydrochloric Acid, Caustic Soda

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Closed loop recycle systems for textile effluents.

2.0 SIC Code: 2231, Wool Broadwoven Fabric Mills

3.0 Name & Location of Company: Referred to as "Textile Mills and Pilot Plants" located at University of Natal, Durban, South Africa

4.0 Clean Technology Category

Recycling, reuse and reclamation: This technology involves the inclusion of treatment/recycle systems for water and chemical recovery and reuse in textile wet processing operations.

5.0 Case Study Summary

5.1 Process and Waste Information: Individual textile wet processing operations of wool scouring, desizing and wool/synthetic fiber dyeing result in a large quantity of effluent containing water and chemicals.

The development of closed loop recycling systems attached to the above mentioned processing operations is described in this case study. Water and chemical recovery and reuse are discussed. Several techniques are discussed as well as results of detailed effluent survey techniques to determine the effluent treatment approach.

Ultrafiltration has been found to be an effective treatment process for recycling wool scouring and desizing effluents, producing permeates suitable for process reuse with 95% grease rejection.

The results from studies suggest that practical water reuse can only be obtained by a method referred to as "desuiting" the wool prior to detergent scouring and by the incorporation of an efficient grease step for the scouring effluent.

Ultrafiltration was also found economically attractive for recovery of sizes in cotton textile mills.

The ion exchange and flocculation treatment systems for the wool/synthetic fiber dyehouse effluent result in a reusable effluent containing the buffer chemicals and recovers the surfactants.

5.2 Scale of Operation: Not reported

5.3 State of Development: Not reported

5.4 Level of Commercialization: Not reported

5.5 Material/Energy Balances and Substitutions:

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Not reported

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Economic benefits are expected over the conventional end-of-pipe treatment approach, but no specifics were provided.

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date Case Study Was Performed: 1979

10.0 Contacts and Citation

10.1 Type of Source Material: Journal

10.2 Citation: G. R. Groves, C.A. Buckley and R.H. Turnbill. Close Loop Recycle Systems for Textile Effluents. Journal of Water Pollution Control Federation. Vol. 51, No. 3, March 1979.

10.3 Level of Detail of the Source material: Not reported

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor Name and Address: UNEP Workgroup, Paris. Reformatted: Elizabeth J. Mooney, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Wet textile mill effluent

11.2 Process Type/Waste Source: Textile mill products, SIC 2231, wool broadwoven fabric mills, desizing chemicals, wastewater

11.3 Waste Reduction Technique: Effluent recovery, close loop systems, ultrafiltration process

11.4 Other Keywords: Wastewater reduction

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Wet Textile Mill Effluent, Textile Mill Products, SIC 2231, Wool Broadwoven Fabric Mills, Desizing Chemicals, Wastewater, Effluent Recovery, Closed-Loop Systems, Ultrafiltration Process, Wastewater Reduction

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Reuse of water in a woollen mill.

2.0 SIC Code: 2299, Textile Goods, NEC

3.0 Name & Location of Company: Shanghai Second Woollen Mills, Shanghai, China

4.0 Clean Technology Category

This technology involves the recycling and reuse of wastewater.

5.0 Case Study Summary

5.1 Process and Waste Information: Coloured wastewater effluents from two workshops at a woollen mill were treated using dissolved air flotation and biological towers. Decolorization was achieved by coagulation and adsorption with activated carbon. After biological treatment and decolorization, the wastewater was diluted with 20% tap water. This water was used to prepare dyeing liquors. A neutral dye and a mordant dye were selected. The dyeing recipe was adjusted to account for the effect of hexavalent chromium ion present in low concentrations in the reuse water.

5.2 Scale of Operation: Not reported

5.3 State of Development: Pilot stage field experiments were performed

5.4 Level of Commercialization: Not reported

5.5 Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Feedstock Use:		
$Al_2(SO_4)_3$	120 ?/day	156 ?/day
Activated Carbon	--	300 ?/day
Water Use:	1450 m^3/day	300 m^3/day
Energy Use:		
Electricity	420?/day	650?/day

? - Units not provided

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Operational use of activated carbon reported to cost 12 Yuan/day (1974). An increase in energy use resulted in a net cost increase of 23 Yuan/day. Wastewater treatment costs increased by 46 Yuan/day. Costs of $Al_2(SO_4)_3$ increased by 13 Yuan/day.

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits: Economic benefits were calculated to be 90 Yuan/day (1974) and resulted from the decreased use of tap water.

Use of the technology minimizes discharges of coloured wastewater

8.0 Obstacles, Problems and/or Known Constraints

Economic feasibility of the technology depends on the availability of activated carbon, and the lack of costs associated with carbon regeneration in this case.

9.0 Date case study was performed: 1974 and 1976

10.0 Contacts and Citation

10.1 Type of Source Material: Conference Proceedings

10.2 Citation: A Study on Reuse of Water in a Woollen Mill. Hu Hiajue et al. Purdue Universty Conference on Industrial Waste Treatment

10.3 Level of Detail of Source Material: Additional information is available in the source material

10.4 Industry/Program Contact and Address: Not provided

10.5 Abstractor and Address: Reformatted: Isaac Diwan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Coloured wastewater

11.2 Process Type/Waste Source:

11.3 Waste Reduction Technique: Wastewater reuse

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Coloured Wastewater, Wastewater Reuse, Textiles

***** DOCNO: 400-027-A-216 *****

1.0 Headline: Application of counter-current rinsing and washing in woollen industry.

2.0 SIC Code: 2299, Textile Goods, NEC, ISIC 3211 Textile, Clothing and Leather Industries

3.0 Name & Location of Company: Textile Industry in France

4.0 Clean Technology Category

This technology involves recycling, reuse and reclamation of wool wash water.

5.0 Case Study Summary

5.1 Process and Waste Information: Fleece (raw wool) contains about 40% impurities by weight which must be removed with the conventional technology. Fleece is beaten and then washed and rinsed in water. Centrifugation of wash water permits recovery of suint and recycling of part of the wash water to the washing baths. Mud and heavy grease separated by centrifuge are discharged to a holding pond.

A number of modifications and new operations are introduced. These include the reuse of rinse water rather than its discharge to public sewers. Effluent from the first washing bath is centrifuged to recover suint and to recycle part of the washing water. Bottom residual water loaded with mud and heavy grease is subjected to further treatments consisting of a multiple effect evaporation to concentrate the grease. Water condensate is reused in rinsing and washing. Grease concentrate is vacuum dried to produce a combustible residue (oil distillate and bitumen) for the evaporation boiler. Liquid wastes are completely eliminated with the low waste technology.

No additional pollution control measures are required with the Low Wastage Technology, except for the treatment of fumes from the boiler with a bag-filter.

5.2 Scale of Operation: Annual production capacity is 18,500 tonnes of wool per year (285 days of operation per year).

5.3 State of Development: This technology is fully implemented

5.4 Level of Commercialization: Not reported

5.5 Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Waste Generation: SO_2 emissions	N/A	1.5 kg/tonne wool
Water Use:	7.5 m^3/tonne	2 m^3/tonne
Energy Use:	0.6 GJ/tonne	5.2 GJ/tonne

6.0 Economics*

6.1 Investment Costs: 15,000,000 French Francs (1981) compared to 32,500,000 FF for conventional technology if a conventional effluent treatment is constructed

6.2 Operational and Maintenance Costs: F 195/m wool washed

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Economic benefits are achieved while regulations are met. Aqueous wastes disappear completely with the low pollution technique. Both techniques bring about atmospheric pollution of 0.5 kg of dust per ton. The low pollution technique allows the reduction of the SO_2 discharged from 2 kg to 1.5 kg per ton.

8.0 Obstacles, Problems and/or Known Constraints

Not reported.

9.0 Date case study was performed: 1981

10.0 Contacts and Citation

10.1 Type of Source Material: Organizational Report, "Counter-current Rinsing and Washing Including Recycling of Rinsewater and Treatment of Washing Water from Wool Washing."

10.2 Citation: United Nations Economic and Social Council, Compendium on Low and Non-waste Technology, ENV/WP.2/5/Add.27 Economic Commission for Europe, July, 1981.

10.3 Level of Detail of Source Material: Additional information available in the source.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor and Address: Reformatted: Isaac Diwan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Wastewater

11.2 Process Type/Waste Source: Wool (fleece) wash water

11.3 Waste Reduction Technique: Reuse, recycle

11.4 Other Keywords: Grease, vacuum dried, evaporation

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Textiles, Wastewater, Wool, Counter-Current Rinsing, SIC 2299, ISIC 3211

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Minimized Environmental Effects in Cotton Production from Organic Growing to Garment Reuse

2.0 SIC/ISIC Code: 0131, 0724, 22XX

3.0 Name and Location of Company:

Novotex A S, Denmark

4.0 Clean Technology Category: The methodology employed here is to produce cotton with the smallest environmental impact by minimizing emissions, energy conservation, and waste minimization. The techniques employed involve all the stages from growing the cotton to recycling of unwanted garments. The first stage is cotton growing, which the company is trying to insist that the growers perform organically without artificial fertilizers, chemical pesticides, and defoliant sprays. Also, company policy demands that all of the cotton used be handpicked to avoid defoliants and does not contain pesticide residue. Vegetable compost and manure can supply the soil with necessary nitrogen and organic materials.

Cotton is spun on advanced computer controlled machines that require greater control of the otherwise dusty atmosphere. Also, only water soluble dyes are used on the cotton and chloride for bleaching is eliminated by using hydrogen peroxide. Dyeing is performed in fully enclosed high pressure jet machines with reduced water consumption and no air pollution. In the drying process, mechanical finishing is performed, eliminating the use of chemicals. Dust from the manufacturing of cotton garments is reduced using dust extraction at the cutting and sewing machines. All wastewater is treated, using chemical precipitation with lime and iron salts to remove the dye and phosphorus, activated sludge biological treatment occurring in 14 meter high towers, followed by sand filtration and aeration prior to discharge.

The company also tries to promote reusing garments, either for continued reuse by another person or for conventional recycling for another use.

5.0 Case Study Summary:

5.1 Process and Waste Information: The facility applies environmental friendly measures on the stages of spinning, knitting, dyeing, finishing, garment production, packaging and transport. Simultaneously, the company carries out a Life Cycle Analysis of each stage of production to examine the environmental aspects of every area of operation

5.2 Scale of Operation: Not Provided.

5.3 Stage of Development: Novotex A S is currently implementing the practices described herein.

5.4 Level of Commercialization: The practices described are readily available.

5.5 Material/Energy Balances and Substitutions: When the facility started operation, 1 percent of its cotton was organically grown, this is now 10 percent and the facility expects it to continue to grow as consumers around the world are enlightened. The facility has cut water usage in the dyeing process by 50 percent and in the heated cleaning line by 67 percent. Also, the drying machines recycle 75 percent of the hot air used and the wastewater discharge from the plant contains a small fraction of the toxic material limits set by the water authority.

6.0 Economics*

6.1 Investment Costs: Not Provided.

6.2 Operational and Maintenance Costs: Not Provided.

6.3 Payback Time: Not Provided.

7.0 Pollution Prevention Benefits

The organic growing method produces healthy plants without polluting the soil and the surrounding environment. Also, the working environment has been improved at all stages of production and the environmental impacts of each stage of production have been minimized.

8.0 Obstacles, Problems, and/or Known Constraints

None Described.

9.0 Date Case Study Was Performed: Not Provided.

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "Minimised Environmental Effects in Cotton Production," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: M Leif Norgaard, Managing Director, Novotex A S, Ellehammervej 8, DK-7430, Ikast, Denmark, Tel: +45 97 15 44 11

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Wastewater

11.2 Process Type/Waste Source: Chlorine bleach, Water insoluble cotton dyes

11.3 Waste Reduction Techniques: Organic growing, Handpicked cotton, Product substitution, Dust Control

11.4 Other Keywords:

11.5 Country Code:

12.0 Assumptions

None.

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wastewater, Chlorine bleach, Water insoluble cotton dyes, Organic growing, Handpicked cotton, Product substitution, Dust Control

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Recovery and reuse of water in wet processing in a textile mill.

2.0 SIC Code: 2299, Textile Goods Manufacture

3.0 Name & Location of Company: Bombay Textile Research Association Member Textile Mill, Bombay, India

4.0 Clean Technology Category

Technology Principle: The technology involves the recovery and reuse of wastewater in wet processing.

5.0 Case Study Summary

5.1 Process and Waste Information: In a BTRA member mill, a month-long study was carried out to study the opportunities for conservation and reuse of water in its wet processing department. The following measures were suggested:

Reduce the rate of flow of water and the throttling of water supply in washing machines.

Counter the current flow of washing on soapers, mercerizing machines, J-box range, etc.

Effectively reuse wash waters at some preceding point in the processing sequence, or by a common sump and pump technique.

Collect and reuse steam condensate for boiler feed water.

Reuse steam condensate from caustic soda recovery plant in washing of mercerized goods.

Apply static washes on jiggers in place of overflow washes.

Use sodium bicarbonate in place of acetic acid for the oxidation of vat-dyed goods for easy removal of caustic soda.

Recycle water for washing of blankets on printing machines.

Reduce the number of washings in a process sequence by giving appropriate treatments to fabric.

The bulk trails for such conservation and reuse measures were carried out in the mills during the processing of a number of fabric varieties like bleached longcloth, dyed poplin, bleached mulls/voiles, and dyed mulls and voiles.

5.2 Scale of Operation: Not reported

5.3 State of Development: Process suggestions fully implemented.

5.4 Level of Commercialization: Not reported

5.5 Balances and Substitutions: Total fresh water consumption before the survey was 183,350 liters/day. After the survey, consumption was 11,950 liters/day. Net savings in fresh water consumption per year was 21,720,000 liters.

Material Category	Quantity Before	Quantity After
Water Use:	183,350 liters/day	110,950 liters/day
Water Reused:	85,200 liters/day	157,550 liters/day

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Total fresh water consumption before survey was 183,350 liters/day. After survey, it was 11,950 liters/day. Total savings in water consumption per year equals 21,720,000 liters. Monetary benefits amounted to 130,320 rupees per year.

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits: Savings from reduced water consumption amounted to 130,320 rupees per year (taking cost of water at 60 rupees per 10,000 liters of water).

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date of Case Study: 1985

10.0 Contacts and Citation

10.1 Type of Source Material: Conference proceedings

10.2 Citation: "Seminar on Avenues for Cost Reduction in Chemical Processing of Textiles," held on February 26, 1985 by Bombay Textile Research Association, Bombay 400 086, BTRA No. 06.3.1

10.3 Level of Detail of Source Material: Additional information is available from the source.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor and Address: UNEP Work Group, Paris. Reformatted by: Marilu Hastings, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Wastewater

11.2 Process Type/Waste Source: Wet processing, SIC 2299

11.3 Waste Reduction Technique: Wastewater recovery, reuse

11.4 Other Keywords: Annual cost savings

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Wastewater, Wet Processing, SIC 2299, Wastewater Recovery, Reuse, Annual Cost Savings

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Conversion of willow dust into biogas at cotton textile processing mill.

2.0 SIC Code: 2211, Cotton Fabric Mill

3.0 Name & Location of Company: Apollo Textile Mills, Bombay,India.

4.0 Clean Technology Category

Technology Principle: The technology involves the conversion of willow dust into biogas and organic fertilizer.

5.0 Case Study Summary

5.1 Process and Waste Information: Textile mills generate considerable quantities of solid waste materials during different stages of operation. Willow dust is a waste generated from a willow machine. In India, 30,000 to 33,000 tonnes of this material is generated every year. To convert this willow dust into biogas, a pilot plant was installed at Apollo Textile Mills in Bombay with assistance from the Cotton Textile Research Laboratory (CTRL). This plant has a 12.5 ton/month capacity. 350 m^3 of biogas was produced per 2 tons of willow dust for a retention period of 90 days.

The mill's average production of willow dust is 12.5 tons/month. The consumption of liquid propane gas by the laboratory alone has been reduced by 65 kg since the installation of this converter.

The scientists at the CTRL have further developed a process which needs less water, and double the quantity of material can be accommodated in the same unit. Improvements have been made so that the calorific value of biogas is increased. Also, the organic substance that is a by-product of fermentation can serve as a good fertilizer.

5.2 Scale of Operation: Average monthly production of willow dust is 12.5 tons.

5.3 State of Development: The clean technology is fully implemented.

5.4 Level of Commercialization: Not reported

5.5 Balances and Substitutions: Not reported

6.0 Economics:* It is assumed that the abbreviation "Rs." stands for "rupees." It is also assumed that the word "lakhs" means "100,000 rupees."

6.1 Investment Costs: The investment cost of the project was 3.4 lakhs (lakh = 100,000 Rs.).

6.2 Operational and Maintenance Costs: Operating costs, including water and collection of willow dust and alkali, are about 18,000 Rs.

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Benefits including biogas and organic fertilizer generation are as follows:

Biogas	12,000 m^3/year	63,412 Rs.
Fertilizer	24 tons/year	2.400 Rs.

Economic benefits will also include reduction in gas expenditures and waste disposal costs.

8.0 Obstacles, Problems and/or Known Constraints

No information provided.

9.0 Date the Case Study was Performed: 1985.

10.0 Contacts and Citation

10.1 Type of Source Material: Organizational report

10.2 Citation: "Production of Biogas from Willow Dust: A Solid Cellulosic Waste from Textile Mills." Cotton Technological Research Laboratory (CTRL). Adenwala Road, Matunga, Bombay - 400 019, India.

10.3 Level of Detail of Source Material: Additional information is available from this source.

10.4 Industry/Program Contact and Address: Industry contact not provided.

10.5 Abstractor and Address: UNEP Work Group, Paris. Reformatted by: Marilu Hastings, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Dust

11.2 Process Type/Waste Source: Cotton textile processing, SIC 2211

11.3 Waste Reduction Technique: Conversion of willow dust into biogas and organic fertilizer

11.4 Other Keywords: Material segregation, reuse

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Dust, Cotton Textile Processing, SIC 2211, Conversion of Willow Dust into Biogas and Organic Fertilizer, Material Segregation, Reuse

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Poly vinyl alcohol recycling in the process of "sizing" cotton fibers in the textile industry.

2.0 SIC Code: 2211, Cotton Broadwoven Fabric Mills

3.0 Name & Location of Company: Referred to as "Textile Industry," located in South Africa.

4.0 Clean Technology Category

Recycling, reuse and reclamation: This technology involves the use of a closed-loop recycling including a ultra-filtration membrane process to capture poly vinyl alcohol (PVA).

5.0 Case Study Summary

5.1 Process and Waste Information: Poly vinyl alcohol (PVA), polyacrylates (PAA) and starch are used in the textile industry for "sizing" cotton fibers; a process where applied chemicals confer strength to the fiber and protect it during the weaving process. The PVA, PAA and starch are removed from the cloth after weaving by washing it in hot water in a "desizing" operation resulting in an aqueous effluent containing these chemicals.

A ultra-filtration process to reduce the amount of PVA and starch in the effluent followed by a closed-loop recycling operation was tested for 16 months in a pilot plant. The ultra-filtration membrane used in this process recovered PVA successfully. Starch is enzymatically solubilized prior to desizing and, therefore, can not be recovered. The film forming characteristics of the PAA during testing were impaired by the formation of a calcium-polyacrylate complex.

5.2 Scale of Operation: Not reported

5.3 State of Development: The process was tested for 16 months in a pilot plant.

5.4 Level of Commercialization: Not reported

5.5 Material/Energy Balances and Substitutions:

6.0 Economics*

6.1 Investment Costs: The capital cost for the ultra-filtration plant is $600,000.

6.2 Operational and Maintenance Costs: Operating costs for ultra-filtration plant was $61,000.

6.3 Payback Time: The payback period is 15 months.

7.0 Cleaner Production Benefits

Economic benefits were calculated in terms of raw material savings based on 4DE 6 meters/year cloth production:

a) PVA sizing - $ 420,000/year
b) Enzymes - $ 100,000/year
c) Steam - $ 20,000/year

This resulted in a net savings of $ 485,000/year from reduced waste generation (900 tons/year) and raw material purchasing needs.

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date Case Study Was Performed: 1982

10.0 Contacts and Citation

10.1 Type of Source Material: Journal

10.2 Citation: Buckley, C.A. 1982. The Performance of an Ultrafiltration Recycling of Textile Desizing Effluents. Water Science and Technology 14:705-713.

10.3 Level of Detail of the Source material: Additional information is available from this source document.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor Name and Address: UNEP Workgroup, Paris. Reformatted: Elizabeth J. Mooney, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Textile mills, poly vinyl alcohol (PVA), polyacrylates (PAA), starch, wastewater, desizing effluent

11.2 Process Type/Waste Source: Textile mill products, SIC 2211, cotton broadwoven fabric mills, desizing effluent

11.3 Waste Reduction Technique: Effluent recovery, PVA (poly vinyl alcohol) recovery, ultra-filtration process

11.4 Other Keywords: Wastewater reduction, South Africa

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Textile Mills, Poly Vinyl Alcohol (PVA), Polyacrylates (PAA), Starch, Wastewater, Desizing Effluent, Textile Mill Products, SIC 2211, Cotton Broadwoven Fabric Mills, Effluent Recovery, PVA (Poly Vinyl Alcohol) Recovery, Ultrafiltration Process, Wastewater Reduction, South Africa

***** DOCNO: 400-026-A-215 *****

HEADLINE:	Wastewater reduced and soda recycled using rinse procedures and evaporators.
INDUSTRY/SIC CODE:	Textile, Clothing and Leather Industries/ISIC 3211
NAME/CONTACT:	Ministere de l'Environment et due Cadre de Vie Direction de la Prevention des Pollutions 14 Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	The company performs mercerizing followed by rinsing in running water and allowing recycle of the soda after concentration. The actual mercerizing operation is identical except that the mercerizer used is more automated: the cotton is immersed in a soda bath containing a wetting agent. The rinsing, instead of taking place in three baths of water (hot then cold) that are discharged after use, takes place in a stream of running water. The rinse water is progressively filled with soda until it is concentrated enough to profitably employ an evaporator to further concentrate it. The concentrated soda is then recycled for mercerizing, along with the wetting agent it contains.
FEEDSTOCKS:	Not reported
WASTES:	Pollution consists of residual soda; for each ton of thread, 100 kg of soda remaining for the low pollution technique, versus 360 kg, in 13 m^3 as opposed to 80 m^3.
MEDIUM:	Water
COST:	(1977 Francs)
CAPITAL COST:	F 1,100,000
OPERATION/MAINTENANCE:	F 1,320/ton thread mercerized
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Reduction of the rate of waste discharge by 67 m^3 per ton of thread mercerized.
IMPACT:	Reduces the amount of wastewater produced.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Counter-current Rinsing and Recycling of Soda in Rinsewater from Mercerizing," Monograph ENV/WP.2/5/Add.26.
KEYWORDS:	Textiles, ISIC 3211, Mercerizing, Counter-Current Rinsing, Rinse Procedures

***** DOCNO: DOCUMENT NOT AVAILABLE ***** <x>

1.0 Headline: Efficient recovery and reuse of caustic soda from mercerizing washwaters.

2.0 SIC Code: 2299, Textile Good Manufacturers

3.0 Name & Location of Company: Bombay Textile Research Association (BTRA) Member Mill, Bombay, India

4.0 Clean Technology Category

Technology Principle: This technology involved the efficient recovery and reuse of caustic soda from mercerizing wastewater.

5.0 Case Study Summary

5.1 Process and Waste Information: A plant floor study examined mercerizing machines and a caustic soda recovery plant in a textile mill. It was observed that only 75% of the caustic soda from washwaters was collected, compared to the normal 85%. Also, the caustic soda recovery plant only recovered 81% of the soda, as opposed to the normal 90%.

The probable causes of the low collection and recovery rates were inefficient washing in the mercerized material, poor squeeze and high quantities of caustic left on the fabric, overflowing/leakage of dilute caustic soda solutions from the washing tank, and seepage from the underground storage tanks. The probable causes of poor recovery were the improper filtration of caustic soda solution prior to recovery, poor heat transfer coefficient in the recovery plant due to scaling of the metallic tubes of the heat exchanger, lower vacuum obtained by the barometric condenser, and the inefficient removal of non-condensate gases from the evaporation body. Necessary corrective steps were taken yielding significant cost savings.

5.2 Scale of Operation: Not reported

5.3 State of Development: System was fully implemented.

5.4 Level of Commercialization: Not reported

5.5 Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Feedstock Use:	1,190 kg/day	775 kg/day

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs:

Particulars	Before Study (kg)	After Study (kg)
Mercerizing production/ day of fabric	10,000	10,000
Caustic soda input/day	3,500	3,500
Collection from washwaters	2,630	2,975
Reuse of dilute solutions in bleaching	310	475
Caustic soda recoverable	2,320	2,500
Recovery of caustic soda	2,000	2,225
Total caustic soda consumed in mercerizing (Total input less recovery/reuse)	1,190	775

Saving of caustic soda/day = 415 kg

Savings per day = 2,282.50 rupees

Savings per year = 684,750 rupees

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits: Savings in caustic produced monetary benefits of 684,750 rupees per year and improved the quality of the fabric.

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date of Case Study: 1985

10.0 Contacts and Citation

10.1 Type of Source Material: Conference proceedings

10.2 Citation: "Seminar on avenues for Cost Reduction in Chemical Processing of Textiles", held on February 26, 1985 by Bombay Textile Research Association, Bombay 400 086, BTRA No.06.3.1

10.3 Level of Detail of Source Material: Additional information is available.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor and Address: UNEP Work Group, Paris. Reformatted by: Marilu Hastings, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Caustic soda

11.2 Process Type/Waste Source: Mercerizing, SIC 2299

11.3 Waste Reduction Technique: Reuse, recovery

11.4 Other Keywords: Textiles

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Caustic Soda, Mercerizing, SIC 2299, Reuse, Recovery, Textiles

***** DOCNO: 400-085-A-314*****

HEADLINE:	Batch degreasing of cloth with solvent and solvent recycling reduce wastes generated.
INDUSTRY/SIC CODE:	Spinning, Weaving and Finishing Textiles/ISIC 3211
POLLUTION PREVENTION OPTIONS SUMMARY:	This case study presents the effects of automating the degreasing of cloth in aqueous solution. Degreasing of cloth is achieved with detergent before dying in an aqueous solution. This process generates large amounts of waste. When using solvent to degrease cloth in a continuous mode, the volume of waste is reduced because the solvent is recycled.
FEEDSTOCKS:	Solvent, cloth
WASTES:	The wastes generated by this process consist of solvent distillation/recovery column bottoms, and solvent resulting from the drying process. Solvent fumes are collected by an activated charcoal filter. Fats are incinerated.
MEDIUM:	Water
COST:	
CAPITAL COST:	FF 660,000 per 1,035 tons of cloth (1976 figures).
OPERATION/MAINTENANCE:	FF 171.5 per ton of cloth (1976 figures).
MONTHS TO RECOVER:	Not Reported
SAVINGS:	
DISPOSAL & FEEDSTOCK:	FF 640,000 per 1,035 tons of cloth in capital cost FF 144.5 per ton of cloth in O&M costs.
FEEDSTOCK REDUCTION:	For one ton cloth, the low-pollution technique requires 14.5 kg of solvent and 2.47 GJ of primary energy. The standard technique requires 14 m^3 of softened water, 29 kg of detergent and 5.85 GJ of primary energy. The low-pollution technique rejects solvent from the drying process while fats are separated when distilling used solvents. The standard technique rejects 45 m^3 of used water loaded with fats and washing products (135 kg of oxidizable matter, 2 kg of equitox) per one ton of cloth.
WASTE PRODUCTION:	With the low-pollution technique, effective wastes are nearly non-existent.
IMPACT:	Another advantage of the low-pollution technique is that it permits energy recovery by burning fats. With the low-pollution technique the quantity of operations (continuous degreasing) is reduced. Therefore, working conditions are improved.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Batch Degreasing of Cloth with Solvent," Monograph ENV/WP.2/5/Add.85.
KEYWORDS:	Textiles, Solvent Recovery, Water-Based Detergents, Degreasing, Distillation, ISIC 3211

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Modified pressure kiers save energy in a textile mill in India.

2.0 SIC Code: 2299, Textile Goods, NEC

3.0 Name & Location of Company: Shri Ranjitsinghji Mills, Solapur and several other mills in Solapur, India

4.0 Clean Technology Category

Technology principle: This technology involves equipment modifications that allow the use of higher temperatures and chemical concentrations and reduce total time required for total kiering operation.

5.0 Case Study Summary

5.1 Process and Waste Information: The productivity of conventional pressure kiers was increased by reducing the time required for total kiering operation. Conventional pressure kiers were modified in a few mills so as to allow steaming of different types of fabrics, pre-saturated with appropriate chemical for scouring or bleaching. The temperature and concentration of the treating solution were increased within controlled limits to reduce the time of treatment. The concentration of chemical on the fabric was increased and the fabric steamed in the fashion of the J. Box system. This is the first instance of the use of conventional pressure kier boiling using the J.Box steaming process.

5.2 Scale of Operation: Daily production of 2 lots of 2000 kg each.

5.3 State of Development: This technology is fully implemented.

5.4 Level of Commercialization: Not reported

5.5 Balances and Substitutions: Not reported

6.0 Economics*

6.1 Investment Costs: Cost of modification is Rs 30,000 (1985)

6.2 Operational and Maintenance Costs: Not reported

6.3 Payback Time: Estimated at less than one month.

7.0 Cleaner Production Benefits

Savings in electrical and thermal energy, water and time required for processing without sacrificing the product quality. A significant economic saving of Rs 50,000 per month was obtained.

8.0 Obstacles, Problems and/or Known Constraints

Not reported

9.0 Date case study was performed: 1985

10.0 Contacts and Citation

10.1 Type of Source Material: Conference Proceedings

10.2 Citation:

(1) M.D. Dixit, Bombay Textile Research Association, Bombay, India. In 43rd All India Textile Conference in Bombay, December, 1986.

(2) S.N. Bhide and S.D. Mahajan, B.R. Damani Research Center, Ranjitsinghji Mills, Solapur, India.

10.3 Level of Detail of Source Material: Additional information available from source material.

10.4 Industry/Program Contact and Address:

(1) M.D. Dixit, Bombay Textile Research Association, Bombay, India.

(2) S.N. Bhide and S.D. Mahajan, B.R. Damani Research Center, Ranjitsinghji Mills, Solapur, India.

10.5 Abstractor and Address: Reformatted: Isaac Diwan, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Not reported

11.2 Process Type/Waste Source: Not reported

11.3 Waste Reduction Technique: Not reported

11.4 Other Keywords: Not reported

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Textiles, SIC 2299

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Change from peroxide bleaching to sodium hypochlorite bleaching reduces costs.

2.0 SIC Code: 2211, Cotton Fabric Mills

3.0 Name & Location of Company: Bombay Textile Research Association (BTRA) Member Textile Mill, Bombay, India

4.0 Clean Technology Category

Technology Principle: This technology involves the substitution of sodium hypochlorite for hydrogen peroxide in bleaching.

5.0 Case Study Summary

5.1 Process and Waste Information: A cotton textile mill in Bombay was using hydrogen peroxide bleaching treatment for textiles, including for those materials that were going to be dyed in medium and dark colors. The BTRA suggested that the mill change to a sodium hypochlorite beaching system. For antichloring of the treated goods, the mill was advised to use only about a 0.3% hydrogen peroxide solution in order to achieve better results. The new process allowed the mill to use less chemicals and reduce pollution.

5.2 Scale of Operation: Not provided

5.3 State of Development: The system was fully implemented.

5.4 Level of Commercialization: Not provided

5.5 Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Hydrogen Peroxide	1.5% solution	0.3% solution
Sodium Hypochlorite	None	3g/l

6.0 Economics*

6.1 Investment Costs:

6.2 Operational and Maintenance Costs: The mill's earlier practice of using peroxide bleaching cost 94,650 Rs./month. The new sodium hypochlorite system cost 24,930 Rs./month. The mill could save 836,640 Rs./year. [Assume Rs. is abbreviation for "rupees."]

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits: Savings in overall chemical consumption, reduced pollution load, and resulting monetary benefits.

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date of Case Study: 1985

10.0 Contacts and Citation

10.1 Type of Source Material: Conference proceedings

10.2 Citation: "Seminar on Avenues for Cost Reduction in Chemical Processing of Textiles", held on February 26, 1985 by Bombay Textile Research Association, Bombay 400 086, BTRA No.06.3.1

10.3 Level of Detail of Source Material: No further information is available.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor and Address: UNEP Work Group, Paris. Reformatted by: Marilu Hastings, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Bleach

11.2 Process Type/Waste Source: Bleaching, SIC 2211

11.3 Waste Reduction Technique: Process redesign, substitution

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Bleach, Bleaching, SIC 2211, Process Redesign, Substitution

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: An all-aqueous method replaces use of solvents during pthalogen blue dyeing.

2.0 SIC Code: 2299, Textile Goods Manufacturer

3.0 Name & Location of Company: Bombay Textile Research Association Member Mill, Bombay, India

4.0 Clean Technology Category

Technology Principle: This technology involved the replacement of solvents from the pad bath formulation with an all-aqueous method of pthalogen blue dyeing.

5.0 Case Study Summary

5.1 Process and Waste Information: In one of the member mills of the BTRA, pthalogen blue dyeing was carried out by a solvent method using Ahurasol TRAF. It was suggested to the mill that it begin using an all-aqueous method of pthalogen blue dyeing. Large scale trials using this method were carried out. The new method's results were found to be comparable to the conventional process. In fact, the new method produced better coverage by the incorporation of small quantities of reactive dyes in the process.

5.2 Scale of Operation: This mill produced 100,000 meters/month of material in the pthalogen blue shade.

5.3 State of Development: Not reported

5.4 Level of Commercialization: Not reported

5.5 Balances and Substitutions:

Material Category	Quantity Before	Quantity After
Feedstock Use:		
Chlore Blue 3GX	6.818	6.818
Copper Complex	13.636	13.636
Ahurasol TRAF	15.679	0
Urea	15.679	12.272
Noigen HC 30	0	6.818
Reactofix Red H8B	0.5	0.5
Ahuralan 42	0.1	0.1
Sodium Bicarbonate	1.136	1.136

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Savings per meter of fabric dyed is 0.156 rupees and total annual savings of 187,200 rupees.

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits: Savings per liter of pad bath formulation = 2.09 rupees. Savings per month of same = 15,600 rupees. Annual savings = 187,200 rupees. Apart from direct economic benefits, there was an improved coverage of dye by incorporation of small quantities of reactive dyes.

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date of Case Study: 1985

10.0 Contacts and Citation

10.1 Type of Source Material: Conference proceedings.

10.2 Citation: "Seminar on Avenues for Cost Reduction in Chemical Processing of Textiles," held on February 26, 1985 by Bombay Textile Research Association, Bombay 400 086, BTRA No.06.3.1

10.3 Level of Detail of Source Material: Additional information is available from this source.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor and Address: UNEP Work Group, Paris. Reformatted by: Marilu Hastings, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Dye, solvent

11.2 Process Type/Waste Source: Textile dyeing, SIC 2299

11.3 Waste Reduction Technique: Material substitution

11.4 Other Keywords: Annual cost savings

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Dye, Solvent, Textile Dyeing, SIC 2299, Material Substitution

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Water reuse in a textile industry reduces wastewater and BOD waste generation.

2.0 SIC Code: 22, Textile Mill Products

3.0 Name and Location of Company: Binny Textile Mills, Madras, India

4.0 Clean Technology Category: This case study focuses on reuse of wastewaters and water conservation.

5.0 Case Study Summary:

5.1 Process and Waste Information: Four areas within the facility are the major wastewater producers: (1) process and treatment department; (2) captive power generation unit (coal fired thermal power station); (3) sizing department; and (4) yarn dyeing and printing department. The following changes were undertaken to conserve water and reduce wastewater generation.

Reuse of pressure filters backwash water. Suspended solids that can easily settle are the main pollutants in pressure filter backwash water. By collecting the backwash water in a pond, with a minimum hydraulic retention time of 12 hours, the supernatant freed from the suspended solids can be reused for gardening purposes. Periodically, the retained suspended solids are removed from the pond and disposed of a solid waste in a landfill site. The net effect is conservation of 20 cubic meters/day of freshwater, which the facility used for gardening purposes.

Reuse of wastewater from the dyeing and finishing department - About 1,200 cubic meters/day of fresh water, including the evaporation loss, was used for quenching hot ash from the boiler house prior to its disposal. Laboratory experiments confirmed that it is feasible to reuse hard wastewater from the dyeing department for ash quenching in lieu of fresh water. Due to adsorption of colors and dyes on the ash particles, there is a approximately a 20% reduction in BOD content in the reused dye department wastewater. Approximately 1,200 cubic meters per day of fresh water was conserved, with a reduction of 552 kg BOD/day.

Reuse of wastewater from the sizing department - In order to avoid spontaneous combustion and to reduce the fines loss, freshwater was used to wet coal in the yard. By collecting in a pond the low volume, high organic strength wastewater from the sizing department, all of the wastewater could be reused for coal wetting. Appropriate facilities must be available at the pond to avoid septicity. Wastewaters from the sizing department were completely reused and 27 cubic meters per day of fresh water were conserved.

5.2 Scale of Operation: Unknown.

5.3 Stage of Development: The technology was fully implemented.

5.4 Level of Commercialization: Not applicable

5.5 Material/Energy Balances and Substitutions: Not reported

6.0 Economics*

6.1 Investments Costs: Investment costs include the facility for pH neutralization pumps and pipeline costs.

6.2 Operational & Maintenance Costs: Savings and reduction in the capital investment is Rs. 7 lakhs annually, and annual O&M costs are Rs. 6 lakhs. Annual savings for 300 workings days per year for purchase of fresh water from the municipal corporation totalled Rs. 4 per cubic meter.

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits: Wastewater reused equals 2,690 cubic meters per day and freshwater consumption was reduced 1.227 cubic meters per day. The overall reduction in wastewater quantity and BOD load were 31% and 25% respectively.

8.0 Obstacles, Problems, and/or Known Constraints: Not available

9.0 Date Case Study Was Performed: 1984

10.0 Contacts and Citation

10.1 Type of Source Material: Unpublished materials.

10.2 Citation: Mr. L. Paneerselvam, Director (PC), National Productivity Council, Lodhi Road, New Delhi 110 003, India.

10.3 Level of Detail of Source Material: Unknown

10.4 Industry/Program Contact and Address: Unknown

10.5 Abstractor Name and Address: The information in this case study was derived from abstracts provided by the United Nations Environment Program (Paris). This abstract was prepared directly from the abstract without access to the case study cited. Mary L. Wolfe, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Wastewater.

11.2 Process Type/Waste Source: Textile mill products, SIC 22

11.3 Waste Reduction Technique: Reuse

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Wastewater, Textile Mill Products, SIC 22, Reuse

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Nordic project on water use reduction in textile industries.

2.0 SIC Code: 22, Textile Mill Products

3.0 Name and Location of Company: 15 textile facilities in Denmark, Finland, Norway, and Sweden.

4.0 Clean Technology Category

Process/Equipment Modification: This technology involves the introduction of automatic water stops to encourage water conservation.

5.0 Case Study Summary:

5.1 Process and Waste Information: Between 1976 and 1981, a Nordic "water care" project was launched to examine avenues of water conservation in textile industries in Denmark, Finland, Norway, and Sweden.

The following changes were reported for batch operations:

Winch dyeing: By dropping the dye batch and avoiding overflow rinsing, water consumption could be reduced 25%.

High and Low Pressure Jet Dyeing: Approximately 50% of water consumption could be reduced by replacing the overflow with batchwise rinsing.

Beam Dyeing: Avoiding overflow during soaking and rinsing can reduce water consumption by approximately 60%.

Jig Dyeing: Switching to stepwise rinsing from the overflow practice resulted in water consumption reductions of 15%-79%.

Cheese Dyeing Apparatus: A water consumption reduction of 70% can be expected with the use of an intermittent rinsing procedure.

For continuous operations, a savings of 20%-30% was reported by the introduction of automatic water stops. Counter current washing was found to be most effective. Horizontal washing equipment was found to deliver the performance of two vertical washing machines for the same water consumption.

5.2 Scale of Operation: Initially, laboratory studies were carried out to ascertain potential possibilities. Approximately 25 setups were installed at 15 textile plants.

5.3 Stage of Development: At the time the case study was reported, the technology was in the pilot stage.

5.4 Level of Commercialization: It is unknown whether the technology was commercially available at the time of the case study.

5.5 Material/Energy Balances and Substitutions: Not reported

6.0 Economics*:

6.3 Payback Time: The only technology with a known payback time is beam dyeing, which has a payback time of about four months.

7.0 Cleaner Production Benefits: Substantially reduced fresh water consumption and reduced cost of effluent treatment plant.

8.0 Obstacles, Problems, and/or Known Constraints: None reported.

9.0 Date Case Study Was Performed: 1976

10.0 Contacts and Citation

10.1 Type of Source Material: Conference Proceedings

10.2 Citation: H. Asnes, "Reduction in Water Consumption in the Textile Industry," IFATCC Conference, London, 1978.

10.3 Level of Detail of Source Material: Unknown

10.4 Industry/Program Contact and Address: Unknown

10.5 Abstractor Name and Address: The information in this case study was derived from abstracts provided by the United Nations Environment Program (Paris). This abstract was prepared directly from the abstract without access to the conference proceedings cited. Mary L. Wolfe, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste type: Wastewater.

11.2 Process Type/Waste Source: Textile Mill Products, SIC 22

11.3 Waste Reduction Technique: Wastewater reduction, equipment modification

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Wastewater, Textile Mill Products, SIC 22, Wastewater Reduction, Equipment Modification

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Reduction of Sulfide in Effluent from Sulfur Black Dyeing Using Hydrol, a Maize Starch Industry By-Product

2.0 SIC/ISIC Code: 22XX, Textile Mill Products

3.0 Name and Location of Company:

Century Textiles and Industries Limited, Bombay, India

4.0 Clean Technology Category: This technique uses a by-product of the maize starch industry, hydrol, to reduce the sulfur dye to the affinity form for dyeing of fabric rather than the old method of using sodium sulfide. Experiments revealed that 100 parts of sodium sulfide could be substituted by 65 parts of the hydrol by-product and 25 parts of caustic soda. The dyeing produced a similar quality product to that produced using the sodium sulfide reducing agent. The sulfide concentration in plant effluent has gone from 30 ppm to less than 2 ppm.

5.0 Case Study Summary:

5.1 Process and Waste Information: Sulfur dyes are an important product, but they cause pollution problems due to the traditional reducing agents used with them. Sulphur dyes are water insoluble and must be converted into a water soluble (leuco) form before application to textile materials. The traditional method is treatment with an aqueous solution of sodium sulfide. Since the leuco compounds have an affinity for cellulosic fibers and are sensitive to atmospheric oxygen, they must be applied from the aqueous solution. After the dye has been absorbed on the fiber surface, the reduced form of the dye must be reconverted into the water insoluable form. Generally, this is carried out through exposure to air or by using a chemical oxidizing agent.

Black dye is an important member of the sulfur series due to its fastness in washing and light and its low cost as compared to other synthetic dyes. It is converted using the process described above. The facility encountered difficulties, however, when the State pollution control board established a 2 ppm maximum sulfide content for treated effluent from textile mills. Rather than attempt to reduce the sulfide in the effluent, the facility sought options to reduce or replace the sodium sulfide. During studies conducted by the facility, it was discovered that an alkaline solution of glucose can satisfactorily reduce the sulfur colors, enabling the facility to substitute the glucose solution for the sodium sulfide. Because the glucose solution prepared in the studies would be cost prohibitive, the facility sought an inexpensive source of glucose. This lead to the use of liquid glucose, a by-product of the starch industry.

The traditional reducing method is treatment with an aqueous solution of highly polluting sodium sulfide, causing an increase in the sulfide content of the plant's effluent. The new process eliminates sulfide usage and thereby reduces effluent pollution. The facility replaced 100 parts sodium sulfide (50%) with 61 parts liquid glucose (80% solids) and 26 parts caustic soda in its sulfur black color dye operations. The facility continued to have difficulties with this mixture because the thick glucose solution required special arrangements for emptying drums. The operation was still cost intensive.

The facility finally substituted an alkaline solution from sugar reduction for the sodium sulfide. A by-product containing 50% reducing sugars was technologically and financially feasible. The facility substitutes 100 parts sodium sulfide (50%) with 65 parts of the product (containing 50% reducing sugars) plus 25 parts caustic soda. Dye qualities were equivalent to the standard process for depth of shades, fastness, and other properties.

5.2 Scale of Operation: This technique is operated at a plant of unknown capacity.

5.3 Stage of Development: This process is fully implemented in the production process.

5.4 Level of Commercialization: The substitute materials are commercially available.

5.5 Material/Energy Balances and Substitutions: Not Identified.

6.0 Economics*

6.1 Investment Costs: No investment costs were involved in this substitution. The substitute chemical used was a waste stream from the maize starch industry, which saved Century Textiles about US$12,000 in capital expenses. The savings in not having to install wastewater treatment was about US$20,000 in capital expenses.

6.2 Operational and Maintenance Costs: Operating costs were found to be marginally lower. The saving in not having to install wastewater treatment was about US$3,000 in annual expenses. The savings in using the substitute chemical is about US$1,800 per year in operating expenses. Also, there has been a considerable but unquantified saving in money and convenience due to the reduction in handling and storage.

6.3 Payback Time: Not Identified.

7.0 Pollution Prevention Benefits

The advantages of the cleaner production include a reduction of sulfide in the wastewater (meeting the mandatory effluent level), improved settling characteristics in the secondary settling tank of the activated sludge unit, less corrosion in the treatment plant due to reduced sulfide levels, and the elimination of foul-smelling sulfide odors.

8.0 Obstacles, Problems, and/or Known Constraints

The substitution resulted in a slight increase in the biochemical oxygen demand (BOD) load, but the increase was not found to be critical and was easily managed with the existing biological treatment system.

The high cost of glucose was the main constraint in making the technology have practical applications. Further, the glucose solution required special handling when drums were emptied and solution replacement was cost intensive. These problems were resolved by the use of suitable by-products containing reducing sugars.

9.0 Date Case Study Was Performed: The process has been in use since April 1990.

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "Reduction of Sulphide in Effluent from Sulphur Black Dyeing," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: Mr R K Dalmia, Joint President (Works), Mr Mahesh Sharma, Manager (Chemical Technology), Century Textiles and Industries Ltd, Worli Bombay, India 400 025, Tel: +91 22 430 03 51

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Wastewater

11.2 Process Type/Waste Source: Fabric Dyeing, Black Sulfur Dyeing

11.3 Waste Reduction Techniques: Material Substitution

11.4 Other Keywords: Sodium Sulfide, Reducing Agents

11.5 Country Code:

12.0 Assumptions

None.

13.0 Peer Review

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wastewater, Fabric Dyeing, Black Sulfur Dyeing, Material Substitution, Sodium Sulfide, Reducing Agents

***** DOCNO: 400-086-A-315*****

HEADLINE:	Computer process control reduces tank bottom losses, improves pigment analysis. and reduces feedstock requirements as well as waste generation rate in textiles industry.
INDUSTRY/SIC CODE:	Spinning, Weaving and Finishing Textiles/ISIC 3211
POLLUTION PREVENTION OPTIONS SUMMARY:	This audit presents the advantages of introducing process control in the pigmentary printing of cloth. First the paste is prepared, then the cloth is printed, dried, and the printing is polymerized. Differences between the conventional and low-waste technologies are in the dressing of the paste. Computer control which is used in the low-pollution process reduces tank bottom losses, and improves the paste's analysis. The paste produced by the low-pollution process contains less white spirit and more water.
FEEDSTOCKS:	For 1,000 m^2 of cloth using low-pollution technique: 55 kg of white spirit 10 kg miscellaneous products 185 m^3 of water
WASTES:	Rejected washing water containing white spirit, white spirit fumes generated during the drying stage, and reusable tank sediments.
MEDIUM:	Aqueous, air, solids
COST:	
CAPITAL COST:	FF 3,730,000 (1980 figures) for an annual production of 2,300,000 m^2 of cloth.
OPERATION/MAINTENANCE:	FF 5.93 per 1,000 m^2 of cloth (1980 figures)
MONTHS TO RECOVER:	
SAVINGS:	
DISPOSAL & FEEDSTOCK:	FF 1.53 per 1,000 m^2 of cloth
FEEDSTOCK REDUCTION:	Difference between the conventional and low-pollution technique is 165 kg of white spirit per 1,000 m^2 of cloth.
WASTE PRODUCTION:	Low-pollution technique generates the following quantities of wastes per 1,000 m^2 of cloth: 7.5 kg of rejected washing water containing white spirit (against 57 kg), 50 kg of white spirit fumes discharged at drying stage (against 175 kg), and 28 kg of reuseable tank sediments (against 57 kg).
IMPACT:	The additional consumption of energy results from the analysis of the paste which contains more water and therefore takes longer to dry. 5.85 GJ for the low-pollution process against 4.60 GJ for the conventional process.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Pigmentary Printing of Cloth with Paste Containing Little White Spirit," Monograph ENV/WP.2/5/Add.86.
KEYWORDS:	Textiles, Wastewater, Pigments, ISIC 3211

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Water and energy conservation through installation of recovery systems in textile industries of Rajasthan, India.

2.0 SIC Code: 2200, Textile Mill Products

3.0 Name & Location of Company: Referred to as "Textile Mills" located in Rajasthan State, India

4.0 Clean Technology Category

Recycling, reuse and reclamation: This technology involves the installation of recovery systems to reduce wastewater in three textile mills.

5.0 Case Study Summary

5.1 Process and Waste Information: (1) In the first plant, a 13,300 pound "Kier" on steam with no water recovery was using approximately 700,000 gal water/day. A 5000 pound Kier was added and a recovery system was activated into a new hot water system under pressure. The plant restricted the water use by placing flow reducers into large lines. (2) In the second plant, 30-35 gallons of water were being used/pound of fabric dyed. Conservation measures of examining the process and restricting water use reduced the water use to 30 gal/pound of fabric dyed. (3) In the third plant, there was a reduction of approximately 800,000 gal/day of wastewaters by the addition of a cooling tower for recirculation of water.

5.2 Scale of Operation: Not reported

5.3 State of Development: Not reported

5.4 Level of Commercialization: Not reported

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Not reported

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits: Not reported

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date Case Study Was Performed: 1987

10.0 Contacts and Citation

10.1 Type of Source Material: Document

10.2 Citation: Document on Textile Processing Industries. Rajasthan State Board for Prevention and Control of Water Pollution. Jaipur, India. September 1983.

10.3 Level of Detail of the Source material: Additional information is available from this source document.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor Name and Address: UNEP Workgroup, Paris. Reformatted: Elizabeth J. Mooney, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Wastewater, rinse water

11.2 Process Type/Waste Source: Textile mill products, SIC 2200, textile mill production

11.3 Waste Reduction Technique: Process waste recovery

11.4 Other Keywords: Wastewater recovery

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Wastewater, Rinsewater, Textile Mill Products, SIC 2200, Textile Mill Production, Process Waste Recovery, Wastewater Recovery

**** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Reclamation of sewage effluent for process use in textile industry.

2.0 SIC Code: 2200, Textile Mill Products

3.0 Name & Location of Company: Referred to as "Textile Industry," located in Bhutan

4.0 Clean Technology Category

Recycling, reuse and reclamation and material/product substitution: This technology involves reclaiming sewage effluent for the use in textile mill production process.

5.0 Case Study Summary

5.1 Process and Waste Information: Recycled water from sewage effluent at a textile mill is used in the entire mill production.

The research on this project was carried out in two stages; (1) feasibility studies through laboratory and mill experiments and (2) with the conversion of the entire mill production to the use of recycled water from sewage effluents.

5.2 Scale of Operation: Not reported

5.3 State of Development: Not reported

5.4 Level of Commercialization: Not reported

5.5 Material/Energy Balances and Substitutions: Not reported

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: Not reported

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits: Not reported

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date Case Study Was Performed: 1980

10.0 Contacts and Citation

10.1 Type of Source Material: Journal

10.2 Citation: American Dyestuff Reporter, No. 1, 1980

10.3 Level of Detail of the Source material: Additional information is available from this source document.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor Name and Address: UNEP Workgroup, Paris. Reformated: Elizabeth J. Mooney, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Wastewater, sewage water

11.2 Process Type/Waste Source: Textile mills, SIC 2200, sewage effluent water

11.3 Waste Reduction Technique: Sewage effluent reuse, sewage effluent recycling, wastewater recovery

11.4 Other Keywords: Wastewater reduction, Bhutan, water conservation

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Wastewater, Sewage Water, Textile Mills, SIC 2200, Sewage Effluent Water, Sewage Effluent Reuse, Sewage Effluent Recycling, Wastewater Recovery, Wastewater Reduction, Bhutan, Water Conservation

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Water reuse in textile industries in Bombay, India.

2.0 SIC Code: 2200, Textile Mill Products

3.0 Name & Location of Company: Referred to as "Textile Mills Under Mill Owner's Association" located in Bombay, India

4.0 Clean Technology Category

Recycle, reuse and reclamation: This technology involved the use of the installation of wastewater recycling systems.

5.0 Case Study Summary

5.1 Process and Waste Information: An average water consumption estimate from 25 textile mills in Bombay, India was around 120-280 liters/kg of cloth.

Remodelling sewer systems to separate reusable wastewaters and direct them to a separate sumps of adequate size to balance inflows and outflows (approximately 10-15% of the volume of water to be reused). The reusable water will then be pumped and distributed by pipes to the point of direct water reuse.

5.2 Scale of Operation: Not reported

5.3 State of Development: Not reported

5.4 Level of Commercialization: Not reported

5.5 Material/Energy Balances and Substitutions:

6.0 Economics*

6.1-2 Investment Costs and Operational and Maintenance Costs: For one of the mills in the study, detailed cost breakup (1970 costs in U.S. $) for various degrees of water reuse was provided as follows:

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits: Not reported

8.0 Obstacles, Problems and/or Known Constraints: Not reported

9.0 Date Case Study Was Performed: 1969.

10.0 Contacts and Citation

10.1 Type of Source Material: Conference proceedings

10.2 Citation: Arceivala, S.J., Kapadia, J.R. and Wadekar, V.R. Economy and Reuse of Water in Textile Mills. All India Textile Conference. 1969. pp. E-9 to E-17.

10.3 Level of Detail of the Source material: Additional information is available from this source document.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor Name and Address: UNEP Workgroup, Paris. Reformatted: Elizabeth J. Mooney, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Wastewater, Rinse water

11.2 Process Type/Waste Source: Textile mill products, SIC 2200, Textile mill production

11.3 Waste Reduction Technique: Process water recovery

11.4 Other Keywords: Wastewater recovery

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Wastewater, Rinsewater, Textile Mill Products, SIC 2200, Textile Mill Production, Process Water Recovery, Wastewater Recovery

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Evaluation of three clean technologies for adoption in textile industries in Thailand.

2.0 SIC Code: (1) 7216, Dry Cleaning Plant Exc Rug; (2) 2269, Finishers of Textiles, NEC; (3) 2200, Textile Mill Products

3.0 Name & Location of Company: Referred to as "Textile mills" located in Bangkok, Thailand

4.0 Clean Technology Category

(1) Process/equipment modification: This technology involves the use of a dry cleaning machine which uses a refrigeration unit to cool the drying air to reduce the amount of solvent remaining at the end of the drying period. (2) Process/equipment modification: This technology involves the use of transfer printing. (3) Material/product substitution: This technology involves the use of hyperfiltration in textile mills.

5.0 Case Study Summary

5.1 Process and Waste Information:

(1) In a conventional dry cleaning machine, an activated carbon filter is used at the end of the drying period which evaporates the solvent (perchloroethylene) into the cleaning room air. A dry cleaning machine developed by BOWE of West Germany was evaluated. The BOWE machine uses a refrigeration unit to cool the drying air to the degree so that only a little amount of solvent remains at the end of the drying period.

(2) Transfer printing reduces the consumption and loss of dye materials.

(3) This technology implements the use of hyperfiltration plants reducing the pollutional load of chemicals.

5.2 Scale of Operation: Not reported

5.3 State of Development: Not reported

5.4 Level of Commercialization: Not reported

5.5 Material/Energy Balances and Substitutions: Not reported

6.0 Economics*

6.1 Investment Costs: Not reported

6.2 Operational and Maintenance Costs: (1) The operating cost of the BOWE machine was found to be 4 Bahts/load less than the conventional machine. The fixed costs of the BOWE machine was found to be higher by 5.68 Bahts/load. Operational and maintenance costs for the other two technologies is not provided. The economic calculations made for the BOWE dry cleaning machine assumed a load of 12 kg., working time of 8.5 hours/day and a cycle time of 30 minutes.

6.3 Payback Time: Not reported

7.0 Cleaner Production Benefits

Economic benefits: (1) The BOWE machine was found to be 1.58 Bahts/load costlier than the conventional dry cleaning machine, so no benefits. No details of economic benefits was provided for the two other technologies.

Regulatory compliance: (1) The emission of perchloroethylene are expected to be lower in the BOWE machine but no standards exist (as of 1985) in Thailand for perchloroethylene. No details of regulatory compliance was provided for the two other technologies.

8.0 Obstacles, Problems and/or Known Constraints

(1) The BOWE machine was found to be technically beneficial but not economical. The number and size of dry cleaning mills in Thailand are very small, lending little commercial opportunities.

(2) The transfer printing technology is restricted to certain types of synthetic fibers. The market share of transfer printing machines is less than 5% of the Thai textile industry, hence the impact of this technology on the Thai textile sector is expected to be low.

(3) While this option was considered to be economically attractive and relevant to the Thai textile industry, in-house technology support, especially with the design of and implementation of hyperfiltration plants, was considered weak and therefore wide spread acceptance of the technology is lacking. Also, the Thai weavers are resistant to change and keep the size formulations secret.

9.0 Date Case Study Was Performed: 1985

10.0 Contacts and Citation

10.1 Type of Source Material: Report

10.2 Citation: Clean Technologies for the Paper and Pulp Industry, the Textile Industry, and the Metal Coating and Finishing in Thailand. Report submitted by Thailand Development Research Institute Foundation to United Nations Environment Program. 1986.

10.3 Level of Detail of the Source material: Additional information is available from this source document.

10.4 Industry/Program Contact and Address: Not reported

10.5 Abstractor Name and Address: UNEP Workgroup, Paris. Reformatted: Elizabeth J. Mooney, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043.

11.0 Keywords

11.1 Waste Type: Perchloroethylene, wastewater, textile dyes

11.2 Process Type/Waste Source: Dry cleaning machines, SIC 7216, SIC 2269, finishers of textiles, NEC, SIC 2200, textile mill products, desizing effluent, dry clean air emissions

11.3 Waste Reduction Technique: Refrigeration of solvents, textile dye reduction, hyperfiltration process

11.4 Other Keywords: Wastewater reduction

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations, and other factors.

Keywords: Perchloroethylene, Wastewater, Textile Dyes, Dry Cleaning Machines, SIC 7216, SIC 2269, Finishers of Textiles, NEC, SIC 2200, Textile Mill Products, Desizing Effluent, Dry Clean Air Emissions, Refrigeration of Solvents, Textile Dye Reduction, Hyperfiltration Process, Wastewater Reduction

TIMBER PRODUCTS

***** DOCNO: 400-037-A-226 *****

HEADLINE:	Closed-circuit recycling of water reduces discharges.
INDUSTRY/SIC CODE:	Wood industry, manufacturing of wood objects, including furniture/ISIC 3311
NAME/CONTACT:	Ministere de l'Environnement et du Cadre de Vie Direction de la Prevention des Pollutions 14, Boulevard du General Leclerc 92521 Neuilly-sur-Seine Cedex, France
TECHNOLOGY DESCRIPTION:	In the low pollution technique, the water necessary for manufacturing circulates in a closed circuit and the fluid used to transport the fibers is itself the final effluent. Only a quantity of water exactly equal to the amount that evaporates during manufacturing is introduced into the closed circuit. The pollution discharged comes from the washing of the roof and floor by rainwater and losses of cooling water. There are 0.8 kg of oxidizable and suspended matter per ton, against 110 kg in the standard technique.
FEEDSTOCKS:	Wastewater
WASTES:	Not reported
MEDIUM:	Aqueous
COST:	Not reported
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	The low pollution technique is more efficient than a standard treatment solution and permits a greater technical adaptability in manufacturing, given the possibility of utilizing toxic products.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Recycling of Water in the Manufacturing of Wood Fiber Panels," Monograph ENV/WP.2/5/Add.37.
KEYWORDS:	Wood Fiber, Closed-Loop Water Recycle, ISIC 3311

TRANSPORTATION

***** DOCNO: 450-003-A-379*****

HEADLINE:	Automotive chassis manufacturer uses ultrafiltration system to recover large volumes of oily wastes and wastewaters.
INDUSTRY/SIC CODE:	Transportation Equipment/ISIC 32
NAME/CONTACT:	Budd Automotive Kitchener, Ontario
POLLUTION PREVENTION OPTIONS SUMMARY:	A manufacturer of automotive chassis, generates wastes that are heavy with oil, grease and solids from industrial washers and die-washing equipment, along with cutting fluids. An ultrafiltration (UF) system was purchased to recover the oil used in the press shop. The system breaks the oil-water emulsion so that a dilute oil solution can be recovered. The oil solution recovered from the UF unit is about 30-40% oil. An acid can be added to concentrate the solution to about 60-70% oil. Some of the recovered oil is reused in the plant, and some is sent to a company for rerefining. The remaining oil is mixed with lime to form a dried lime slurry which is disposed of at a landfill.
FEEDSTOCKS:	Wastes high in oil, grease, and solids
WASTES:	Unrecovered oil, dried lime slurry
MEDIUM:	Liquid
COST:	
CAPITAL COST:	$100,000
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	Less than 24
SAVINGS:	
DISPOSAL & FEEDSTOCK:	The washing system, consisting of four or five 8,000-gallon tanks, are now emptied and refilled with fresh water every 6-12 months instead of every 3-6 weeks.
FEEDSTOCK REDUCTION:	Waste requirements are reduced.
WASTE PRODUCTION:	Oily waste generation is reduced.
IMPACT:	Large volumes of oily wastes and washwaters are now being recovered instead of requiring disposal. The system greatly reduces oil raw material costs, water, and disposal costs.
CITATION:	"Catalogue of Successful Hazardous Waste Reduction/Recycling Projects," Energy Pathways Inc. and Pollution Probe Foundation, prepared for Industrial Programs Branch, Conservation & Protection Environment Canada, March, 1987, page 94.
KEYWORDS:	Automotive, Ultrafiltration, Oily Waste, Recovery, ISIC 32

MISCELLANEOUS

***** DOCNO: 400-004-A-195 *****

HEADLINE:	Oil-fired heating systems retrofitted conserve energy and reduce emissions.
INDUSTRY/SIC CODE:	Oil-fired Furnaces/SIC 3433
NAME/CONTACT:	Canadian Combustion Research Laboratory, Energy Research Laboratory, CANMET, Department of Energy, Mines, and Resources, Ottawa, Ontario / Mr. R. Breaton
TECHNOLOGY DESCRIPTION:	Retrofitting oil-fired heating systems with special air mixing tube, positive damper control, fuel shut-off valve to improve energy efficiency and to reduce emissions. The changes to a conventional oil-burning furnace are: (1) Replace air mixing tube (2) Install smaller nozzle (3) Solenoid shut-off valve in fuel line (4) Positive damper in stack (5) Interlocking wiring Benefits range from 15-20% fuel cost reduction.
FEEDSTOCKS:	Oil
WASTES:	Emissions of CO, particulates, and hydrocarbons
MEDIUM:	Not reported
COST:	(1979 Canadian Dollars)
CAPITAL COST:	$400
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	36 to 84
SAVINGS:	
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	20%
WASTE PRODUCTION:	9% reduction in SO_2 and NO_2
IMPACT:	Reduces fuel consumption and waste emissions
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Retrofitting Oil Fired Furnaces," Monograph ENV/WP.2/5/Add.4.
KEYWORDS:	Residential Heating, Heating Oil, SIC 3433

***** DOCNO: 400-007-A-198 ***** <x>

HEADLINE:	Waste heat distillation recovers heat from cooling waters.
INDUSTRY/SIC CODE:	Sea Water Desalination, Nuclear Power Generation/ISIC 4200
NAME/CONTACT:	Nord-Aqua Oy, Vuorimiehenpuistikko 4D, 00140 Helsinki 14, Finland.
TECHNOLOGY DESCRIPTION:	The company uses low temperature waste heat distillation as a means of heat recovery. Nuclear power plant cooling water discharges may be used. A water stream containing waste heat is partially evaporated in vacuum and the vapor is condensed to fresh water in heat exchange with colder cooling water. The vacuum is created by barometric columns and air is pumped out of the vacuum by means of water flows. A temperature difference of 7 degrees Centigrade between the warm and cold water streams is an economical minimum requirement for the process.
FEEDSTOCKS:	Not reported
WASTES:	No waste, no chemicals
MEDIUM:	Not reported
COST:	(1979 Dollars)
CAPITAL COST:	$1,842,000
OPERATION/MAINTENANCE:	$1,503/ton
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	None
IMPACT:	Local thermal pollution of power plants can be reduced by using larger cooling water flow rates. The risk of radioactive pollution of water is reduced, if all cooling water of a nuclear power plant condenser is used for waste heat desalination.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Nord-Aqua Low Temperature Waste Heat Desalination", Monograph ENV/WP.2/5/Add.7.
KEYWORDS:	Waste Heat, Desalination, Heat Recovery, Nuclear Power, ISIC 4200

***** DOCNO: 400-090-A-257*****

HEADLINE:	Energy savings and pollution reduction result from supplementing gas supply with evaporated solvents.
INDUSTRY/SIC CODE:	Printing, Publishing and Allied Industries/ISIC 3420
TECHNOLOGY DESCRIPTION:	The process demonstrates the savings achievable by an over-all review of the energy consumed in the manufacturing of adhesive tapes. Modifications involve a change from indirect steam heating to direct gas firing, improved air circulation and web transport in the oven, and supplementing the gas supply with incinerated evaporated solvents. Three ovens are used in the process. Solvents from one are returned to the burner which supplies drying energy for all three ovens. Two of the ovens incorporate heat wheels to preheat make-air.
FEEDSTOCKS:	Natural gas (22 GJ/ton product)
WASTES:	Solvent vapors
MEDIUM:	Gaseous
COST:	
CAPITAL COST:	421,000 British Pounds
OPERATION/MAINTENANCE:	Not reported
MONTHS TO RECOVER:	32
SAVINGS:	
DISPOSAL & FEEDSTOCK:	151,000 British Pounds
FEEDSTOCK REDUCTION:	6.5 - 10.2 (23-35%) GJ energy/ton of product
WASTE PRODUCTION:	360 ton/year solvent vapors
IMPACT:	Since current technology consists of emitting the solvent to the atmosphere or burning the solvent in the exhaust air, pollution and fuel requirements are reduced. Energy savings are realized by a more efficient drying system which uses direct gas firing rather than steam heated drying. Air circulation is also improved in the ovens.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Energy Saving and Pollution Prevention In Adhesive Tape Ovens Using Gas-fired Solvent Incinerators and Waste Heat Recovery", Monograph ENV/WP.2/5/Add90.
KEYWORDS:	Paper, Energy Review, Solvent Recovery, ISIC 3420

***** DOCNO: 400-102-A-263 ***** <x>

HEADLINE: Use of a side stream separator improves particulate collection efficiency and reduces energy needs.

INDUSTRY/SIC CODE: Electricity, Gas and Steam/ISIC 41

TECHNOLOGY DESCRIPTION: The process controls coal-fired boiler particulate emissions through the use of side stream separator technology. This technology can provide a highly cost-effective means of reducing particulate emissions below levels currently obtainable with conventional high efficiency mechanical collectors. A portion (side stream) of the combustion gas is drawn off at the point in which the gas stream reverses through a bag filter. This system has demonstrated an improvement in the over-all efficiency of emissions control for 15 boilers by an average of 55 per cent. The particulate emissions levels have been reduced from 0.29 lb/MMBtu to 0.13 lb/MMBtu. In addition, the collection efficiency of finer particulates increased to approximately 90 percent from 66 per cent. All of this was done at substantially less cost than a conventional control system.

FEEDSTOCKS:

WASTES: Gaseous and particulate emissions from coal-fired boilers.

MEDIUM: Gaseous

COST:
CAPITAL COST: $700,000
OPERATION/MAINTENANCE: Not reported
MONTHS TO RECOVER: Not reported

SAVINGS:
DISPOSAL & FEEDSTOCK: Not reported
FEEDSTOCK REDUCTION: Not reported
WASTE PRODUCTION: Not reported

IMPACT: The side-stream separator system utilizes 60 per cent less energy than operation of a full bag filter. The compact design and size of the system allows for retrofitting of existing installations without major modifications.

CITATION/PAGE: Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Side Stream Separator Control of Particulate Missions", Monograph ENV/WP.2/5/Add102.

KEYWORDS: Particulate Emissions, ISIC 41, Pollution Control, Coal-Fired, Boilers

CASE STUDIES FOR THE REUSE AND RECYCLING OF POST-CONSUMER WASTES

***** DOCNO: 400-002-A-193 *****

HEADLINE:	Recycling of mixed plastic wastes by plastification into granules for extrusion or injection molding.
INDUSTRY/SIC CODE:	Recovery of Mixed Waste Plastics, Manufacture of Plastic Items - Unclassified Elsewhere/ISIC 3560
NAME/CONTACT:	Fabrique Nationale de Herstal, Industrial Equipment and Service Division, B 4400 Herstal (Liege), Belgium
TECHNOLOGY DESCRIPTION:	This company performs plastification of mixed plastics into granules for use in traditional extrusion or injection molding. After collection of industrial plastic waste or after an automatic unit extracts plastic from household garbage, this process reduces mixed plastic waste to reusable plastic granules. The process proposed by F.N. Herstal S.A. at present covers the industrial recycling of mixed polymer fractions. The process is concerned primarily with urban plastic waste from household garbage. However, it is also concerned with industrial plastic waste which has not as yet been evaluated. The essential feature of the F.N.-CRIF homogenization process is the short time in the molten state, coupled with intense mixing on a plastification disc. This process is available on a turnkey basis.
FEEDSTOCKS:	Mixed plastic waste primarily from urban household garbage.
WASTES:	None.
MEDIUM:	Plastic
COST:	Not reported
CAPITAL COST:	Not reported
OPERATION/MAINTENANCE	Not reported
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	Reduces the disposed waste to none.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Recovery of Mixed Plastic Waste Products," Monograph ENV/WP.2/5/Add.2.
KEYWORDS:	Plastic, Mixed Plastic Waste Recovery, ISIC 3560, F.N.-CRIF Process

***** DOCNO: 400-082-A-253*****

HEADLINE:	Pyrolysis of used tires provides disposal alternative and generates energy.
INDUSTRY/SIC CODE:	Manufacture of Chemical Products, NEC/ISIC 3529
TECHNOLOGY DESCRIPTION:	The Foster Wheeler pyrolysis technology is a process in which used, shredded tires are heated in absence of air to produce a light fuel oil, solid fuel, and high grade steel. Hot gases (600°C), containing no oxygen, are passed through the bed of tires causing pyrolysis to occur. Oil in the vapor phase is condensed and collected in the quench column. Remaining gases either fuel the process or are recycled through the reactor. Solid products are continuously removed from the reactor.
FEEDSTOCKS:	Tires up to 1.75 meters. 32% steel content. 4.577 GJ/ton energy required per ton.
WASTES:	Light oil, solid fuel, steel, carbonaceous char
MEDIUM:	Liquid and solid wastes
COST:	
CAPITAL COST:	6.65 million Pounds Sterling
OPERATION/MAINTENANCE:	1.655 million Pounds Sterling in first year
MONTHS TO RECOVER:	Return on investment of up to 35% based on 10 year operational life.
SAVINGS:	
DISPOSAL & FEEDSTOCK:	Cost of landfill, incineration, or reclaiming of used tires.
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Presenting disposal alternative for approximately 65% of 3,000,000 metric tons/year of used tires.
IMPACT:	This technology addresses the problem of disposing of the 3,000,000 metric tons/year of used tires estimated to be generated in the U.K. 20-25% are retreaded, 15-20% have alternate end uses, while up to 65% present an immediate disposal problem. The products of this pyrolysis process are readily distributable energy sources for which markets exist. Possibility exists to apply the technology to a variety of feeds ranging from plastics to urban wastes.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Foster Wheeler Power Products Limited Pyrolysis Technology for Energy from Used Tires", Monograph ENV/WP.2/5/Add82.
KEYWORDS:	Tires, Energy Recovery, Waste Recovery, Pyrolysis, SIC 3529

***** DOCNO: 400-001-A-192 *****

HEADLINE:	Quarry waste and waste glass is used in mineral products.
INDUSTRY/SIC CODE:	Manufacture of Non-Metallic Molded Mineral Products Unclassified Elsewhere/ISIC 3699
NAME/CONTACT:	Mineral Products, Ave. du Bois 31, 4920 Embourg, Belgium. National Institute of Extractive Industries (UNIEX), rue du Chera Zoo, 400 Liege, Belgium
TECHNOLOGY DESCRIPTION:	This company crushes quarry waste or glass for recycling, produces pulp by mixing polyester resin with the charge, and places the pulp in ambient temperature molds. After vibration, the shaped elements are taken out of the mold. Material and energy requirements per ton of product manufactured include: 1) 850 kg of mineral charges, 2) 130 kg of polyester resin, 3) 20 kg of various materials, 4) 3 GJ of energy. The resulting waste is nil and is comprised of any dust and styrene emanations.
FEEDSTOCKS:	Quarry waste and recycling glass
WASTES:	None
MEDIUM:	Solid
COST:	
CAPITAL COST:	$ 1,666,667
OPERATION/MAINTENANCE:	$ 432,000
MONTHS TO RECOVER:	Not reported
SAVINGS:	Not reported
DIRECT COST:	Not reported
FEEDSTOCK REDUCTION:	Not reported
WASTE PRODUCTION:	Not reported
IMPACT:	Waste dumped in the environment is reduced to none.
CITATION/PAGE:	Compendium on Low and Non-waste Technology, United Nations Economic and Social Counsel, "Use of Quarry Wastes or Waste Glass", Monograph ENV/WP.2/5/Add.1.
KEYWORDS:	Waste Glass, Quarry Waste, ISIC 3699, Molded Products

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: De-inking Process for Waste Paper Using Air Flotation Cells

2.0 SIC/ISIC Code: 26XX

3.0 Name and Location of Company:

St Regis Paper Co Ltd, United Kingdom

4.0 Clean Technology Category: Initially, the waste paper is pulped to breakdown and detach the ink from the paper. This pulping is conducted at a relatively low temperature with a low energy output. De-inking is carried out using a flotation cell using air, caustic soda (pH control), soap (foaming agent), sodium silicate and hydrogen peroxide (brighteners and cleaners). No chlorine bleach is used. Chemical usage is low and as the technology is further refined, additional reductions are anticipated. Foam from the process is removed and centrifuged to around 50 percent solids for landfill disposal. The de-inked stock is diluted and screened to remove small solids and then sent to a drum thickener.

The secondary de-inking process follows dewatering and kneading of the pulp. The secondary process relies on carry over, rather than the addition, of chemicals.

The de-inking process allows a wider range of available waste paper to be converted to high quality printing paper. Water is recycled and reused, and eventually passes on to the wastewater treatment plant. Quality reprise paper containing 80 percent recycled fibers is possible.

5.0 Case Study Summary:

5.1 Process and Waste Information: Use of waste paper for recycled paper has often been criticized because of the poor quality of the reprise paper. In the technology described here, a two stage de-inking process is used to remove ink and dirt from the waste paper prior to being processed into a feedstock suitable to make new paper.

5.2 Scale of Operation: Not Provided.

5.3 Stage of Development: The process is fully implemented.

5.4 Level of Commercialization: The availability of the process is not discussed.

5.5 Material/Energy Balances and Substitutions: Not Discussed.

6.0 Economics*

6.1 Investment Costs: Not Provided.

6.2 Operational and Maintenance Costs: Not Provided.

6.3 Payback Time: Not Provided.

7.0 Pollution Prevention Benefits

The benefits of this process include allowing the use of a wider range of printed waste paper, the amount of dirt in the finished paper is reduced thereby improving quality and reducing the amount of reject paper,

the brightness of the finished paper is improved without the use of chlorine bleach, the energy requirements are low, the demands on effluent and waste disposal are minimal, and the plant is safe to operate giving minimum risk to personnel and the environment.

8.0 Obstacles, Problems, and/or Known Constraints

None Identified.

9.0 Date Case Study Was Performed: The booklet, on which the de-inking process was implemented, was produced in 1993.

10.0 Contacts and Citation:

10.1 Type of Source Material: Booklet Article.

10.2 Citation: Cleaner Production Worldwide, United Nations Environmental Programme, produced by Robert Flain, Clean Technology Coordinator for DoE, "De-inking Process for Waste Paper," 1993.

10.3 Level of Detail of the Source Material: Very little detail on cost and waste information was available in the source document.

10.4 Industry/Program Contact and Address: Mr Harry Cyprus, St Regis Paper Co Ltd, Silverton Mill, Hele, Exeter, Devon, EX5 4PX, Tel: +44 392 881601

10.5 Abstractor Name and Address: Jack Faulk, Science Applications International Corporation, 7600A Leesburg Pike, Falls Church, Virginia, 22043

11.0 Keywords:

11.1 Waste Type: Waste paper

11.2 Process Type/Waste Source: Paper de-inking

11.3 Waste Reduction Techniques: Process modification

11.4 Other Keywords:

11.5 Country Code:

12.0 Assumptions

None identified.

13.0 Peer Review: Mary Waldron, Science Applications International Corporation, 7600-A Leesburg Pike, Falls Church, Virginia 22043

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Waste paper, Paper de-inking, Process modification

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Enzymatic wastepaper modification

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Genencor International Europe Ltd, SF-02460 Kantvik, Finland.

4.0 Cleaner Technology Category

Higher proportion of lower-quality waste paper can be used in papermaking. This possibility is particularly timely given the current emphasis on higher recycling levels.

5.0 Case Study Summary

5.1 Process and Waste Information: In practical terms, enzymes, such as the commercial product Liftase A 40 (a blend of cellulases and hemicellulases), are pumped into the stock chest ahead of the headbox at an addition rate of 0.5-2.0 l/dry ton pulp. Indicative conditions are a reaction time of 20-120 min when enzymes are added to stock at 2.0-4.0 % consistency having a temperature of 40-60°C and a pH value of 4.0-7.0.

While the mechanisms of the reactions are not known, it is thought that the enzymes improve drainage by attacking and removing colloids in the pulp slurry.

Laboratory work has also achieved better drainage from nonwood fiber pulps.

5.2 Scale of Operation: Mill scale application.

5.3 Stage of Development: Fully implemented.

5.4 Level of Commercialization: The equipment and enzyme needed are commercially available.

5.5 Material/Energy Balances and Substitutions:

Material Category	QTY Before	QTY After
Waste Generation:	positive effect*	
Feedstock Use:		
Water Use:	positive effect*	
Energy Use:	positive effect*	

* The actual situation varies strongly case by case.

6.0 Economics*

6.1 Investment Costs: Nearly zero.

6.2 Operational and Maintenance Costs: Maintenance cost is nearly zero. Operational cost depends on the amount of Liftase A 40 needed to get desired effect.

6.3 Payback Time: Short, but varies strongly case by case.

7.0 Cleaner Production Benefits

The basic effect of Liftase A40 treatment is improved drainage. This means for example possibilities to use higher levels of low-quality waste paper because there is more room for using mechanical action (refining) and/or headbox dilution for improving paper properties.

8.0 Obstacles, Problems and/or Known Constraints

9.0 Date Case Study Was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Journal articles.

10.2 Citation: (1) Grant, R., Biotechnology's potential is growing, PPI, May 1990, pp. 118-119; (2) Grant, R., First mill-scale trials get underway, PPI, June 1991, pp. 61-63; (3) Pommier, J-C., Fuentes, J-L. and Goma, G., Using enzymes to improve the process and the product quality in the recycled paper industry, Tappi Journal, June 1989, pp. 187-191; (4) Pommier, J-C., Goma, G., Fuentes, J-L. and Rousset, C., Using enzymes to improve the process and the product quality in the recycled paper industry, Part 2: Industrial applications, Tappi Journal, December 1990, pp. 197-202

10.3 Level of Detail of the Source Material: Additional information is available on request.

10.4 Industry/Program Contact and Address: Olli Jokinen, Product Manager, Pulp & Paper Enzymes, Genencor International, SF-02460 Kantvik, Finland, phone: +358 0 297 4660, fax: +358 0 298 2203, telex: 121076 supo sf

10.5 Abstractor Name and Address: Olli Jokinen, Product Manager, Pulp & Paper Enzymes, Genencor International, SF-02460 Kantvik, Finland, phone: +358 0 297 4660, fax: +358 0 298 2203, telex: 121076 supo sf

11.0 Keywords

11.1 Waste type: Wastepaper

11.2 Process type/waste source: Paper production

11.3 Cleaner Production Technique: Enzymatic wastepaper upgrading

11.4 Other Keywords: Liftase A40, Drainage

11.5 Country Code: Finland.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Wastepaper, Paper production, Enzymatic wastepaper upgrading, Liftase A40, Drainage

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: The PAN TERRE plant

Recycled mixed paper panels are produced in the Pan Terre plant. The panels are 100 percent organic products made of equal parts of mixed post-consumer paper and a vegetable fiber.

2.0 SIC/ISIC Code: I3419

3.0 Name and Location of Company:

Pan Terre, Belgium.

4.0 Cleaner Technology Category

The public pressure for increased paper recycling continues to rise. With growing concern over the greenhouse effect and deforestation worldwide, every effort to leave trees uncut and instead reuse wastepaper is an excellent investment for the global future.

The paper panels show many benefits - energy savings, environmental clean-up, reduced pressure on scarce fuel and forest reserves, and a sounder economic footing for industry by reducing its dependence on costly virgin resources imported from afar.

5.0 Case Study Summary

5.1 Process and Waste Information: Pan Terre panels are 100 percent organic products made of roughly equal parts of mixed post-consumer paper and a vegetable fiber. Though wheat straw is used in Belgium, rice husks, peanut shells, coffee bean hulls, bagasse and other similar materials, preferably ones that are locally available, may be used as substitutes. Paper mill sludge also performed well in this application, and offers the potential to manufacture heavier, stronger boards. The typical recipe for the paper fraction is 80 % newspaper, 10 % magazines and 10 % corrugated and boxboard grades.

Depending on intended end-use applications, other Pan Terre ingredients include an organic fire retardant, 100 percent recycled cardboard surface-coats on some product lines, and an organic glue for surface-coating.

The loose paper and straw drawn from the silo are weighed and manually batch-fed into a two-stage hydropulping system, where the paper fibers break down and blend with the straw into a paste.

The material is not deinked, and process water is continuously treated so that there is no effluent discharge.

The liquid paste, containing a high proportion of water, is conveyed to the preformer; at this stage tramp metals are captured by a filter. The preformer operates like a hydraulic press. The preformer achieves a uniform panel thickness and squeezes out about 30 % of the water without compressing the fibers, thereby preserving the acoustical and heat-insulating properties of the panels.

From the preformer the pulp slabs are fed to the drying oven. The boards are dried by hot air blown on both surfaces for even drying. The only water loss in the process occurs here through evaporation. Using a heat exchanger, this steam is captured to heat the plant in winter.

Boards intended for surface-coating continue to a sanding machine for the surfaces to be smoothed; dust from this step is recycled to the hydropulper.

The panels continue to the finishing station, where they are surface coated, pressed and trimmed. The trimmings are captured and returned to the pulper.

Pan Terre is unique for its acoustical and thermal insulating properties. As an acoustical material,it has consistently performed above European standards for sound abatement. Pan terre has twice the thermal insulating action of rock wool.

5.2 Scale of Operation: The Belgian plant consists of one line rated to consume 2,850 metric tons per year of mixed waste paper and 3,400 metric tons of wheat straw. The plant produced about 100,000 panels in its first year, operating at 60 % of production capacity.

Plant designs for the U.S. will be of at least two production lines at this size. Larger installations are also available.

5.3 Stage of Development: The Pan Terre process is fully implemented.

5.4 Level of Commercialization: The Pan Terre technology has first been realized as a pilot project in Belgium in 1986. The Belgian industrial scale facility completed its first full operation year in 1989. Now the technology is available at industrial scale for licensing in the U.S.

5.5 Material/Energy Balances and Substitutions:

Material Category	QTY Before	QTY After
Waste Generation:	N/A	no waste
Feedstock Use:	2,850 t waste paper/y	3,400 t wheat straw/y
Water Use:	N/A	N/A
Energy Use:	N/A	188 MJ nat.gas/pound

6.0 Economics*

6.1 Investment Costs:

6.2 Operational and Maintenance Costs:

6.3 Payback Time:

7.0 Cleaner Production Benefits

The Pan Terre process is best described as intermediate or appropriate technology. The process hinges on a natural reaction in the mixture of pulped paper and vegetable fibers, causing them to bind together without the need of glue. Also, Terre developers resolved to design the technology so that it would yield an all-natural product, and produce no process waste or pollution. They created a panel free of asbestos, formaldehyde, blowing agents like chlorofluorocarbons, synthetic adhesives, urea, and other chemicals or ingredients that could affect the environment or people. The production system avoids deinking and

resulting effluents, and reuses all process water and scrap materials. The panels themselves are 100 % recyclable.

8.0 Obstacles, Problems and/or Known Constraints

Certain contaminants, for instance self-sticking labels, poly-coated or plastic-coated paper, as in frozen food packages or milk cartons, and treated facsimile and carbon papers should be held to a minimum. During pulping, these materials can interfere with binding of the fibers, and in kiln drying, plastics will melt.

Also, removal of metal staples and paper clips is desirable to improve board dimensions and avoid sparks during sanding.

9.0 Date Case Study Was Performed: The research work began in 1981. In 1983, Terre designed and implemented a pilot scale production plant. In 1986 Terre was awarded a grant toward the costs of scaling up the pilot plant to industrial level production. The new facility completed its first full operation year in 1989.

10.0 Contacts and Citation

10.1 Type of Source Material: Journal article.

10.2 Citation: Brewer, G., Quiet, cozy and green: recycled mixed paper panels, Resource Recycling, January 1991, pp. 62-69

10.3 Level of Detail of the Source Material: More information on process background and product properties as well as applications is available in the source material.

10.4 Industry/Program Contact and Address: Mrs Virve Tulenheimo, MSc, Research Engineer, Technical Research Centre of Finland, Non-Waste Technology Research Unit, P.O.Box 205, SF-02151 Espoo, Finland, Telephone +358 0 4561, Telefax +358 0 460 493, Telex 122972 vttha sf

10.5 Abstractor Name and Address: Same as in 10.4.

11.0 Keywords

11.1 Waste type: Waste paper

11.2 Process type/waste source: Paper mill

11.3 Cleaner Production Technique: Recycled paper panels

11.4 Other Keywords: Insulating panels, Acoustic panels

11.5 Country Code: Belgium, USA.

12.0 Assumptions

13.0 Peer Review

Yes.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Waste paper, Paper mill, Recycled paper panels, Insulating panels, Acoustic panels

***** DOCNO: DOCUMENT NOT AVAILABLE *****

1.0 Headline: Recycling cement sack papers

Recycling cement sack papers into products with higher aggregate value. Desaggregation and cleaning cement sack paper in water and bleaching it with peroxide.

2.0 SIC/ISIC Code: I3411

3.0 Name and Location of Company:

Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

4.0 Cleaner Technology Category

Recycling papers into products with higher added value, such as sanitary paper.

5.0 Case Study Summary

5.1 Process and Waste Information:

Process Area: Paper recycling.

Base Process: Used cement sacks are torn into small pieces and fed into a hydropulper for disintegration and separation of dirt. The pulp formed with the desaggregated paper passes through a vibratory or a pressurized screw.

The screened fibres, with a consistency of 10-12 %, are fed into a screw where they are mixed with part of the chemicals (NaOH, EDTA, sodium silicate), going then to an other screw, where a charge of hydrogen peroxide is applied.

It is necessary to perform some laboratory scale trials to determinate the appropriate charge of chemicals that should be applied to the specific cement sack paper fibres. The brightness level obtained depends on the conditions and the charge of chemicals applied to the fibres.

Depending on the kind of furnish used in the manufacture of the sack papers, it is possible that after cleaning, the suspension of fibres shows coloured fibres. This kind of dirt can only be separated from others with more complex and expensive methods of pulp cleaning, such as flotation and deinking. These methods should be used because it is practically impossible to discolour such kind of fibres by using peroxide only.

New Waste Stream: This method allows to recycle cement sack papers, but forms a slurry resulting of the residual cement washed from the paper.

Raw Materials: Used cement sack papers, without any plastic coating or paint.

Energy Usage: Not yet computed.

Process Changes: The use of peroxide is suggested instead of chlorine in the stage of pulp bleaching.

Operating Procedures: The main operating procedure, described above is commonly used in the industry of paper recycling. The only difference is that the furnish usually consists of cement sack papers. These papers generally use fibres with a high content of residual lignin. This makes it necessary to perform laboratory trials to adjust the condition of the peroxide bleaching.

5.2 Scale of Operation: A full-scale recycling mill has an annual output of 30-50 ADMT/day.

5.3 Stage of Development: Partly bench and partly pilot scale.

5.4 Level of Commercialization: The fundamentals of the technology are ready for use; some adjustment is necessary for commercialization.

5.5 Material/Energy Balances and Substitutions:

Material Category	QTY Before	QTY After
Waste Generation:	N/A	N/A
Feedstock Use:	N/A	N/A
Water Use:	N/A	N/A
Energy Use:	N/A	N/A

6.0 Economics*

6.1 Investment Costs: Detailed economic figures have not been prepared, but the necessary equipment is the same used in the regular mills for recycling papers.

6.2 Operational and Maintenance Costs: Depend on the case and situation.

6.3 Payback Time: Not available.

7.0 Cleaner Production Benefits

This alternative process allows to use recycled cement sack paper bleached pulp in the production of papers of good quality.

8.0 Obstacles, Problems and/or Known Constraints

The technical constraints appear mainly if the furnish presents coloured fibres or plastic cover; or if the price of chemicals is too high.

9.0 Date Case Study Was Performed:

10.0 Contacts and Citation

10.1 Type of Source Material: Personal contact, unpublished material.

10.2 Citation: Training report of Heli A. Sorsa for J.M. Neves: Bleaching with peroxide of secondary fibres of cement sacks. IPT Internal Report, 1989.

10.3 Level of Detail of the Source Material: Fairly well detailed.

10.4 Industry/Program Contact and Address: Dr. Jose Mangolini Neves, Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

10.5 Abstractor Name and Address: Dr. Jose Mangolini Neves, Instituto de Pesquisas Technologicas do Estado de Sao Paulo S.A. - IPT, DPFTC - Agrupamento Celulose e Papel, P.O.Box 7141, 01064-970-Sao Paulo SP-Brasil, phone: 55 11 2682211, fax: 55 11 8693353, telex: 11 83144 INPT BR.

11.0 Keywords

11.1 Waste type: Slurry of residual used cement

11.2 Process type/waste source: Recycling of paper/cement sack paper

11.3 Cleaner Production Technique: Alternative recycling of cement sack papers

11.4 Other Keywords: Sanitary papers

11.5 Country Code: Brasil.

12.0 Assumptions

13.0 Peer Review

No.

(*) - Disclaimer: Economic data will vary due to economic climate, varying governmental regulations and other factors.

Keywords: Slurry of residual used cement, Recycling of paper/cement sack paper, Alternative recycling of cement sack papers, Sanitary papers

APPENDIX A

THE INTERNATIONAL CLEANER PRODUCTION CLEARINGHOUSE AND THE POLLUTION PREVENTION INFORMATION CLEARINGHOUSE

The International Cleaner Production Information Clearinghouse and The Pollution Prevention Information Clearinghouse

The International Cleaner Production Information Clearinghouse (ICPIC) and the Pollution Prevention Information Clearinghouse (PPIC) are dedicated to reducing or eliminating industrial pollutants through technology transfer, education, and public awareness. The Clearinghouses contain technical, policy, programmatic, legislative, and financial information concerning source reduction and recycling efforts in the United States and abroad. They are free, nonregulatory services of the UNEP-IE/PAC and the U.S. EPA and are accessible by personal computer, telephone hotline, or mail.

UNEP-IE/PAC Cleaner Production Programme

The Cleaner Production Programme was established by the United Nations Environment Programme(UNEP) Industry and Environment Programme Activity Centre (IE/PAC) in response to a decision from the UNEP Governing Council on the need to reduce global industrial pollution and waste. The Programme, which encompasses five elements (publications, training, working group, technical assistance services, and ICPIC), was established with four objectives:

- To increase worldwide awareness of the cleaner production concept
- To help governments and industry develop cleaner production programs
- To foster the adoption of cleaner production technologies
- To facilitate the transfer of cleaner production technologies.

To meet these objectives, the Programme focuses on the collection and dissemination of information on industrial operations conducted using concepts and technologies that prevent or reduce the generation of pollutants and wastes.

ICPIC

ICPIC is a computerized information exchange system developed through a cooperative agreement between UNEP and the United States Environmental Protection Agency (U.S. EPA) to provide information to the international community. It is patterned after its sister system, the U.S. EPA's Pollution Prevention Information Exchange System (PIES) with which nightly file and message exchanges occur. Both systems contain information that explains and illustrates production using techniques that conserve raw materials and energy, that eliminate the use of toxic raw materials, and that reduce the quantity and toxicity of emissions and wastes from manufacturing operations.

Specifically, ICPIC contains:

- A **Message Centre** allowing communication with other users on all subjects, including questions and answers to technical questions
- **Bulletins** containing the latest news and announcements in the international clean technology community
- An **On-line Repository** affording electronic orders of hardcopy documents
- A **Calendar of Events** listing upcoming national and international conferences, training seminars, and workshops
- A **Case Study Data Base** of technical and programmatic case studies highlighting various industries, the wastes involved, economic incentives, and cost recovery time periods
- An **On-line Bibliography** with hundreds of clean technology document abstracts and information for ordering
- A **Directory of Contacts** representing an automated version of UNEP's Cleaner Production Directory providing a list of the names, affiliations, addresses and phone numbers of international technical experts and government representatives.
- Access to **PIES** and to the **U.S. EPA's Pollution Prevention Information Clearinghouse (PPIC)** through a topical conference system. Operating just like the main system, the PIES conference includes a message center, bulletins, and the data bases contained in the PIES as well as access to the other avenues of information exchanges available through the PPIC

ICPIC has representation from over 40 countries. It contains 1,151 cleaner production abstracts and 652 industrial case studies for an extensive list of different industries. It also affords access to 160 cleaner technology professionals through its directory of contacts.

Accessing ICPIC

Regular Phone Line

PSN

The ICPIC computer system can be accessed 24 hours a day by using a personal computer or a dumb terminal equipped with a modem (1200 or 2400 baud) and appropriate communications software. With these equipment, the computer system may be contacted in one of three ways: (1) by direct dialing of the system through a public telephone system, (2) by using the data Packet Switching Network (PSN), "SprintNet," which is connected directly to ICPIC, or (3) by using any other PSN that can access SprintNet. If you are calling from outside France, SprintNet may be the least costly way to access ICPIC. For more information or to find out the number of the PSN in your area, contact:

SprintNet France:

Mr. Paul Henric
Sprint International France S.A.
Mini-Parc du Verger
1, rue Terre Neuve
91967 Les Ulis Cedex B.
France
Tel: 33-1-64-46-23-24
Fax: 33-1-64-46-45-38

U.S. SprintNet:

Mr. Art MacDowell (commercial)
Data Division
U.S. Sprint
8229 Boone Boulevard
Suite 500A
Vienna, Virginia 22182
United States
Tel: 19-1-703-827-7238(direct)
19-1-703-827-0221
Fax: 19-1-703-827-7251

To access the system by dialing directly or via a PSN, set the communications software to 8 data bits, no parity, and 1 stop bit, then dial either the ICPIC telephone number (33-1-45-79-40-59), the SprintNet access number, or the appropriate PSN access number. Once in ICPIC, all functions are easily performed using abbreviated commands (e.g., **B** to look at a **B**ulletin, **R** to **R**ead a message, etc.).

Hotline or Mail

Information in ICPIC can also be accessed by those without a computer, modem or the appropriate communications software by contacting UNEP at the address and telephone number provided below.

Additional Information

A users guide for ICPIC is available by contacting UNEP at the address listed below. Information, questions and comments on ICPIC should be directed to:

United Nations Environment Programme
Industry and Environment Programme Activity Center
Tour Mirabeau
39-43 quai Andre' Citroen
75739 Paris CEDEX 15
France
Telephone: 33-1-44-37-14-50
Facsimile: 33-1-44-37-14-74
Telex: 204 997F
Cable: UNITERRA PARIS

PPIC

The U.S. EPA's PPIC is a national and international communications network targetting multi-media source reduction and recycling opportunities and affording information exchange through four means:

- **Repository** representing a hard copy reference library containing the most current pollution prevention information including case studies, fact sheets, programmatic and legislative information, and training materials
- The **Pollution Prevention Information Exchange System (PIES)**, a 24-hour electronic network consisting of message centers, technical data bases, issue-specific "mini-exchanges" (including ICPIC), and a calendar of events devoted exclusively to pollution prevention
- **Hotlines** providing toll-free telephone services to answer or direct questions and to link users without access to computer equipment to PIES
- **Outreach Efforts** including workshops and information packets containing industry-specific materials on pollution prevention opportunities.

Accessing PPIC

Regular Phone Line

Users with a personal computer or a dumb terminal equipped with a modem and the appropriate communications software may access PPIC by setting the communications software to 8 data bits, no parity, 1 stop bit and by calling (703) 506-1025. A toll-free number has been established for authorized Federal, State, and local government users. Such users should contact the PPIC Technical Support Hotline (listed below) to see if they qualify for use of this number.

Hotline

Individuals without access to computer equipment may obtain information from PIES and PPIC by contacting the hotline and technical support numbers provided below:

RCRA/Superfund Hotline:	(800) 424-9346
Small Business Ombudsman (SBO) Hotline:	(800) 368-5888
EPA Clearinghouse Hotline:	(202) 260-1023
EPA PIES Project Manager:	(202) 260-3161
PIES Technical Support Hotline:	(703) 821-4800
ICPIC Technical Support Hotline:	(33) 1-45-79-40-59

Mail Information may also be obtained by mailing a request to the following address:

Pollution Prevention Information Clearinghouse
U.S. Environmental Protection Agency (PM-211A)
401 M Street, SW
Washington, DC 20460

Telenet Telenet is a private data network service. If you already subscribe to this service, dial your local Telenet access number. At the @ prompt, type: c 20256131 to access the PIES. If you would like to receive information about how to subscribe to Telenet, contact the PPIC. Note: Telenet is not affiliated with the U.S. EPA or the PPIC.

Other U.S. Data Services If you have access to one of the U.S. private data services that has a gateway to Telenet, you can connect to the PIES. These data systems are: BinNet, Western Union, SNET, Bell Atlantic, Bell South, Ameritech, NYNEX, Pacific Bell, Southwestern Bell, U.S. West, and Cincinnati Bell. Follow the local access procedures established by your data network to connect to anouther network. At their prompt, type: 311020256131 to access the PIES.

Overseas Data Service Provider If you are a user outside North America, you must access a data service in your country that has a gateway to Telenet (contact the PPIC for a complete list of participating networks). Follow the local access procedures established by your data network to connect to another network. At their prompt, type: 311020256131 to access the PIES.

Additional Information

A PIES user guide is available and may be obtained free-of-charge either by leaving a message on the system addressed to "Sysop," by writing the above address, or by calling one of the hotlines.

OzonAction Information Clearinghouse

Through ICPIC, it is also possible to access the OzonAction Information Clearinghouse (OAIC) which provides technical, programmatic, and policy options for phasing out the use of Ozone Depleting Substances (ODS) controlled under the Montreal Protocol. As a provision of the 1987 Montreal Protocol, UNEP was charged with the establishment and management of an international clearinghouse for reduction alternatives to the use of chlorofluorocarbon (CFC) and halon families. The primary CFC/halon source ares addressed by the OAIC include:

- Aerosols, sterilants, miscellaneous uses, and carbon tetrachloride
- Foams
- Halons
- Methyl bromide*
- Refrigeration, air conditioning, and heat pumps
- Solvents, coatings and adhesives.

EPA and PPIC are working closely with UNEP to develop and maintain this system. The clearinghouse provides ICPIC and PPIC users with information on ODS international experts, country phase out programs, ODS technology alternatives, UNEP technical option reports, international publications on ODS alternatives, chemical properties data bases, and industry case studies. The clearinghouse is specifically designed for Article 5 country users but may be accessed by others in developed or developing areas worldwide to exchange information. UNEP strongly encourages the submission of any information about the reduction and/or elimination of ODS in industrial applications. UNEP may be contacted at the address provided above.

* Although methyl bromide is not currently controlled under the Montreal Protocol, information on this chemical is being collected by the OAIC due to increased interest is this substance.

APPENDIX B

CASE STUDY FORMAT GUIDELINES

Guidelines for Case Study Submissions to PIES

The PPIC is constantly in search of new information describing how companies or organizations successfully prevent pollution generation. This information is useful to others who are faced with similar waste generation problems, but who need more practical information about technology, method, or cost options. The PPIC has helped design a case study format to make this information available to its users in a concise, yet useful manner. By sharing this case information with each other, PIES users contribute to the improvement of our common environment.

If you have case studies that describe useful pollution prevention technologies, methods, or approaches, please consider submitting them to PIES' case study data base. The guidelines in this appendix are intended to assist abstractors in preparing case studies with the format required for the PIES system—please follow them closely.

Once the PPIC has received your submissions, the case studies will undergo engineering/technical reviews, quality assurance checks, and style/format review. This review process will be conducted by a combination of the following organizations:

PPIC
ICPIC
UNEP Cleaner Production Industry Working Groups
American Institute for Pollution Prevention (AIPP)
Illinois Hazardous Waste Resource Information Center (HWRIC)

During the review process, you may be contacted by members of the review teams to supply additional/missing information or to clarify statements.

You may submit potential case studies by uploading a text file to the PIES (See "PIES File Transfer" section) or by transmitting them to the PPIC by mail or facsimile.

PPIC
c/o SAIC
7600-A Leesburg Pike
Falls Church, Virginia 22043

Telephone: (703) 821-4800
Fax: (703) 821-4775

Case Study Format Guidelines

1.0 Headline: A short attention-getting phrase or sentence highlighting the significance of the case study. The headline should include industry or process, waste type, waste volume/toxicity reduction, and pollution prevention techniques. Describe quantitatively the problem that was solved.

2.0 SIC Code and/or ISIC Code: Four-digit Standard Industrial Classification code(s) that best describe the industry segment(s) referenced by the case study. Employ the highest level of specificity (i.e., use three- or two- digit SIC/ISIC codes if information does not allow more detailed identification). Use as many SIC/ISIC codes as are relevant to the subject study; however, the primary SIC/ISIC code should always be the first code listed. Precede all International SIC codes with "I" (e.g., I2261).

3.0 Name and Location of Company: The name and location of the facility that implemented the case study. Include address if possible (street, city, state or province, country, and postal code).

4.0 Pollution Prevention Category: A brief description of the principle(s) behind the pollution prevention technology referenced in the case study, such as:

- Periodic assessments
- Process/equipment modification
- Recycling, reuse, and reclamation
- Material/product substitution
- Training and supervision
- Housekeeping
- Production planning and sequencing
- Waste segregation and separation.

5.0 Case Study Summary: Summarize information, to the level of detail provided in the case study, in the following areas:

5.1 Process and Waste Information: A description of the relevant original manufacturing process or area of the plant to which the pollution prevention technique applies, physical state of the target waste streams (solid, liquid, gas, or sludges), changes in the process resulting from the pollution prevention technique, and a description of any positive or negative effects on the wastes, products, or production rate after implementing the new technology. Include any changes in:

- Products or production rates resulting from the application
- New or existing waste stream generation and composition
- New or existing raw materials and consumption rates
- Energy usage
- Operating procedures.

5.2 Scale of Operation: A description of the size of the process or operation. If possible, include quantitative information on the amount of product being produced or manufactured and the amount of waste being generated.

5.3 Stage of Development: A one-line description of the stage of development the pollution prevention technique was in at the time of the case study (e.g., planning stage, bench test, pilot state, or fully implemented). Indicate whether quantitative figures are estimated or based on actual production.

5.4 Level of Commercialization: An indication of whether the technology or process was commercially available at the time of the case study. Indicate whether or not the equipment and/or materials were readily available, or if they were specifically designed for this application.

5.5 **Material/Energy Balances and Substitutions (optional):** A tabulation of quantitative changes in material generation and use prior to and resulting from the pollution prevention technique. Include in the following table information for each waste stream or product, and designate "N/A" when information is not available (provide units of measurement for all numerical data):

Material Category	Qty. Before	Qty. After
Waste Generation:		
Feedstock Use:		
Waster Use:		
Energy:		

6.0 **Economics[1]:** A summary of the costs and savings reported in the case study. Include dates and currencies for all economic data reported.

6.1 **Investment Costs:** A summary of all capital costs and a detailed description of the purchased item(s) or service. Include any specifications (i.e., number, size, capacity, etc.) for each item used.

6.2 **Operational and Maintenance Costs:** Changes in operational and maintenance costs (per month or year) and changes in personnel or hours required.

6.3 **Payback Time:** The approximate payback period for the particular pollution prevention technology used in the case study (total investment/net/ savings/year).

7.0 **Pollution Prevention Benefits:** A detailed discussion of the benefits resulting from the pollution prevention technique, including, but not limited to:

- Economic benefits (include source of savings, e.g., reduced feedstock)
- Improved public relations
- Changes in regulatory compliance.

Indicate, if possible, what factors were the driving force behind implementing the technique.

8.0 Obstacles, Problems, and/or Known Constraints (optional): A description of the technical constraints that could prevent implementation of the technology (e.g., physical, chemical, or biological limits of a manufacturing or treatment process). Discuss any regulatory barriers in implementing the technology and indicate what other problems were encountered during implementation of the technology.

9.0 Date Case Study Was Performed: The actual data the pollution prevention measures were initiated.

10.0 Contacts and Citation

10.1 Type of Source Material: The type of source material abstracted:

- Book or chapter
- Journal or journal article
- Organizational report
- Conference proceedings
- Unpublished material
- Other (specify).

10.2 Citation: Citation for the document abstracted, including: author(s); title of book, journal article, or proceedings; volume; number; and month and year of publication (see the *Chicago Manual of Style* for appropriate formats). In addition, if the document is available through NTIS, enter the NTIS number.

10.3 Level of Detail of the Source Material: An indication of whether or not additional detail is available in the source document for this case study (applicable only for documents that are publicly available). Indicate what additional information is available (e.g., process, waste, etc.).

10.4 Industry/Program Contact and Address: The name, address, and phone number of the person who can be reached for further information concerning the case study. Authorization must be given by the contact prior to including their name in this field.

10.5 Abstractor Name and Address: The name, organization, and address of the person preparing the case study abstract.

11.0 Keywords: Descriptive keywords selected from the ICPIC keyword list[2] for each of the following categories:

11.1 Waste Type: The conventional waste(s) that is/are acted on by the pollution prevention option, not the waste(s) generated after implementing the pollution prevention techniques.

11.2 Process Type/Waste Source: The original industrial process(es) or sources of the waste(s) that is/are modified by the pollution prevention technique.

11.3 Waste Reduction Techniques: The techniques that were implemented at the facility and are principally responsible for reducing waste generation.

11.4 Other Keywords: Other keywords, as appropriate, that accurately describe the case study and assist users in locating this abstract, including:

- Environmental media (air, water, soil)
- Product names
- Feedstocks
- Special incentives
- Geographical/institutional keywords (Italy, Ruhr Valley, USDA, etc.).

Use as many keywords as are necessary to accurately describe the case study in each category. If ideal key-

words are not found in the keyword list, please add new ones to the list.

12.0 Assumptions: A listing of any assumptions used when abstracting. Reference the sections of the abstract that relied upon the assumption. Any discrepancies encountered in the source document should also be presented.

13.0 Peer Review: An indication of whether or not the source document has gone through a technical peer review process. Indicate: Yes, No, or Unknown.

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[1] Disclaimer: economic data will vary due to economic climate, varying governmental regulations, and other factors.

[2] A list of keywords can be obtained by contacting the PPIC or leaving a message to the PIES SYSOP.

Note: Samples of completed case studies are available for guidance in developing your own case study. To receive samples, contact the PPIC.

APPENDIX C

FOREIGN CURRENCY EXCHANGE RATES

FOREIGN CURRENCY EXCHANGE RATES
AS OF JUNE 30, 1992

FOREIGN CURRENCY RATES (Highlighted currencies are associated with case studies located in the compendium)		
COUNTRY	*CURRENCY NAME*	*CURRENCY TO $1.00*
Afghanistan	afghani	55.00
Algeria	dinar	22.04
Angola	kwanza	29.92
Antigua	dollar	2.700
Argentina	peso	.9890
Australia	dollar	1.317
Austria	schilling	11.48
Azores	Portuguese escudo	134.9
Bahamas	dollar	1.000
Bahrain	dinar	.3769
Bangladesh	taka	38.91
Barbados	dollar	2.040
Belgium	franc	33.55
Bolivia	boliviano	3.840
Botswana	pula	2.132
Brazil	cruzeiro	2910.0
Brunei	dollar	1.612
Bulgaria	lev	22.70
Burkina Faso	CFA franc	274.0
Burma	kyat	6.119
Burundi	franc	203.8
Cameroon	CFA franc	274.0
Canada	dollar	1.202
Cape Verde	escudo	67.53
Central African Rep.	CFA franc	274.0
Chad	CFA franc	274.0

FOREIGN CURRENCY RATES (Highlighted currencies are associated with case studies located in the compendium)		
COUNTRY	*CURRENCY NAME*	*CURRENCY TO $1.00*
Chile	peso	660.6
China	yuan	5.480
Columbia	peso	660.6
Congo	CFA franc	274.0
Costa Rica	colon	129.7
Cuba	peso	.7402
Cyprus	pound	.4589
Czechoslovakia	koruna	28.47
Czechoslovakia	tuzex koruna	8.400
Denmark	krone	6.283
Djibouti	franc	176.8
Dominican Rep.	peso	12.79
Ecuador	sucre	1471.00
Egypt	pound	3.333
El Salvador	colon	8.190
Equatorial Guinea	CFA franc	274.0
Estonia	ruble	104.0
Ethiopia	birr	2.054
Fiji Islands	dollar	1.489
Finland	markka	4.423
France	franc	5.480
Gabon	CFA franc	274.0
Gambia	dalasi	8.650
Germany	mark	1.631
Ghana	cedi	410.0
Greece	drachma	193.5
Grenada	dollar	2.700
Guatemala	quetzal	4.990

FOREIGN CURRENCY RATES (Highlighted currencies are associated with case studies located in the compendium)		
COUNTRY	*CURRENCY NAME*	*CURRENCY TO $1.00*
Guinea	franc	922.0
Guinea-Bissau	peso	6232.0
Guyana	dollar	123.0
Haiti	gourde	9.660
Honduras	lempira	5.480
Hong Kong	dollar	7.738
Hungary	forint	78.80
Iceland	krona	57.82
India	rupee	28.94
Indonesia	rupiah	2027.0
Iran	rial	71.00
Iraq	dinar	.3100
Ireland	pound	.6099
Israel	shekel	2.414
Italy	lira	1228.0
Ivory Coast	CFA franc	274.0
Jamaica	dollar	28.90
Japan	yen	129.6
Jordan	dinar	.6780
Kenya	shilling	40.00
Khmer Rep.	riel	1650.0
Korea	won	784.0
Kuwait	dinar	.2908
Laos	kip	715.0
Lebanon	pound	1630.0
Lesotho	South African rand	2.851
Liberia	dollar	1.000
Luxembourg	franc	33.55

FOREIGN CURRENCY RATES (Highlighted currencies are associated with case studies located in the compendium)		
COUNTRY	*CURRENCY NAME*	*CURRENCY TO $1.00*
Madagascar	franc	1938.0
Malawi	kwacha	3.168
Malaysia	ringgit	2.523
Mali	CFA franc	274.0
Malta	pound	.3165
Martinique	French franc	5.480
Mauritania	ouguiya	78.40
Mauritius	rupee	15.65
Mexico	peso	3096.0
Mongolia	tugrik	40.00
Morocco	dirham	8.599
Mozambique	metical	2345.0
Nepal	rupee	47.57
Netherlands	guilder	1.836
Netherlands Antilles	guilder	1.780
New Zealand	dollar	1.867
Nicaragua	cordoba oro	5.050
Niger	CFA franc	274.0
Nigeria	naira	19.20
Norway	krone	6.353
Oman	rial	.3849
Pakistan	rupee	25.08
Panama	balboa	1.000
Papua New Guinea	kina	.9630
Paraguay	guarani	1445.0
Peru	inti	1.130
Philippines	peso	26.70
Poland	zloty	13790.0

FOREIGN CURRENCY RATES (Highlighted currencies are associated with case studies located in the compendium)		
COUNTRY	*CURRENCY NAME*	*CURRENCY TO $1.00*
Portugal	escudo	134.9
Qatar	riyal	3.639
Romania	leu	371.0
Rwanda	franc	121.3
Saudi Arabia	riyal	3.750
Senegal	CFA franc	274.0
Seychelles	rupee	5.150
Sierra Leone	leone	510.0
Singapore	dollar	1.631
Solomon Islands	dollar	2.865
Somalia	shilling	3812.0
South Africa	rand	2.851
Spain	peseta	101.7
Sri Lanka	rupee	43.28
Sudan	pound	94.05
Surinam	guilder	1.770
Swaziland	emalangeni	2.851
Sweden	krona	5.866
Switzerland	franc	1.487
Syria	pound	11.20
Taiwan	dollar	24.93
Tanzania	shilling	298.5
Thailand	baht	25.47
Togo	CFA franc	274.0
Tonga	pa'anga	1.319
Trinidad & Tobago	dollar	4.244
Tunisia	dinar	.8887
Turkey	lira	6772.0

FOREIGN CURRENCY RATES (Highlighted currencies are associated with case studies located in the compendium)		
COUNTRY	*CURRENCY NAME*	*CURRENCY TO $1.00*
Uganda	shilling	1138.0
USSR[1]	ruble	1.671
United Arab Emirates	dirham	3.673
United Kingdom	pound sterling	.5541
Uruguay	new peso	2941.0
Venezuela	bolivar	65.57
Vietnam	pisatre	755.0
Western Samoa	tala	2.422
Yemen	rial	12.00
Yugoslavia	dinar	1211.00
Zaire	zaire	185000.00
Zambia	kwacha	145.4
Zimbabwe	dollar	5.158

1. The USSR is now known as the CIS (Commonwealth of Independent States). Currently, the ruble is the basic monetary unit of each individual republic within the CIS.

APPENDIX D

COMMON CHEMICAL ELEMENTS AND SYMBOLS

COMMON CHEMICAL ELEMENTS AND SYMBOLS

Element	Symbol	Element	Symbol
Aluminum	Al	Lead	Pb
Antimony	Sb	Lithium	Li
Arsenic	As	Magnesium	Mg
Barium	Ba	Manganese	Mn
Beryllium	Be	Mercury	Hg
Bismuth	Bi	Molybdenum	Mo
Boron	B	Nickel	Ni
Bromine	Br	Nitrogen	N
Cadmium	Cd	Oxygen	O
Calcium	Ca	Phosphorus	P
Carbon	C	Potassium	K
Chlorine	Cl	Selenium	Se
Chromium	Cr	Silicon	Si
Cobalt	Co	Silver	Ag
Copper	Cu	Sodium	Na
Fluorine	F	Sulfur	S
Gold	Au	Tin	Sn
Helium	He	Titanium	Ti
Hydrogen	H	Tungsten	W
Iodine	I	Zinc	Zn
Iron	Fe		

APPENDIX E

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BIBLIOGRAPHY

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