EPA

ENVIRONMENTAL REVIEW of SYNTHETIC FUELS

INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY

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INTRODUCTION

In response to the shift in the U.S. energy supply priorities from natural gas and oil to coal, the Environmental Protection Agency (EPA) has initiated a comprehensive assessment program. The program is evaluating the environmental impacts of synthetic fuel processes with a high potential for commercial application. It is directed by the Fuel Process Branch of EPA's Industrial Environmental Research Laboratory in Research Triangle Park, NC (IERL-RTP).

The primary objectives of the EPA Synthetic Fuels Environmental Assessment/Control Technology Development Program are 1) to define the environmental and health effects of multimedia discharge streams, and 2) to define control technology needs for an environmentally sound synthetic fuels industry. The synthetic fuels from coal technologies being studied in this program include low/medium-Btu gasification, high-Btu gasification, and liquefaction. To achieve the program's overall objectives, the EPA has defined six major task areas: current process technology background, environmental data acquisition, current environmental background, environmental objectives development, control technology assessment, and technology and/or commercial development. The contractors involved in the program, their EPA Project Officers, and the duration of each effort are tabulated on page 7.

This is the latest in a series of periodic reviews of recent activities in EPA's synthetic fuels program. Activities of EPA contractors are covered in sections on current process technology background, environmental data acquisition, and control technology assessment. Highlights of major symposia, a calendar of upcoming meetings, and a list of major publications provide up-to-date information on national and international development in synthetic fuels technology. Comments or suggestions which will improve the content or format of these reviews are welcome. Such comments should be directed to the EPA or Radian Corporation personnel identified on page 16 of this Review.

CURRENT PROCESS TECHNOLOGY BACKGROUND

General Topics

Environmental Assessment Data Base Reports—In late 1978, TRW, Inc., completed an environmental assessment data base report for high-Btu coal gasification technology. Reports for low/medium-Btu gasification and liquefaction technology have been compiled by Radian Corporation and Hittman Associates, respectively. The data base reports complete a major step in the EPA synthetic fuels program.

Each report is a comprehensive compilation and analysis of data currently available for coal conversion technology. The reports present technical and environmental data for various process and pollution control technologies and identify data gaps. The titles and report numbers are:

- Environmental Assessment Data Base For High-Btu Gasification Technology: Volumes I, II, III. Report EPA-600/7-78-186a, b, and c. NTIS No. PB 288 602, 3, and 4.
- Environmental Assessment Data Base For Low/Medium-Btu Gasification Technology: Volumes I, II. Report EPA-600/7-77-125a and b. NTIS No. PB 274 844 and 3.
- Environmental Assessment Data Base For Coal Liquefaction Technology: Volume I. Systems for 14 Liquefaction Processes; Volume II. Synthoil, H-Coal, and Exxon Donor Solvent Processes. Report EPA-600/7-78-184a and b. NTIS No. PB 287 799 and 800.

Liquefaction

Air Quality Impacts of SRC Versus Coal—A recent report by Hittman Associates, Inc., compares the impact on ambient air quality when burning Solvent Refined Coal (SRC) and coal. The report, "Air Quality Impacts Using SRC Versus Conventional Coal In Power Plants" (EPA-600/7-78-203), concludes that substituting SRC for conventional coal in steam-electric power plants would significantly reduce ambient SO_2 and particulate concentrations.

The three plants selected for the study were: TVA's Kingsville Plant (1700 MW) in eastern Tennessee; Penn Electric's Shawville Plant (640 MW) in western Pennsylvania; and Penn Electric's Seward Plant (268 MW) in western Pennsylvania. National Ambient Air Quality Standards (NAAQS) are exceeded in these areas when these

plants burn conventional coal.

Ambient air pollutant concentrations from burning both SRC and conventional coal were estimated using the EPA CRSTER Gaussian plume model. Data from a SRC test burn at Georgia Power's Plant Mitchell were used to calculate the particulate and SO_2 emission rates used in the model.

The results of the ambient air modeling indicate that switching from conventional coal to SRC would reduce the predicted ambient SO_2 levels around the three plants by 60 to 72 percent. Predicted annual mean particulate concentrations would be reduced to essentially background levels. Abnormally high oxygen levels during the SRC test burn at Plant Mitchell prevented reliable estimation of NO_x concentrations.

Solvent Refined Coal (SRC) Systems—Hittman Associates, Inc., is preparing an Environmental Assessment Report (EAR) on SRC systems. (For a general description of EAR's, see the ***Environmental Review of Synthetic Fuels,*** Volume 2, Number 1). Preliminary results indicate that SRC facilities can use existing control technologies to comply with existing and proposed regulatory requirements. However, solid waste discharges may be a potential source of adverse environmental impact. Water can be conserved using zero discharge wastewater treatment methods but at costs higher than those associated with conventional wastewater treatment methods.

Coal Liquids for Industrial Boilers—Hittman Associates, Inc., has assessed the production of coal derived liquids and their use as fuels for small industrial boilers. The results from this work, in addition to assessments performed by other contractors, will be used by EPA to develop standards for industrial boilers.

Of the commercial and developing liquefaction processes evaluated, the SRC-I, SRC-II, Exxon Donor Solvent, and H-Coal processes were identified as offering the best prospects for near term use. The evaluation focused on environmental impacts (especially those associated with SO_x, NO_x, and particulate emissions), energy impacts, and economics for both liquefaction facilities and coal liquid-fired industrial boilers.

ENVIRONMENTAL DATA ACQUISITION

General Topics

Laboratory Gasifier Pollutants—Research Triangle Institute (RTI) recently completed the second year of research on a semi-batch, fixed-bed, laboratory gasifier. During this past year more than 30 tests were completed using 8 different kinds of char, coal, lignite, and peat as gasifier feed. Over 400 pollutants were analyzed from the gasifier streams and more than 100 of these pollutants have been quantified for several test cases.

The semi-batch reactor produces a raw gas product closely simulating that of proposed and operating processes. The reactor can accommodate broad variations in operating conditions. Temperatures may range from 790°C to 1034°C (1454°F to 1893°F), and carbon can be converted at 50-100 percent. The reactor can also handle variations in oxygen/coal ratios (zero/0.9) steam/oxygen ratios (0.9/zero) and steam partial pressure/total pressure ratios (0.25/0.96 at gas inlet).

Major pollutants in the gas stream are benzene, hydrogen sulfide, and other sulfur species. When the product gas is an emission stream, carbon monoxide is also considered a pollutant. Eliminating these pollutants from consideration reduces the gas stream hazard factor by 4 to 5 orders of magnitude to a value of around 1. (Potential hazard factors are calculated as the pollutant concentration in a stream divided by that pollutant's minimum acute toxicity effluent (MATE) value. The potential hazard factors for the pollutants are added to determine the overall stream hazard factor.)

Although phenols and cresols are major potential pollutant hazards in the by-product tar stream, their elimination would lower the tar hazard factor to only about 10^3. The remaining fused aromatic hydrocarbons (such as phenanthrene, chrysene, and 9-methylanthracene) account for a significant portion of the tar potential hazard factor.

Aqueous condensate from the new product gas is primarily contaminated by phenols and ammonia. Removal of these pollutants reduces the potential hazard factor in the condensate to approximately 10.

Pollutant levels, especially of trace constituents, were suprisingly consistent when testing with different coals and under varied operating conditions. Micrograms of pollutant produced per gram of carbon converted in the reactor usually varied by less than 1 order of magnitude.

Analysis of the gasifier pollutants is continuing. Coal gasification process fractions under study include crude tar, tar fractions (polar neutral, non-polar neutral, polynuclear aromatics, tar-acids, and tar-bases), and extracted volatiles.

Various crude tar fractions have been evaluated in bioassay studies (Ames Tests) for acute and synergistic effects of pollutant mixtures. Bacterial strains of ***Salmonella typhimurium*** are being used to identify potential mutagens and carcinogens. The histidine-requiring mutant strains indicate both simple DNA base pair substitution and frame shift mutation. (This latter mutation is usually a measure of more significant genetic alteration.)

Low/Medium-Btu Gasification

Testing at Overseas Gasifier—The EPA is sponsoring an environmental data acquisition program in cooperation with the government of Yugoslavia. Radian Corporation is the contractor. This program focuses on a medium-Btu Lurgi gasification facility located in the Kosovo region of Yugoslavia. The main objective of the program is to gather information which will help the EPA define environmental controls needed for U.S. gasification plants.

The Kosovo test program is divided into two phases. The Phase I tests were completed during November 1978. Approximately 40 of the plant's most significant emission streams were screened. As part of this effort, stream flows were determined and analyses were performed to identify the major components present.

Future (Phase II) tests at Kosovo will involve the sampling/analysis of a more select group of about 20 streams. The work will focus on detailed characterizations of trace and minor component emissions, including trace metals and organics.

An overall summary of the Kosovo test program, including presentation of the results obtained to date, was given at the fourth symposium on "Environmental Aspects of Fuel Conversion Technology." Sponsored by the EPA's Industrial Environmental Research Laboratory (RTP), this symposium was held April 17-20, 1979, in Hollywood, Florida.

Source Test and Evaluation Program—Another ongoing Radian test program involves a Wellman-Galusha gasifier which produces low-Btu gas for an iron ore pelletizing operation. The gasifier and pelletizer are being operated by the U.S. Bureau of Mines (BOM)

and a consortium of steel companies on the BOM's property at Ft. Snelling, Minnesota.

Continuous monitoring data (fixed gases, light hydrocarbons, and sulfur species) will be collected for both product gases and combustion gases. Original plans included tests on four types of coal: bituminous, semi-bituminous, subbituminous, and lignite. However, since the BOM has postponed the subbituminous coal tests until the spring of 1979, the subbituminous coal sampling effort is not included in the current test plan.

Samples of all major process and waste streams were obtained in December during the lignite test. Inorganic, organic, and biological analyses of these samples will be conducted through July.

Environmental Assessment of Commercial Gasification Facility—In connection with a third Radian test program, the final report, "Environmental Assessment: Source Test and Evaluation Report—Chapman Low-Btu gasification," EPA-600/7-78-202, has recently been released. The report is available through NTIS (PB 289 940). It describes the first major environmental assessment sampling program completed as part of the EPA's Synthetic Fuels Environmental Assessment/Control Technology Development Program. The objectives of this study were to:

- Characterize the waste streams and potential fugitive emission and effluent streams from a commercial Chapman low-Btu gasification facility.
- Evaluate the applicability of Level 1 sampling and analytical methodology to such a characterization.
- Evaluate the particulate removal efficiency of the product gas cyclone.

Level 1 methodologies required some modification to meet the program objectives but all objectives were met. Results from the chemical and bioassay testing indicate that all waste and process streams examined contain potentially harmful organic and/or inorganic materials. Such materials in the coal feeder vent gases included polycyclic aromatic hydrocarbons (PAH's), CO, and chromium. Potentially harmful species detected in the separator vent gases included PAH's, amines, CO, NH_3, C_2-hydrocarbons, heterocyclic nitrogen compounds, chromium, vanadium, and silver. A variety of trace elements occurred at potentially harmful levels (the specific valence state or compound is not known) in the gasifier ash and cyclone dust. These elements included beryllium, phosphorus, iron, calcium, aluminum, lithium, barium, selenium, lead, copper, titanium, cadmium, antimony, vanadium, cobalt, uranium, and cesium. About 60 percent particulate removal was obtained in the product gas cyclone.

High-Btu Gasification

Preparation for Testing—TRW, Inc., has been making arrangements to conduct sampling and analysis at selected facilities in support of high-Btu gasification. Two potential test sites are a Koppers-Totzek (K-T) plant and a Lurgi plant. In January, TRW and Krupp-Koppers held final pre-test discussions concerning the division of sampling and analytical responsibilities, costing, and logistics involved in sampling the foreign K-T plant. TRW, on behalf of EPA, DOE, and NIOSH, has contacted the German Democratic Republic for access to their energy complex at Schwarze Pumpe.

Liquefaction

Site-Specific Pollutant Evaluation—Hittman Associates, Inc., has completed a study of the potential pollutants associated with the operation of a commercial size Solvent Refined Coal (SRC) plant. The report, "SRC Site-Specific Pollutant Evaluation" (EPA-600/7-78-223a and b), details the possible environmental effects of waste streams from a proposed SRC plant in White County, Illinois. The commercial size facility would use 28,123 Mg (31,000 tons) of Illinois No. 6 coal per day. The objectives of the study were to (1) evaluate the pollutants identified in the Standards of Practice Manual for the SRC Liquefaction Process (EPA-600/7-78-091); (2) estimate potentially adverse effects from operating the proposed SRC facility; and (3) provide background information for the SRC Environmental Assessment Report (EAR).

The SRC system uses a non-catalytic direct-hydrogenation liquefaction process. It converts high sulfur and ash coal into clean-burning gaseous, liquid, or solid fuels. There are two variations, SRC-I, which produces a solid coal-like product of less than 1 percent sulfur and 0.2 percent ash, and SRC-II, which produces a low-sulfur (0.2-0.5 percent) fuel oil and naphtha product. Both produce gaseous hydrocarbons which are further processed to substitute natural gas and liquefied petroleum gas. By-products recovered from the hydrogenation reaction include sulfur, ammonia, and phenol.

The estimated SRC pollutants were evaluated using multimedia environmental goals (MEG's) and the Source Analysis Model (SAM/IA). (The SAM/IA procedure is explained in Volume 1, Number 3 of the ***Environmental Review of Synthetic Fuels.***) The MEG's were determined using Minimum Acute Toxicity Effluent (MATE) values.

Results from the SAM/IA analysis of the hypothetical SRC facility suggest that: (1) the most important gaseous emissions appear to be carbon dioxide and carbon monoxide; (2) the most important effluents appear to contain aluminum, copper, zinc, nickel, and several organic compounds; and (3) the most toxic general category of waste streams will be the solid wastes. However, these findings should be used with caution until more definitive data are obtained from a comprehensive pilot plant program and an operational demonstration plant.

There is also a detailed discussion of the influence of environmental forces that decrease, increase, or neutralize the adverse effects of pollutants.

The SAM/IA procedure was used mainly to determine safe emission limits for major pollutants. However, suggesting safe limits for discharge of pollutants is complicated by the complexity of the SRC system and an incomplete understanding of certain phenomena. Transportation of pollutants through air, water, and land and transformation of compounds (from harmless chemicals to damaging pollutants) by physical, chemical, or biological means are examples of phenomena that need to be better understood.

CONTROL TECHNOLOGY ASSESSMENT

General Topics

Assessment and Control of Wastewater Contaminants From the Production of Synthetic Fuels—The University of North Carolina (UNC) has completed part of a study which assesses the environmental impact of wastewater contaminants. The report for the study, "Assessment of Coal Conversion Wastewaters: Characterization and Preliminary Biotreatability" (EPA-600/7-78-181), describes work during the first 18 months of the 5 year project. It summarizes the characterization of coal conversion wastewater and preliminary biotreatability experiments.

Chemical characteristics and organic contaminants were identified by reviewing published literature, visiting gasification and liquefaction R&D installations, and analyzing reports and project documents from a variety of coal conversion operations. Results indicate that approximately 60 to 80 percent of the total organic carbon

(TOC) is phenolic in nature, consisting of monohydric phenols, dihydric phenols, and polyphenols. The remaining organic material consists of mono- and polycyclic nitrogen-containing aromatics, oxygen- and sulfur-containing heterocyclics, polynuclear aromatic hydrocarbons, and simple aliphatic acids. Wastewater composition appears to be relatively independent of process technology and coal feed, especially in the case of the phenolic constituents.

The discharge of untreated wastewaters would have an adverse impact on aquatic life. Aerobic biological processes may be among the methods of choice for wastewater treatment, but more information is needed to determine the applicability and to develop design and operating guidelines.

An experimental program is underway to test activated sludge reactors. Effluent TOC's from 5-, 10-, and 20-day residence reactors are 220, 100, and 50 mg/l, respectively. The raw synthetic wastewater feed has a TOC of 1600 mg/l. Ongoing tests will examine the effects of varied reactor operating conditions and wastewater feed composition. GC/MS analysis and mammalian cytotoxicity screening of the reactor effluents have also been started.

Study of High Temperature Desulfurization Technologies—The Applied Research Division of Dynalectron Corporation, under subcontract to Hydrocarbon Research, Inc. (HRI), is completing a report on hot gas cleanup (HGC) processes. The report summarizes the status and operating characteristics of 22 HGC processes, identified by thorough literature and patent searches. The processes are generically classified according to absorbent type: solid, molten salt, or molten metal. HGC processes using solid absorbents are further categorized according to the type of active cation in the sorbent including calcium, iron, copper, and zinc.

HGC absorbents purify gas streams by reacting with the hydrogen sulfide present in the gas to form sulfides. The reaction occurs at temperatures above 430°C (800°F). The sulfide-rich sorbents are regenerated in a reaction with oxygen, air, steam, carbon dioxide, or a mixture of steam and carbon dioxide.

Evaluation of Control Technology for H-Coal and EDS Processes—Another report on control technology for two liquefaction processes is being completed by the Applied Research Division of Dynalectron Corporation, under subcontract to HRI. Controls for the H-Coal and Exxon Donor Solvent (EDS) processes are assessed for both pilot and proposed commercial plants. Extrapolations to the larger commercial size are based partly on pilot plant data and, when such data are not available, on engineering judgement.

The report characterizes and quantifies gaseous emissions, liquid effluents, and solid wastes. Emphasis is on process complexity and efficiency. Information gaps are identified, and recommendations for additional study are outlined.

Evaluation of Control Technologies for Particulates and Tar Emissions—The Applied Research Division of Dynalectron Corporation, under subcontract to HRI, is completing another report which evaluates alternative control technologies for particulate and tar emissions from coal converters. Particulate and tar emissions in the raw product gases of several gasifiers are characterized. Data for total quantity, chemical composition, and particle size distribution are presented for fixed-, fluid-, and entrained-bed gasifiers.

The report also describes the design and operating features of alternate control technologies. These technologies include cyclones, wet scrubbers, electrostatic precipitators, and granular bed filters. Collection efficiencies are characterized as functions of particle size and other important parameters.

Control technologies are evaluated in terms of their applicability to gasifier types and various end uses. End uses include combined cycles and gas-fired boilers. These evaluations are based on existing and proposed environmental regulations and process requirements for product gas purity. The purified product gases, liquid effluents, and solid wastes or sludges resulting from the various gasifiers are examined for the presence of particulate and tar emissions. The report also identifies gaps in the present data base.

TECHNOLOGY AND/OR COMMERCIAL DEVELOPMENT

Loan Guarantee Program for High-Btu Coal Gasification Plants—The Department of Energy (DOE) is drafting regulations for a loan guarantee program to benefit high-Btu gasification plants. The proposed regulations must be approved by the Office of Management and Budget (OMB) and Congress. If approved, the regulations will require a budget of $235 million in fiscal year 1980. Financial problems with the nation's first commercial-size coal gasification plant demonstrate that DOE loan guarantees would solve many of the funding problems that face commercialization of coal technology. The financing plan of a joint venture headed by American Natural Resources Company was denied Federal Energy Regulatory Commission (FERC) approval. The plan included customer financing for 75 percent of the $1.4-billion plant if the project failed because of technical problems. This plan was developed after other financing requests were denied. Traditional funding sources are reluctant to back large scale gasification plants because the technology has not been applied in the U.S.

Competitors to Proceed with Designs for Coal-to-Gas Demonstration Plants—DOE has authorized both the Illinois Coal Gasification Group (ICGG) and Conoco Coal Development Company to continue designs of a coal conversion demonstration plant.

Both firms were awarded contracts about 2 years ago to start a competition for designing a facility capable of processing high-sulfur Appalachian coals into substitute natural gas.

In late 1978 both projects reached comparable stages of conceptual design, and DOE convened a panel to evaluate pilot plant tests, technical feasibility, and commercial conceptual designs. A review of the panel's findings showed that insufficient information was available for selecting one design over the others.

Thus both firms will now proceed with a detailed design of the demonstration plant. While the designs are underway, better estimates of construction costs, market potential, product economics, and proposed cost-sharing arrangements will be gathered. Enough information should be available to permit a selection sometime in 1980.

If selected, the Conoco plant would be built in Noble County, Ohio. It would use a Lurgi gasifier to process up to 40 kg/s (3,800 tons/day) of high-sulfur coal and produce 1.6 million m^3 (58 million ft^3) of pipeline gas.

The ICGG plant would be in Perry County, Illinois. It would integrate two previously piloted processes, COED and COGAS. The COED process produces coal liquids and char; the COGAS process uses the char to produce synthetic gas. The plant would convert 23 kg/s (2,200 tons/day) of coal into 0.51 million m^3 (18 million ft^3) of gas and 381 m^3 (2,400 bbls) of heavy coal liquids.

Feasibility of Low-Btu Gas for Ore Pelletizing Operations—Tests are underway to determine if low-Btu gas can be substituted for natural gas in firing iron ore pellets. The testing, conducted at the Bureau of Mines metallurgy research center in Twin Cities, Minnesota, is a joint venture of the Bureau, DOE, and 17 private corporations. The Bureau of Mines wants to determine the technical feasibility of using low-Btu gas for firing the iron ore pellets. DOE is interested in the operations and technology of the gasifier. EPA is providing separate funding to identify all the discharges of the process. EPA also wants to determine the effects of varied operating conditions on gas composition since this affects end-use emissions.

The research effort will consist of several tests (about 120 hours each). Eastern Kentucky bituminous coal from Colorado, Wyoming, and Montana, and North Dakota lignite will be gasified.

100 MW Coal Gasification Power Plant—Southern California Edison (SCE), the Electric Power Research Institute (EPRI), and Texaco are planning a 100 MW coal gasification, combined-cycle power plant. The plant will cost about $250 million and will convert 908 Mg (1,000 tons) of coal per day into a medium-Btu gas. The product gas will be used to fire an existing 65 MW gas turbine unit at SCE's Cool Water plant near Doggett, California. Future plans are to integrate the coal gasifier with a 100-MW combined-cycle generating unit. The project is scheduled for completion in 1986.

Applicability of Slagging Gasifier to Power Plants—The Electric Power Research Institute (EPRI) and British Gas have agreed to test British Gas' slagging gasifier under power plant operating conditions. The test will determine if the gasifier can operate with variation in load levels. The $1.97 million program is scheduled to begin in April and continue for 3 months.

According to EPRI, British Gas' slagging gasification process is a second generation process similar to the Lurgi process except that the former operates at much higher temperatures and produces an ash residue from the coal. The residue must be removed as molten slag.

Budget Cutbacks Force Closing of Synthane Plant—The Department of Energy (DOE) has closed its Synthane pilot plant at Brucetown, Pennsylvania, because of budget cutbacks. All plant operations were terminated in January, although the facility will be on standby status for 2 years. The plant started operating in July 1976 and was designed to test an advanced process for producing a clean-burning gaseous fuel that could be substituted for natural gas. When operating at full capacity the plant could convert 65 Mg (72 tons) of coal per day into 34,000 m^3 (1.2 million ft^3) of methane.

Hydrogen as Alternate Fuel for Power Plants—The State of Iowa and Forrest City Municipal Utilities are jointly conducting a study to determine the feasibility of converting coal into hydrogen fuel for diesel generating plants. The city's generating plants are now capable of burning either natural gas or fuel oil. Using hydrogen gas as fuel would require few modifications on existing equipment.

Billings Energy Corporation of Provo, Utah, will perform the study. Three different gasifier feedstocks will be compared: Iowa coal, western coal, and petroleum coke. Methods of gasification and hydrogen storage will also be evaluated. A decision on the plant should be reached by mid-1979.

DOE Cancels Powerton Project—The Department of Energy (DOE) has cancelled plans to build an experimental combined-cycle plant at Pekin, Illinois. The Powerton Project would have tested a Lurgi gasifier in conjunction with a conventional gas turbine. (See the ***Environmental Review of Synthetic Fuels***, Volume I, Number 3.) This would have been an alternative to burning high-sulfur coal and using flue gas scrubbers.

DOE has decided that potential benefits do not justify the estimated $225 million cost for the facility. This projected cost reflects a 33 percent increase over original estimates for the plant. Since more laboratory work would be required to improve the gasifier and other critical components of the combined-cycle facility, a smaller-scale laboratory test facility will be operated before any major plant is constructed.

Demex Process May Recover Usable Liquefaction Products—DOE and UOP, Inc., are cosponsoring a project to determine if UOP's coal liquids refining technology can be applied to coal liquefaction processes to recover valuable materials. The commercially available Demex process will be evaluated at UOP's Corporate Research Center in Des Plaines, Illinois. The Demex process is a solvent deasphalting-deashing separation technique. It will be applied to the usable product materials in vacuum flash distillation unit bottoms. The distillation procedure separates refinable products from solids and nondistillate tars. These residual materials are difficult to recover because of mechanical damage to the units caused by the high temperatures required during the distillation process.

Methanol-From-Coal Pilot Plant to Produce Electricity—The Electric Power Research Institute (EPRI) and Southern California Edison (SCE) are conducting a project to combine a coal gasifier with a superior methanol synthesis process. This system could substantially decrease methanol-from-coal costs. Electric power could be produced at the same plant.

New Process Benefits SRC Systems and Direct Hydrogenation Processes—The Electric Power Research Institute (EPRI) has announced a substantial breakthrough in liquefaction research. Separating solids from liquids has been a major problem in coal conversion processes. Kerr-McGee may have solved this problem by using organic solvents to separate the SRC product from ash, unreacted coal, distillate fuel, and residuum. Tests have been conducted using products from EPRI's 31 g/s (3 ton/day) reactor in Wilsonville, Alabama.

The Kerr-McGee process capability to fractionate hydrocarbon mixtures quite accurately may prove more valuable than its use in SRC extraction. Potential hydrogen donors can be separated from the reacted materials produced in direct hydrogenation processes and recycled to the hydrogenation step to reduce overall hydrogen requirements. Because of the major savings in process costs, plants capable of producing a mixture of fuels could be constructed. A variety of coal liquids ranging from cheap boiler fuel to premium turbine fuel could then be selectively extracted from the mixture.

Joint Solvent Refined Coal (SRC) Project—A joint project involving government and private industry in the U.S. and West Germany will build a SRC-II demonstration plant. The 63 kg/s (6,000 ton/day) plant will be located near Morgantown, West Virginia. The plant will convert high-sulfur bituminous coal to a low-viscosity oil having a sulfur content of about 0.25 percent and a very low ash content. The preliminary design should be completed in April 1979. West Germany will participate in the detailed design in consultation with Gulf Oil Corporation, the prime contractor. Construction is scheduled to begin in mid-1980 with operation beginning in mid-1983. The West German government and German companies will provide 25 percent of the $700 million needed for the 7- to 8-year project. Negotiations are underway to determine if Japan will also participate in the project.

TVA to Combine Coal Gasification, Fuel Cells, and Cogeneration—Talks are underway between DOE and the Tennessee Valley Authority (TVA) on a plan to combine medium-Btu coal gasification, first generation fuel cells, and cogeneration to meet energy needs in the TVA service area.

Mitsubishi Constructs Coal Gasification Plant—Mitsubishi Heavy Industries, Ltd., (MHI) is constructing a large coal gasification facility expected to process 36 Mg (40 tons) of coal a day. The project is sponsored by the Coal Mining Research Center, which specializes in the development of technologies based on coal and related materials. The gasification facility is located at MHI's Wagasaki Shipyard

and Engineer Works and is scheduled to be completed in the spring of 1979.

The MHI system produces a low-Btu gas and operates at 2 MPa (20 atm). The system is suitable for a high-efficiency combined-cycle power generating plant. This will decrease plant operation costs and also enable the Japanese industries to accommodate their current fuel supplies. The gasifier will be capable of handling a variety of coals, including the slightly caking coal widely available in Japan.

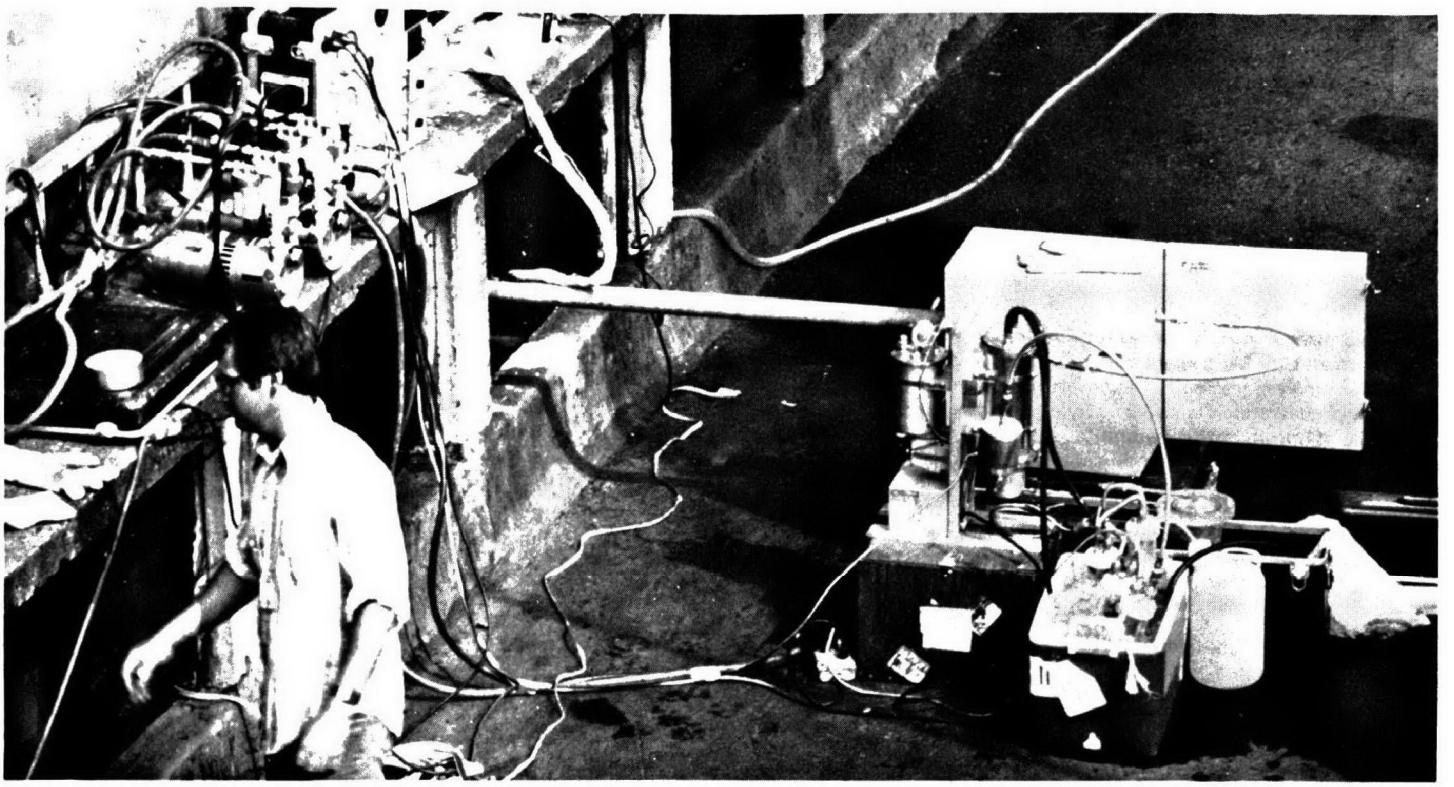
Koppers-Totzek Coal Gasifier Startups—A demonstration-scale version of a pressurized Koppers-Totzek coal gasifier started up in November 1978 after 4 years of development. The unit gasifies 150 Mg/day (165 ton/day) of coal and costs over $50 million. It is located at Shell International Petroleum/Maatschappij B.V.'s Hamburg-Harburg oil refinery in West Germany. If all goes well with the demonstration, a 1000 Mg/day (1100 ton/day) prototype is planned for 1985. The Shell-Koppers process operates at 3 MPa (30 atm), compared with 0.1 MPa (1 atm) for the conventional Koppers-Totzek entrained-bed gasifier. The pressurized coal gasifier would allow larger capacities than before and reduce energy costs since the product gas does not have to be compressed.

Successful Test Burn of Liquid Solvent Refined Coal—A successful test burn of liquid Solvent Refined Coal (SRC) was recently conducted at Consolidated Edison Co. in New York City. The test involved approximately 715 m^3 (4,500 bbl) of SRC II oil produced by Gulf Mineral Resources Company at its Ft. Lewis, Washington, pilot plant. Results of EPRI's preliminary data analysis indicate that NO_x emissions from the combustion of SRC II fuel would meet the standard for coal-derived liquid fuels proposed in September by EPA. In addition, boiler efficiencies are comparable to those obtained with fuel oil. Further assessment of the data is to be conducted by KVB, Inc., of Tustin, California.

DOE Cancels Plans for Syncrude Pilot Plant—Plans for a $60-million pilot plant to refine syncrude into gasoline or fuel oil have been cancelled by the DOE. The plant would have produced up to 16 m^3/day (100 bbls/day) of marketable fuel oil or gasoline from liquids similar to those produced by the H-Coal or Exxon Donor Solvent processes. DOE believes that a syncrude refining plant would not be commercialized before mid- to late-1980 and that other liquefaction plants, like SRC modules, would be onstream before then. These plants would produce a boiler fuel that would not need refining.

Bituminous Coal-to-Gas Unit—DOE and Exxon Research and Engineering Company have signed an agreement to develop the catalytic coal gasification (CCG) process for converting bituminous coal to pipeline quality gas. Exxon has been studying the process since 1971 at their Baytown, Texas, pilot plant. The $16.8 million awarded by DOE calls for the continuous demonstration of the 10 g/s (1 ton/day) integrated pilot plant by late 1980. Exxon will conduct related research into gasification kinetics, catalyst recovery, and catalyst/mineral interactions. Economic studies of the process will also be performed.

In the CCG process, ground coal is sprayed with the catalyst solution, dried, and then injected into the gasifier where it is mixed with steam at relatively low temperatures. The product gas is recycled continuously until it reaches pipeline quality. The CCG process is considered superior to thermal gasification processes because higher methane yields are produced, less heat is required, and less initial capital outlay is necessary. The CCG process also eliminates swelling and caking problems which have plagued other processes.



Source Assessment Sampling System (SASS) in use.

PROJECT TITLES, CONTRACTORS, AND EPA PROJECT OFFICERS IN EPA'S IERL-RTP FUEL PROCESS BRANCH ENVIRONMENTAL ASSESSMENT PROGRAM

Project Title	Contractor	EPA Project Officer
Environmental Assessment of Low/Medium-Btu Gasification (March 1976-November 1979)	Radian Corporation 8500 Shoal Creek Blvd. Austin, TX 78766 (512) 454-4797 (Gordon C. Page)	William J. Rhodes IERL-RTP Environmental Protection Agency Research Triangle Park, NC 27711 (919) 541-2851
Environmental Assessment of High-Btu Gasification (April 1977-April 1980)	TRW, Inc. 1 Space Park Redondo Beach, CA 90278 (213) 536-4105 (Chuck Murray)	William J. Rhodes IERL-RTP Environmental Protection Agency Research Triangle Park, NC 27711 (919) 451-2851
Environmental Assessment of Coal Liquefaction (August 1976-August 1979)	Hittman Associates, Inc. 9190 Red Branch Road Columbia, MD 21043 (301) 730-7800 (Wayne Morris)	William J. Rhodes IERL-RTP Environmental Protection Agency Research Triangle Park, NC 27711 (919) 541-2851
Control Technology For Products/By-Products (September 1976-September 1979)	Catalytic, Inc. 1500 Market Street Center Square West Philadelphia, PA 19102 (215) 864-8104 (A. B. Cherry)	Robert A. McAllister IERL-RTP Enivronmental Protection Agency Research Triangle Park, NC 27711 (919) 541-2851
Control Technology For *Converter Output* (January 1977-January 1980)	Hydrocarbon Research, Inc. P. O. Box 6047 134 Franklin Corner Road Lawrence Township, NJ 08648 (609) 896-1300 (John Kunesh)	Robert A. McAllister IERL-RTP Environmental Protection Agency Research Triangle Park, NC 27711 (919) 541-2851
Waste Stream Disposal and Utilization (April 1977-April 1980)	Pullman Kellogg Research and Development Center 1300 Three Greenway Plaza East Houston, TX 77046 (713) 960-2625 (Louis Bostwick)	Robert A. McAllister IERL-RTP Environmental Protection Agency Research Triangle Park, NC 27711 (919) 541-2851
Acid Gas Cleaning Bench Scale Unit (October 1976-September 1981) (Grant)	North Carolina State Univ. Department of Chemical Engineering Raleigh, NC 27607 (919) 737-2324 (James Ferrell)	N. Dean Smith IERL-RTP Environmental Protection Agency Research Triangle Park, NC 27711 (919) 541-2851
Water Treating Bench Scale Unit (November 1976-October 1981) (Grant)	Univ. of North Carolina Department of Environmental Sciences and Engineering School of Public Health Chapel Hill, NC 27514 (919) 966-1023 (Phillip Singer)	N. Dean Smith IERL-RTP Environmental Protection Agency Research Triangle Park, NC 27711 (919) 541-2851 (919)
Pollutant Identification From a Bench Scale Unit (November 1976-October 1981) (Grant)	Research Triangle Institute P. O. Box 12194 Research Triangle Park, NC 27709 (919) 541-6000 (Forest Mixon)	N. Dean Smith IERL-RTP Environmental Protection Agency Research Triangle Park, NC 27711 (919) 541-2851

REPORTS SUMMARY

Applicability of Coke Plant Control Technologies to Coal Conversion

by

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Catalytic, Inc.

Waste and process streams from the coke oven industry contain pollutants similar to those discharged by coal conversion processes. Control technologies used by the coke oven industry should therefore be applicable to the synfuels industry. Such technologies, examined in a recent study (Report Number EPA-600/7-78-190; NTIS No. PB 288 630), include acid gas treatment, sulfur recovery, fugitive emissions control, wastewater treatment, and by-product recovery and refining.

A comparative listing of coke oven and coal conversion process and waste streams is presented in Table 1. Although the constituents in the streams from the two industries are similar, their concentrations, temperatures, and pressures vary. These variables determine the best control technology for a particular stream.

Several processes are used to remove hydrogen sulfide and recover sulfur from coke oven gas. These processes fall into three major categories: 1) Liquid Absorption Processes (Vacuum Carbonate, Sulfiban (amine type), Firma Carl Still); 2) Wet Oxidative Processes (Stretford, Takahax, Giammarco Vetrocoke); and 3) Dry Oxidative Processes (Iron Oxide or Dry Box). Historically, the Dry Oxidative Process with iron oxide has been used most extensively. However, the Vacuum Carbonate Process, the Stretford Process, and, more recently, the Sulfiban Process are now favored for commercial use. The Claus Process is also used, despite initial problems with hydrogen cyanide, iron sulfide, and iron cyanide. These difficulties were resolved by adjustments to the Claus unit.

The H_2S removal or sulfur recovery efficiencies possible for the coke oven industry processes are 99 percent for the Dry Oxidative (iron oxide) Process (for low gas volumes), 93 to 98 percent for the Vacuum Carbonate Process, and 90 to 98 percent for the Sulfiban Process. Sulfur recovery efficiencies attainable with the Stretford Process are greater than 99.5 percent, while those possible using Claus sulfur recovery are 95 to 96 percent.

The Claus and Stretford Processes are the most common sulfur recovery processes in the coke oven industry. Generally, the Stretford Process is more economical when treating acid gas containing less than 15 percent H_2S, whereas the Claus Process is the method of choice for levels above 15 percent.

Both the Claus and Stretford Processes will have wide application in coal conversion. The Claus is being used in several developing gasification processes: both the HYGAS and BIGAS pilot plants have Claus sulfur recovery units. The Stretford Process is part of: the Synthane pilot plant at the Pittsburgh Energy Research Center; the SRC pilot plant at Fort Lewis, Washington; and the Sasol I coal conversion plant in South Africa.

Among the acid gas removal processes found in the coke oven industry, the amine and carbonate type solvent processes should be applicable to low pressure gasification processes. They may also be used to treat low pressure off-gases from liquefaction processes.

Coke ovens are a major source of gaseous emissions in the steel industry. Topside coke oven workers have a substantially higher risk of lung cancer than the average worker, probably because of carcinogens in the particulate emissions. Various schemes to control these emissions and alleviate potentially adverse health effects are being developed. These include collecting and removing the smoke, particulate matter, and gaseous emissions that occur during the charging, coking cycle, coke pushing, and quenching operations. These fugitive emission controls, described below, may have potential applications in the synfuels industry in analogous situations such as ash quenching or SRC solidification operations.

An enclosed coke pushing and quenching system is being developed jointly by EPA and the National Steel Corporation at National's new Weirton Steel Division, Brown's Island Coke Plant. In this system the coke will remain totally enclosed from the time it leaves the oven until after it is quenched. A high energy scrubber

TABLE 1. COKE OVEN AND COAL CONVERSION STREAM SIMILARITIES

Coke Oven Streams	Coal Conversion Counterparts	Major Common Pollutants or Similarities
Raw gas and acid gas	Raw gas and acid gas from gasification, and off-gas from liquefaction	H_2S, NH_3, CO, CO_2, and hydrocarbons
Fugitive emissions	Fugitive emissions	Same as above
Process wastewater	Process wastewater	NH_3, phenols, oils, sulfides, and cyanides
Coal pile runoff	Coal pile runoff	Suspended solids and organic extracts
Coke breeze	Coal fines, chars	Similar by-products
Oily and biosludges	Oily and biosludges	Oil, grease and tar, biomass, refractory organics
Tar, naphthalene, light oil, phenol, and ammonia	Tar, naphthalene, light oil, phenol, and ammonia	Similar by-products

removes emissions generated during the push and transfer to the quench station.

Another system for abating coke oven fugitive emissions is being tested by the Ford Motor Company. Its main features are a fume collecting hood, a fume main, a venturi scrubber, and a modified quench car with a synchronization system which coordinates the quench car's movement with that of the pusher.

Wastewater constituents are similar in gasification and coke oven operations, although concentrations vary. Process wastewaters from coke plants contain large amounts of phenol, ammonia, sulfide, cyanide, oil, and grease. Various control technologies are used to remove these pollutants.

Ammonia is being removed and recovered by steam stripping at alkaline pH, or by the Phosam-W Process. The latter is a proprietary (U.S. Steel) process that uses combined scrubbing (ammonium phosphate solution) and distillation to produce an anhydrous ammonia product. Steam stripping to remove wastewater sulfide is not commonly practiced in the coke oven industry.

Phenol is removed by solvent extraction, steam stripping and/or biological oxidation, and carbon adsorption. Biological treatment of coke oven wastewaters has been successfully used to meet existing phenol regulations. The activated sludge system has achieved a phenol removal efficiency of about 99.8 to 99.9 percent; B.O.D. removal has ranged from 85 to 95 percent.

Many coke oven plants recycle wastewaters containing cyanide and use them for coke quenching. Cyanide-laden wastewaters can also be successfully treated by alkaline chlorination, although this practice is not necessary for coke oven plants where existing cyanide limitations are met without additional wastewater treatment.

Some coke oven plants use a by-product light oil upgrading pro-

TABLE 2. COKE PLANT CONTROL TECHNOLOGIES AND THEIR APPLICABILITY TO COAL CONVERSION

Coke Plant Control Technology	Applicability to Coal Conversion Systems
Acid Gas Treatment	
Amine solvents	Suitable for removal of H_2S and CO_2 from low pressure raw product and off-gases. Solvent degradation may be encountered. Can produce high H_2S concentration streams.
Carbonate solvents (e.g., Vacuum carbonate and Benfield)	Same as above. Processes remove carbonyl sulfide and cyanides. Benfield process suitable for high pressure application.
Sulfur Recovery	
Stretford	Suitable for low H_2S (less than 15%) containing gases. Organic sulfur not removed. High CO_2 levels require large units.
Claus	Applicable for high H_2S (greater than 15%) containing gases. Removal of high levels of cyanide, ammonia, and hydrocarbons will be required.
Fugitive Emissions Control	
Enclosed coke pushing and quenching system	Potentially suitable for ash quenching, SRC solidification applications.
Fume recovery and scrubbing	Applicable to analogous sources.
By-product Recovery/Refining	
Ammonia from wastewater (Stripping, Phosam-W)	Suitable for sour waters.
Ammonia from raw gases (Scrubbing, Phosam-W)	Applicable for low pressure gas purification.
Phenol from wastewater (Solvent extraction)	Suitable for process wastewater containing 1,000 mg/l or more phenol.
Tar, naphthalene, light oil from raw gases	Suitable, but design must be modified for different pressures, temperatures, and compositions.
Light oil refining (e.g., Litol process and solvent extraction)	Suitable for recovery of benzene, toluene, xylene from coal derived naphthas.
Wastewater Treatment Technology	
Biological oxidation; carbon adsorption; ammonia, phenol, and oil removal processes	Generally applicable; design basis must be established for the specific waste.

cess which has potential application in the synfuels industry. This method, known as the Litol process, has been developed and licensed by the Houdry Division of Air Products and Chemicals, Inc. It is a catalytic process by which coke oven light oils are refined and dealkylated to produce quality reagent grade benzene at essentially stoichiometric yields. The Litol process has been in commercial service since 1964 and is now used in the U.S. and several other countries.

The various coke oven control technologies potentially applicable to coal conversion are summarized in Table 2. Many of these control technologies have been tested in coal conversion applications; however, most of these tests have been in pilot scale plants. A few have been used at the commercial scale in first generation coal gasification processes (e.g., the Lurgi Process).

Applicability of a control technology does not mean that the coke oven design can be duplicated in the coal conversion application. Different variables in wastestream characteristics must be taken into consideration during control technology design. Design information must be developed through laboratory or pilot scale testing with actual wastes from coal conversion processes.

EPA has recently assessed the health effects of coke oven emissions (see the ***Environmental Review of Synthetic Fuels,*** Volume 1, Number 3). Coal conversion plants generate many of the same waste components (H_2S, CO, CO_2, hydrocarbons, and polynuclear aromatics) found in streams from coke oven plants. Many of the new control technologies under development in the coke oven industry should remove significant amounts of these potentially hazardous pollutants. The need for additional controls can be determined after these new technologies have been operating for a longer period.

Standards of Practice Manual For The Solvent Refined Coal Liquefaction Process

by

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Hittman Associates, Inc.

EPA's Standards of Practice Manual (SPM) for the Solvent Refined Coal Liquefaction Process provides an integrated multimedia appraisal of control/disposal options, emissions, and environmental requirements. The appraisal is based on a hypothetical 8000 m^3/day (50,000 bbl/day) Solvent Refined Coal (SRC) facility producing gaseous and liquid fuels. The following discussion summarizes the major conclusions of the SPM (published in June 1978, Report Number EPA-600/7-78-091; NTIS No. PB 283 028).
waste streams, conventional control equipment can be used to achieve compliance with existing emission standards. Costs for control equipment, though significant, are not prohibitive.

The SPM delineates available and developing control/disposal practices for gas, liquid, and solids treatment schemes.

Air Emissions

The air emissions control options evaluated include:

- Particulate emission controls (gravity settling chambers, cyclones, electrostatic precipitators, wet scrubbers, and others).
- Hydrocarbon emission controls (direct-fired and catalytic afterburners, flares, condensation systems, and adsorption systems).
- SO_2 emission controls (over 30 control systems evaluated).
- NO_x emission controls (combustion modification, flue gas treatment, and several potential techniques for NO_x treatment).

There are seven major gaseous waste streams which must be treated to remove one or more specific pollutants. Table 3 lists these streams and the contaminants which may have to be removed.

Liquid Effluents

EPA's SPM evaluates pollution control equipment for coal liquefaction wastewaters containing suspended and dissolved solids, extreme pH, toxic chemical species, oil wastes, and oxygen demanding species.

Selection and sizing of pollution control equipment for the SRC process depend on flow rate, amenability of wastewaters to chemical and/or biological treatment, chemical composition, chemical recoverability, intended end-use of treated wastewaters, and economic considerations. Parameters generally considered in the design of pollution control equipment are BOD, COD, temperature, pH, suspended solids, dissolved solids, heavy metals, toxic materials such as cyanides and phenols, and oils and greases.

Numerous liquid wastewater streams which may be highly variable in both volume and chemical composition are generated in coal liquefaction processes. Wastewater streams in the SRC process result from hydrogen production, gas purification, cryogenic separation, cooling towers, hydrotreating, and gas separation. Typical stream constituents are ammonia, hydrogen sulfide, phenols, organic compounds, oils and greases, heavy metals, cyanides, suspended solids, chemical additives (e.g., MEA, Polyrad, and oleyl alcohol), carbon dioxide, trace elements, sulfates, phosphates, nitrates, organics, nitrogen compounds, sulfur compounds and alkalinity.

Pretreatment processes (e.g., equalization, neutralization, solids removal, heavy metals removal, oil and grease removal, toxic pollutant removal, and chemical recovery operations) are sometimes required before the main treatment step. These methods prevent various stream parameters from adversely affecting the operation of the main treatment process. Depending on the efficiencies of the main treatment processes, additional treatment may also be required to reduce the wastewater constituents to acceptable levels.

Wastewater treatment processes can be divided into three classes according to their function:

- Primary treatment (equalization, sedimentation, neutralization, oil and grease separation, recovery processes, and stripping).

TABLE 3. GASEOUS WASTE STREAMS IN THE SRC PROCESS – MAJOR CONTAMINANTS AND STREAM CHARACTERISTICS

Stream	Major Pollutants	Stream Characteristics and Criteria for Control Module Selection
1. Dust from coal receiving	Particulates	Highly variable flow rate; ambient temperature and pressure; high grain loading; abrasive; particle size 1-100μm.
2. Dust from coal storage	Particulates	Intermittent flow rate; dispersed, variable dependent on wind conditions; same as 1.
3. Dust from coal reclaiming and crushing	Particulates	Same as 1.
4. Stack gas from coal drying	Volatile organics Particulates Moisture	High temperature, pressure, and flow rate; low grain loading; high moisture content.
5. Dust from SRC product storage	Particulates Volatile organics	Same as 1.
6. Effluent gas from Stretford sulfur recovery	Light hydrocarbons Nitrogen oxides Ammonia Fly ash Hydrogen sulfide	Moderate temperature and pressure; low grain loading; high, relatively constant flow rate; corrosive; low pollutant concentrations.
7. Flue gas from coal-fired boilers (steam generation)	Sulfur dioxide Nitrogen oxides Particulates Carbon dioxide	High temperature; near atmospheric pressure; high, relatively constant flow rate; corrosive; abrasive; moderate grain loading.

- Secondary treatment (biological and flocculation/flotation).
- Tertiary treatment (filtration, carbon adsorption, electrodialysis, reverse osmosis, and ion exchange).

Solid Wastes

Solids treatment involves both mechanical reduction of solids volume and treatment processes which improve waste disposal characteristics such as handling and leachability. The SPM addresses the following types of pollution control equipment:

- Volume reduction processes (thickening, filter pressing, centrifuging, and others).
- Treatment processes (wet oxidation, pyrolysis, incineration, lime recovery, and heat drying).
- Other processes (capillary dewatering and others).

Numerous sludges are produced in an SRC plant. These include lime sludge from raw water treatment; sludge from gasification, scrubbing, and hydrogen production; spent hydrotreating catalyst; solids separation residues; and reactor sludge from fractionation tower bottoms.

The SPM addresses other aspects of control/disposal, including final disposal, combustion modification, fuel cleaning, fugitive emission control, and accidental release technology.

Environmental Regulations

No legislation currently exists which directly concerns SRC or other liquefaction systems. Before commercialization, such legislation could occur at federal, state, or local levels.

The SPM delineates environmental policies of the 16 states which are potential sites for commercial SRC plants. The following federal regulations are also presented by the SPM:

- National Primary and Secondary Ambient Air Quality Standards.
- Federal New Source Performance Standards of Related Technologies.
- Federal Effluent Guidelines and Standards for New Sources.
- Some EPA Requirements and Recommendations for Solid Wastes.

Environmental Assessment

The SPM compares estimated concentrations of specific pollutants in air, water, and solid waste streams (after treatment) with Multimedia Environmental Goals (MEG's). MEG's are levels of contaminants judged (1) appropriate for preventing certain negative effects on the surrounding populations or ecosystems, or (2) representative of the control limits obtainable with current technology. A comparison of MEG's with emissions characteristics is an integral part of the environmental assessment methodology being developed at EPA/IERL-RTP.

The SPM compares the following emissions with MEG's:

- Estimated air emissions from coal receiving—trace metals.
- Estimated air emissions from coal reclaiming and crushing—trace metals.
- Estimated air emissions from the dryer—trace metals.
- Estimated Stretford tail gas emissions.
- Estimated air emissions from steam generation.
- Slag from the gasifier—trace metals.
- Estimated effluents from the wastewater treatment plant—organics, trace metals, and others.

MEETING CALENDAR

Ammonia Production via Coal Gasification, May 8-10, 1979, Muscle Shoals, AL. Contact: Phebus C. Williamson, National Fertilizer Development Center, Tennessee Valley Authority, Muscle Shoals, AL 35660.

Sixth National Conference on Energy and the Environment, May 21-24, 1979, Pittsburgh, PA. Contact: Duane G. Nichols, Research Triangle Institute, P. O. Box 12194, Research Triangle Park, NC 27709.

10th Biennial Lignite Symposium, May 30-31, 1979, Grand Forks, ND. Contact: Gordon H. Gronhovd, Grand Forks Energy Research Center, P. O. Box 8213, University Station, Grand Forks, ND 58202; telephone (701) 795-8000.

Fourth Annual Conference on the Interagency Energy/Environment RD&D Program, June 7-8, 1979, Washington, DC. Sponsored by EPA's Office of Energy, Minerals, and Industry. Contact: Conference Coordinator, Automation Industries, Inc., Vitro Laboratories Division, 4/2109 14000 Georgia Ave., Silver Spring, MD 20910.

72nd Annual Meeting of the Air Pollution Control Association, June 24-28, 1979, Cincinnati, OH.

Ninth Intersociety Conference on Environmental Systems, July 16-19, 1979, San Francisco, CA. Contact: H. F. Brose, Hamilton Standard, Windsor Locks, CT 06096.

1979 Intersociety Energy Conversion Engineering Conference, August 5-10, 1979, Boston, MA. Contact: Barbara Hodsdon, Manager of Meetings and Expositions, 1155 16th St., NW, Washington, DC 20036.

AIChE 87th National Meeting, August 19-22, 1979, Boston, MA. Contact: Ralph A. Buonopane, Department of Chemical Engineering, Northeastern University, 360 Huntington Ave., Boston, MA 02115.

1979 Symposium on Instrumentation and Control for Fossil Energy Processes, August 20-22, 1979, Denver, CO. Contact: Mrs. Miriam L. Holden, Director, Conference Planning and Management, Argonne National Laboratory, Building 223, 9700 South Cass Avenue, Argonne, IL 60439; telephone (312) 972-5585.

10th World Petroleum Congress, September 1979 (dates not known), Bucharest, Romania. Contact: William F. O'Keefe, American Petroleum Institute, 2101 L St., NW, Washington, DC 20037.

178th National Meeting of the American Chemical Society, September 9-14, 1979. Contact: A. T. Winstead, ACS, 1155 16th St. NW, Washington, DC 20036.

National Energy Economics III, September 16-19, 1979, Houston, TX. Contact: Charles F. O'Connor, Council for Energy Studies P. O. Box 7374, Tulsa, OK 74105; telephone (918) 582-1582.

RECENT MAJOR MEETINGS

AIChE 71st Annual Meeting

The 71st Annual Meeting of the American Institute of Chemical Engineers was held November 12-16, 1978, in Miami Beach, Florida. There were 134 sessions on a variety of topics, a number of them dealing with fuel conversion, liquefaction, and gasification.

A two-part symposium on reaction engineering in coal gasification and liquefaction included papers on gasification modeling and the use of catalysts in the SRC process. Models of the Synthane process development unit (PDU) gasifier, an integrated coal pyrolysis gasification and combustion reactor system, and entrained-bed coal gasification were described, as was a simulation of the CO_2 Acceptor Coal Gasification Process. The use of metallic sodium and dolomite in the desulfurization of coal derivatives, coal liquefaction in inorganic/organic liquid mixtures, and the application of a catalytic two-stage concept in the SRC process were among other papers presented.

Process design was discussed in a symposium on reaction engineering in processing solid fossil fuels. The symposium included papers on process design for coal conversion reactors, the production of SNG via catalytic gasification, and liquefaction of coal in a fixed-bed non-catalytic reactor. A steady state model of a countercurrent moving bed gasifier was described in one paper; liquefaction of coal in a fixed-bed non-catalytic reactor was summarized in another.

One session dealt with coal liquefaction processes and products. Deashing of SRC and liquefied coal was discussed, as was the use of a new rotary precoat filter for the filtration of liquefied coal. One paper described the selective conversion of methanol to high octane gasoline in a fluidized bed. Another summarized the flash hydropyrolysis of coal with Rocketdyne short-residence-time reactors. A general discussion of the H-Coal Process was also presented.

Several papers dealt with the conversion and utilization of lignite. Liquefaction of lignite with hydrogen donor solvents and by the Co-Stream Process was described. Gasification of lignite in a slagging fixed bed gasifier was discussed. Operating data and a discussion of problems were presented for the extended operation of a solvent refined lignite process development unit.

Another two-part symposium dealt with the environmental assessment of solid fossil fuel processes. Several papers were presented on the environmental aspects of coal gasification and liquefaction processes. In another symposium the measurement of fugitive hydrocarbon emissions in petroleum refineries was described.

Performance of several pilot plants was summarized in the symposium on fluidization and fluid-particle systems in coal processing. Among those described were an ash agglomerating combustor/gasifier and the IGT U-Gas pilot plant.

More papers concerning gasification and liquefaction were presented in other symposia, including a numerical model of coal gasification in entrained flow reactors and a discussion of the TRI-GAS low-Btu gasification concept. Separation of liquefied coal from residual solids by dense vapor stripping and new liquefaction technology by short contact time processes were also described. In addition, the SASOL II project, in which the government of South Africa is building a large coal gasification plant, was summarized.

RECENT MAJOR PAPERS AND PUBLICATIONS

Gasification Technology

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Chandra, K., B. McElmurry, E. W. Neben, and G. E. Pack, *Economic Studies of Coal Gasification: Combined Cycle Systems for Electric Power Generation,* Report EPRI AF-642, RP 239. Irvine, CA, Fluor Engineers & Constructors, Inc., January 1978.

Colaluca, M. A., M. A. Paisley, and K. Mahajan, "Progress in the Development of the TRI-GAS Low-Btu Gasification Concept," Presented at the 71st Annual AIChE Meeting, Miami Beach, FL, November 12-16, 1978.

FMC Corporation, *Gasification of COED Chars in a Koppers-Totzek Gasifier,* Report EPRI AF-615, RP 264-1. Princeton, NJ, July 1978.

Gallagher, J. E., Jr., and H. A. Marshall, "Production of SNG from Illinois Coal via Catalytic Gasification," Presented at the 71st Annual AIChE Meeting, Miami Beach, FL, November 12-16, 1978.

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Johnson, B. C., M. M. Fegley, R. C. Ellman, and L. E. Paulson, Gasification of North Dakota Lignite in a Slagging Fixed Bed Gasifier," Presented at the 71st Annual AIChE Meeting, Miami Beach, FL, November 12-16, 1978.

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McElmurry, B., and S. Smelser, *Economics of Texaco Gasification-Combined Cycle Systems, Economic Studies of Coal Gasification Combined Cycle Systems for Electric Power Generation,* Report EPRI AF-753, RP-239. Irvine, CA, Fluor Engineers & Constructors, Inc., April 1978.

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Overturf, B. W., G. V. Reklaitis, and F. Kayihan, "Modeling and Analysis of an Integrated Coal Pyrolysis, Gasification, and Combustion Reactor System," Presented at the 71st Annual AIChE Meeting, Miami Beach, FL, November 12-16, 1978.

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Sandstrom, W. A., M. K. Vora, and A. G. Rehmat, "IGT U-Gas Pilot Plant: High Temperature Fluidization," Presented at the 71st Annual AIChE Meeting, Miami Beach, FL, November 12-16, 1978.

Schneyer, G. P., D. H. Brownell, W. D. Henline, and T. R. Blake, "A Numerical Model of Coal Gasification in Entrained Flow Reactors," Presented at the 71st Annual AIChE Meeting, Miami Beach, FL, November 12-16, 1978.

Schulz, Helmut W., *The Simplex Coal and Biomass Gasification Process.* Harrison, NY, Dynecology, Inc., 1978.

Southern California Edison, *Preliminary Design Study for an Integrated Coal Gasification Combined Cycle Power Plant,* Report EPRI AF-880, RP 986-4. Rosemead, CA, August 1978.

Springmann, Helmut, "Oxygen for Coal Gasification Power Plants," Presented at the 71st Annual AIChE Meeting, Miami Beach, FL, November 12-16, 1978.

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Ziegler, F., P. Gupta, S. Tia, P. Gallier, and L. Evans, "Simulation of the CO_2 Acceptor Coal Gasification Process," Presented at the 71st Annual AIChE Meeting, Miami Beach, FL, November 12-16, 1978.

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