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Project Summary

On-site Waste Ink Recycling

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Recycling ink has good potential as a way to reduce waste and promote long-term cost savings. The evaluation summarized here addresses the product quality, waste reduction, and economic issues involved in recycling printing ink in a facility such as *The Hartford Courant* newspaper in Hartford, CT. The specific unit evaluated is based on the technology of distillation and filtration. Selected performance tests on the waste, recycled, and virgin inks determined product quality. The recycling unit achieved a good product quality of recycled ink, and the recycled ink fared well in such laboratory tests as viscosity, grind, residue, tack, tinting strength, water content, and water pickup. Qualified professionals, in comparisons with newspapers printed with virgin ink, favorably reviewed newspapers printed with recycled ink. Ink and solvent that would have gone to waste were recovered and reused. The resulting cost saving gave a payback period of about 10 years.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

This study, performed under the U.S. Environmental Protection Agency's (EPA's) Waste Reduction and Innovative Technology Evaluation (WRITE) Program, was a cooperative effort among EPA's Risk Reduction Engineering Laboratory, Connecticut Hazardous Waste Management Service, and *The Hartford Courant*. The goal of the WRITE Program is to evaluate, in a typical workplace environment, examples of prototype or innovative commercial technologies that have potential for reducing wastes and to provide this information to potential users. The objectives of the waste ink recycling study were to evaluate (a) the quality of the recycled ink, (b) the waste reduction potential of the technology, and (c) the economic feasibility of the technology. The recycling process is shown in Figure 1. The major components of the recycling unit were purchased on a skid from Separations Technologies Inc.* Other equipment was added as required. Trays containing waste ink (consisting of 75% black and 25% colored ink) from the press room are emptied on a 1/4-in. wire mesh to remove nuts, bolts, and other gross contaminants. The waste ink then goes to a large waste ink storage tank. When enough ink is available in this tank, the batch is processed. Processing primarily involves vacuum distillation, filtration, and blending.

Waste ink from the storage tank is transferred to the distillation still and distilled at 140°C under vacuum. Solvent and water from the waste ink are vaporized, condensed (by a chiller), and collected in a separator tank where water and solvent separate out into two phases under gravity. The water is drained off and discharged to the municipal sewer (under permit), and

* Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

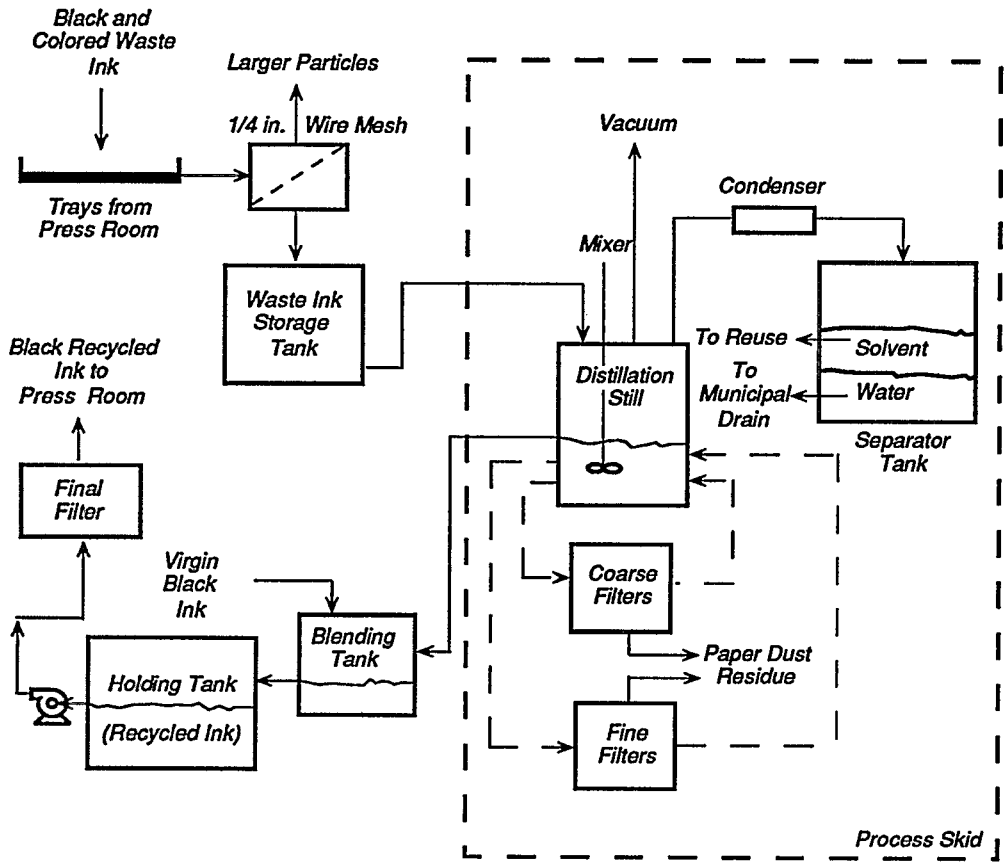

Figure 1. Waste ink recycling process.

the solvent is reused in the presses. The ink in the distillation still is sent through 100- and 325-mesh filters to remove paper dust and then transferred to a blending tank. At this point, a grind test and a drawdown test are performed, and the amount of virgin black ink required (typically three to four times the amount of the processed ink) for blending is determined. The virgin ink is added to improve the color, consistency, and other functional properties of the processed ink to an acceptable range. The processed ink, after blending with virgin black ink, is called the final "recycled" ink.

The study was done at *The Hartford Courant*, which employs about 1,500 people and has a daily circulation of 225,000 and a Sunday circulation of 320,000. Approximately 175 gal of waste ink are collected per week. Previously, the ink was sent to a vendor location where it was blended with other solvents to create a supplemental fuel. Since October of 1990, waste ink has been recycled on-site and reused for printing.

Product Quality Evaluation

During the printing process, the excess (waste) ink is collected underneath the presses, along with excess fountain solution (water) and the blanket wash solution (typically an aliphatic-aromatic blend solvent). Paper dust and fibers generated by the newsprint also enter the waste ink. The recycling process should remove these impurities and restore the properties of the ink.

Two batches of waste ink were processed through the recycling unit and samples of the waste and recycled (blended) ink were collected for analysis. Samples of the virgin (new) ink used at *The Courant* were also collected and analyzed. A comparison of the analytical results of the waste and recycled inks indicates the improvement achieved by recycling, and a comparison of the recycled and virgin inks indicates how closely the recycled product approximates the virgin product.

The results of the product quality analyses are shown in Table 1. The recycled ink fared well in most of the analyses. The viscosity, as measured by ASTM D 4040-89, of the recycled ink was within ± 1 Poise and in the normal range for newspaper inks. The grind (ASTM D 1316-87) and residue (U.S. Printing Ink Method #12) analyses indicated that some very fine particulates were retained in the recycled ink, although this did not cause any problems in the printing process at *The Courant*. Tack (ASTM D 4361-89) was measured at speeds specific to *The Courant* (1200 rpm at 1 min for web-fed inks). One sample was slightly above industry recommendation and the other was within this standard. Press operators at the *The Courant* did not think that the sample that was slightly out of range was of any significant concern.

Relative tinting strength was measured by a method similar to ASTM D 387, D 2745, and D 4838, and again, one sample was slightly out of range. Since the recycled ink is blended with virgin ink, the ratio of virgin-to-processed ink could be increased to improve the tinting quality of the ink. Water content (ASTM D 1744-83)

Table 1. *Results of Analytical Tests for Product Quality*

Batch No.	Sample Type	Analytical Tests: Viscosity (Poise)	Grind (mil) 4/10 [a]	Residue (%)	Tack (gram-meter)	Tinting Strength (%) [b]	Water Content (%)	Water Pickup (%)
1,2	Waste Ink	NA [c]	NA	NA	3.4	69	23.6	NA
1	Recycled Ink [d]	19	0.4/0.3	0.0817	4.4	96	0.102	86
2	Recycled Ink [d]	21	0.6/0.3	0.0735	3.9	92	0.049	80
—	Virgin Ink	20	0.3/0.0	0.0019	4.0	100	0.057	50
—	Industry Standard	—	<0.4/<0.2	<0.01	3.7-4.3	>93	—	—

[a] *4/10 refers to 4 or 10 scratches at reported endpoints.*
[b] *Strength of recycled ink was compared to the virgin ink and given as a percentage of the virgin ink strength.*
[c] *NA = Not analyzed. Tests could not be performed because of the large amount of water in the sample.*
[d] *Processed ink blended with virgin ink in the ratio 1:3.*

analyses showed that most of the water is removed in the recycling process. No industry standards are indicated for this because it depends on the individual printing process. Operators at *The Courant* observed no problems resulting from water. Water pickup (ASTM D 4942-89) analyses determines the emulsifying capability of the ink. This parameter also varies with the printing process, and the recycled ink results posed no problems.

The visual effect and behavior of the recycled (blended) ink, once it is printed on a newspaper, was evaluated by (a) densitometer readings of black image areas of newspapers printed with virgin and recycled inks and (b) analysis by 11 experienced viewers of newspaper pages printed with recycled or virgin inks. Table 2 shows the results of the densitometer measurements. In general the recycled ink was much denser than the virgin ink on the wrapper, or exterior pages, of the newspaper. The virgin ink was only slightly denser than the recycled ink on the core, or interior pages. The results of the visual judging (Table 3) showed that the newspapers printed with recycled ink were of comparable quality to those printed with virgin ink.

Waste Reduction Potential

Waste reduction potential was measured in terms of (a) volume reduction and (b) pollutant reduction. Volume reduction addresses the gross waste stream and affects environmental resources (e.g., landfill space) expended during disposal (e.g., waste ink), whereas pollutant reduction addresses the specific hazards of individual pollutants (e.g., heavy metals) in the gross waste stream.

The waste-volume reduction potential of the technology involves the amount of waste ink and solvent that does not enter the environment (by landfilling, waste incineration, or as supplemental fuel). *The Courant* generates approximately 175 gal/wk, or 9,100 gal/yr of waste ink. This waste ink consists of 5,460 gal of ink, 546 gal of solvent and 3,049 gal of water. Recycling at *The Courant* means 6,006 gal of ink and solvent will not be disposed of. *The Courant* is also considering installing an activated carbon filter for polishing off organics in the wastewater from the separator so that the water can also be reused.

Waste ink contains a number of components that potentially could render it hazardous. The waste ink at *The Courant* has been tested and is not considered a hazardous waste per Resource Conservation and Recovery Act (RCRA) regulations and can be disposed of according to state regulations for oily wastes. Solvent washes for other inks that contain lead or chromium in their formulation are, however, listed as hazardous wastes (EPA Waste Number K086) under RCRA. In addition,

Table 2. *Results of Densitometer Readings on the Newspapers*

Paper Type [a]	Densitometer Readings (units): Location on Page [b]	Paper Printed with Virgin Ink	Paper Printed with Recycled Ink [c]	% Difference [d] (Recycled to Virgin)
Wrapper - Newspaper 1	1	0.95	1.10	14.6
	2	0.99	1.00	1.0
	3	0.98	1.09	10.6
Wrapper - Newspaper 2	1	0.91	1.08	17.1
	2	0.95	1.03	8.1
	3	1.00	1.11	10.4
Wrapper - Newspaper 3	1	0.94	1.07	12.9
	2	0.97	1.02	5.0
	3	0.91	1.04	13.3
Core - Newspaper 1	1	1.05	0.99	-5.9
	2	1.00	1.01	1.0
	3	1.02	0.92	-10.3
Core - Newspaper 2	1	1.08	1.06	-1.9
	2	1.02	1.01	-1.0
	3	1.01	1.02	-1.0
Core - Newspaper 3	1	1.05	1.01	-3.9
	2	1.01	0.97	-4.0
	3	0.97	0.98	1.0

[a] *Wrapper refers to the exterior pages of a newspaper section while core refers to the interior pages. Three complete editions were printed with virgin ink and three with recycled ink.*
[b] *The same three locations were tested on each wrapper page and each core page.*
[c] *Processed ink blended with virgin ink in the ratio 1:3.*
[d] *A positive % difference indicates that the tested areas were denser for recycled ink according to the densitometer, and vice versa.*

Table 3. Results of Visual Judging [a] for Product Quality

Parameter	Wrapper Page (outer) # Viewers Preferring Virgin Ink	Wrapper Page (outer) # Viewers With No Preference or Preferring Recycled Ink [b]	Wrapper Page (outer) Upper 95% Confidence Bound on the Proportion Preferring Virgin Ink	Core Page (inner) # Viewers Preferring Virgin Ink	Core Page (inner) # Viewers With No Preference or Preferring Recycled Ink [a]	Core Page (inner) Upper 95% Confidence Bound on the Proportion Preferring Virgin Ink
Glossiness	0	11	0.238	2	9	0.470
Smoothness	0	11	0.238	4	7	0.650
Opacity	0	11	0.238	4	7	0.650
Rub Resistance	3	8	0.564	1	10	0.364
Blackness	0	11	0.238	4	7	0.650
Absorption/ Blood-Through	2	9	0.470	1	10	0.364
Sharpness	1	10	0.364	3	8	0.564

[a] Eleven experienced viewers of newspapers.
[b] Processed ink blended with virgin ink in the ratio 1:3.

other waste inks could contain constituents that render them flammable or toxic. Many toxicity problems are caused by the pigments used. Lead, chromium, barium, and organic compounds are common toxics in pigments. Solvents in the waste ink are usually aliphatic-aromatic blends. These solvents may contain hazardous organic constituents. By recycling, virtually all of these potential pollutants in ink are reused and thus prevented from entering the environment.

The recycling process generates paper-dust residue, which is basically a paste-like substance containing paper fibers covered with a thick mass of ink. The hazards associated with this residue are the same as those discussed above for the ink, but the advantage is that, for every 200 gal of waste ink, less than 1 gal of this residue is generated.

Economic Evaluation

The economic evaluation took into account the capital and operating costs of the recycling equipment, as well as the savings resulting from reduced amounts of raw materials (virgin ink and solvent) and disposal costs. A return on investment of about 9% is obtained in the tenth year of recycling. With a payback period of about 10 yr for the $318,000 capital requirement, the recycling equipment tested here is a large investment, even for a medium- to large-size newspaper such as *The Courant*. Smaller modules with similar capabilities are, however, commercially available and could be considered by smaller newspapers. As the cost of disposal continues to grow (as indicated by current trends) and issues of long-term liability assume greater importance, the economic attractiveness of this system can be expected to increase.

Discussion

The waste ink recycling evaluation demonstrated that the potential for waste reduction with ink recycling is promising. *The Hartford Courant* reduced waste volume from over 9,000 gal of waste ink to approximately 46 gal of paper dust and 3,049 gal of wastewater per yr. The recycled product fared well in both product quality testing of the recycled ink and quality of the actual printed material. The slight deviation of some recycled ink test results from the industry standard did not cause any noticeable reduction in print quality. The blanket wash solvent in the waste was also recovered and reused. The wastewater (generated from the fountain solution component of the waste) contained some levels of contaminants that make it toxic; however, the small volume of this wastewater (254 gal/mo) should not be a problem for a POTW. Nevertheless, it would be desirable from a resource recovery standpoint, to recover this water on-site by passing it through an activated carbon filter and reusing it.

Economic incentive for recycling is the value of the ink and solvent recovered, as well as reduced disposal costs and potentially reduced liabilities through direct control over potentially hazardous waste. If waste disposal and liability costs follow current trends, the economic incentive for recycling will improve.

A much smaller recycling system than the one installed at *The Courant* would be sufficient for smaller newspapers. The technology (distillation and filtration) used at *The Courant* is fairly straightforward, and smaller scale units can be assembled. Several smaller vacuum distillation batch stills are commercially available at much lower cost. Some smaller newspapers have designed their own filtration systems for reclamation of ink. Another option for smaller newspapers is to use the services of a mobile, truck-mounted recycling system that goes from site to site and recycles waste ink for a charge. One such mobile unit is being operated by a vendor in California. Printers other than newspapers, may be able to use similar technologies.

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The complete report, entitled "On-site Waste Ink Recycling," (Order No. PB93-141026; Cost: $19.50, subject to change) will be available only from
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