Recycled paper and sludge

As the use of recycled paper increases across the nation, consumers are beginning to question the environmental implications of the paper manufacturing process and its waste by-products.

Removing the ink, clay, coatings and contaminants from waste paper in order to salvage reusable cellulose fibers to produce recycled paper creates deinking sludge. And deinking sludge creates disposal problems. The sludge also creates consumer concern about the potential presence of heavy metals, polychlorinated biphenyls (PCBs) and dioxin.

Is recycled paper harmful to the planet? What are the environmental liabilities associated with this aspect of paper recycling? And what can be done with all that sludge?

Recycled paper mills and sludge
Deinking mills shoulder sizeable costs, not only from the capital investment required to establish a deinking facility but also from the expense of managing and disposing the waste by-products.

Thirty-one tissue mills, nine newsprint mills, nine printing/writing mills and eight market pulp mills in the United States have deinking facilities, with a total annual capacity of approximately five million short tons, according to the American Paper Institute. The amount and nature of sludge generated is directly related to the type of waste paper consumed by the mill. Along with the inks, deinking removes other noncellulose materials from the fiber, including coatings, adhesives, dyes and fillers like calcium carbonate and clay, as well as obvious trash like paper clips, baling wire, staples and banana peels. All wind up in the sludge.

"Yield" is the term used by paper manufacturers for the amount of usable fiber rendered after the cleaning and deinking processes remove contaminants. In a recent report for the Recycling Advisory Council, Franklin Associates, Ltd. estimated average yields of 90 percent for recycled paperboard and containerboard, 85 percent for newsprint, 75 percent for tissue and 70 percent for printing/writing papers. An API spokesperson indicated that some mills are reporting yields as low as 60 percent when using mixed post-consumer waste paper.

Each deinking operation produces sludge with somewhat unique characteristics, depending on the type of waste paper processed. Waste paper with high amounts of filler, such as clay-coated magazine paper, produces much lower yields of usable fiber than does waste paper that is mostly cellulose fiber, such as computer printout or old newspaper. Paper that is only lightly printed will produce less sludge than paper that is heavily printed. Alkaline papers contain high filler-to-fiber ratios and, therefore, produce more sludge. Post-consumer feedstocks generally produce more sludge than pre-consumer grades because they tend to be more heavily contaminated.

Solid waste disposal problem
Deinking sludge is definitely a solid waste disposal headache. The Franklin report estimated that about 700,000 tons of sludge will be generated by deinking and repulping operations in 1995. Disposal is becoming a major problem because siting new landfills is difficult and because few commercially viable uses exist for sludge. Some paper industry representatives believe that while the government mandate for paper recycling may extend the lives of municipal landfills, it unfairly shifts responsibility and costs for solid waste disposal to private landfills managed by paper mills.

An illustration of sludge generation potential by recycling mills is offered by Pat Hoekstra, a process consultant with Jaakko Pöyry, Inc., in an article published in American Papermaker in April.
1991. Hoekstra calculated that a large, state-of-the-art deinking mill (500 metric tons per day with an 87 percent yield) generates 175 cubic yards of sludge per day — enough to cover two acres of land in one year with a layer of sludge 20 feet deep.

Disposal options
Traditionally, deinking sludge has been handled in three different ways: landfilling, incinerating and landspreading.

Landfilling. Landfilling is the most widely used method for disposal of deinking sludge. Before the sludge is landfilled, water is removed from it to make it about 40 percent solids. Some mills are permitted to use municipal landfills, but most use their own private disposal facilities. Private landfills, like public ones, are becoming more difficult to site because of community opposition, protracted and complex state environmental permitting processes, and rising real estate costs. Siting problems are particularly difficult for new recycling projects, which tend to be located near good sources of waste paper, in urban areas where land costs are higher.

Incinerating. A few mills burn deinking sludge in their boilers as “hog” fuel. This practice is not widespread, however, because the high moisture of the sludge affects its ability to burn efficiently. To enhance its heating value, the sludge is sometimes mixed with dry waste material (such as wood chips).

Fluidized bed combustion is one emerging technology that works particularly well with the wet sludges produced by deinking mills. In this process, air is bubbled through a bed of inert material (usually sand or limestone), which greatly improves the combustion process. This technology also produces fewer sulphur dioxide and nitrous oxide emissions than do conventional hog boilers.

Burning sludge is advantageous because the landfill volume required for ash disposal is about 25 percent of that required for sludge. In addition, boiler ash from deinking sludge incineration is sometimes used as an aggregate in cement and concrete. Sludge ash concentrates heavy metals, however, and if found to contain hazardous levels, the ash requires special handling.

Landspreading. Several mills landspread sludge. One example is Pope & Talbot, a 100 percent recycled tissue mill in Eau Claire, Wisconsin. The sludge, which is composed of 50 percent inorganic fillers (clay and calcium carbonate) is spread on farmland with the farmers’ cooperation and approval. The material adds some organic matter to the soil and provides trace nutrients, including nitrogen, phosphorus and potassium. The calcium carbonate acts as a lime substitute, which helps balance overly acidic conditions. The clay increases the soil’s capacity to hold nutrients and is particularly effective for sandy soils. The Pope & Talbot mill conducts detailed evaluations of each site to ensure that the sludge is spread on appropriate soil types. Important factors such as depth to groundwater or bedrock, and the location of homes, wells and surface water are all taken into account. Landspreading is only done during spring and summer because it cannot be performed properly if the ground is frozen or too waterlogged.

The U.S. Environmental Protection Agency recently published proposed regulations for the disposal of deinking sludge.
regulations for the landspreading of sludge from pulp and paper mills using chlorine and chlorine-derivative bleaching processes. Among other things, the proposed regulations would establish stringent standards for organochlorine (such as dioxin) levels in the sludge. The regulations do not differentiate between virgin paper mills and recycling mills. (Though many recycling mills do not use elemental chlorine in their bleaching processes, organochlorine molecules from the recycled paper are usually present in minute but detectable levels in recycling sludges.) Many paper industry representatives and the American Paper Institute have challenged the scientific validity of the risk assessment conducted by EPA.

Toxicity

**Heavy metals and PCBs.** In the past, the greatest percentage of hazardous material in deinking sludge came from the inks and pigments used on the waste paper. In recent years, however, ink manufacturers have made enormous strides in eliminating heavy metals from commercial printing inks.

| Table 1 — Heavy metal content of sludge in parts per million (1) |
|------------------|------------------|------------------|
|                  | Deinking sludge | Deinking sludge | Municipal |
|                  | lowest content  | highest content | sludge    |
| Cadmium          | 0               | 0.2             | 15        |
| Chromium         | 16              | 118             | 200       |
| Copper           | 31              | 400             | 1,000     |
| Lead             | 3               | 210             | 600       |
| Manganese        | 31              | 660             | 300       |
| Nickel           | 1               | 25              | 50        |
| Zinc             | 36              | 1,200           | 1,200     |

(1) Heavy metal content in sludge samples from five deinking plants compared with a sample of municipal sludge.


While deinking sludge is routinely tested for leachable heavy metal content, a recent study found that a municipal sludge sample contained three times the amount of lead and more than double the amount of copper typically found in deinking sludges (see Table 1). Polychlorinated biphenyls (PCBs) are another potentially hazardous material that can occasionally be found in deinking sludge. Their source is almost exclusively old file stock that contains old carbonless paper. Because carbonless manufacturers stopped using PCBs 20 years ago, however, the sporadic incidence of this material will diminish over time.

**Dioxin and furan.** Dioxin has been called the most toxic substance known to man. Although the accuracy of that charge has been challenged, definitive answers are difficult to reach because of the lack of scientific consensus, even on methods of measurement. The federal...
government has not established regulations that set acceptable levels in paper mill water effluent for the family of organochlorines, commonly known as dioxin and furan. Proposed EPA regulations for the landspreading of paper mill sludge would set a de minimis concentration level for these substances of 10 parts per trillion (ppt).

Many states now regulate dioxin levels. Maine, a major papermaking state, has the most stringent regulations for organochlorine levels in paper mill sludge. The state has a tiered standard, where sludges with dioxin and furan levels of 27 ppt or lower are approved for agricultural applications, while levels of 28-250 ppt are restricted to nonagricultural uses. Sludges with levels higher than 250 ppt cannot be landspread in Maine. Most deinking sludges fall within the middle range and, therefore, are acceptable for nonagricultural uses.

**Environmental permitting**

At the same time that state governments are imposing recycled content requirements on the paper they buy and are providing economic incentives for the paper industry to build new deinking facilities, they are also imposing complex environmental permitting requirements on paper companies. Many paper industry officials report that obtaining government permits is their single biggest obstacle in getting a recycling operation on line.

**Alternative uses for deinking sludge**

Recognizing that sludge disposal is a growing concern, the paper industry is engaged in intensive research (much of it proprietary) to develop alternative uses for the material.

**Fiber recovery.** Prime Fibers of Appleton, Wisconsin has developed a technology that recovers fibers from paper mill sludge and processes them for reuse in papermaking. According to Robert Orth, the company's president, high transportation costs and Wisconsin's relatively low landfill fees have made reclaiming fiber from sludge economically unprofitable. Prime Fiber has applied the technology to waste paper deinking, however, and the company currently runs a successful commercial office waste paper deinking operation.

**Landfill liner and cap.** In the future, deinking sludge with high clay content could be used as liner and capping material for landfills. Experimental landfill cells using sludges as barrier materials have shown promising results, according to recently published findings of the two-year field study conducted by the National Council of the Paper Industry for Air and Stream Improvement.

**Composting.** Resource Conservation Services of Brunswick, Maine, has pioneered the composting of paper mill sludge. According to Tom Rumpf, manager of the company's Residual Utilization Group, RCS has worked with several deinking mills in New York and Maine over the past few years, developing marketable compost products. Deinking sludge is mixed with a variety of organic sludges, including municipal sludges and food and fish processing waste. The resultant compost is sold in bulk for commercial uses, such as road-side revegetation projects, golf courses and commercial landscaping. (The product is generally not used for agricultural

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RCS has not experienced any incidents of heavy metal or PCB contamination when using the sludge, according to Rumpf.

Grow-Rich, in Niagara Falls, Ontario, also produces compost by mixing paper mill sludge with organic ingredients. Manufacturing about 200 tons per day, the company ships the compost to a large chain of Canadian garden centers. According to Ed Ciepiela, Grow-Rich is restricted to a horticultural market because the company's production volume is too small for agricultural applications.

Carrier for chemicals. One company with commercially viable sludge disposal technology is a subsidiary of Fort Howard Corporation, the largest producer of deinking sludge in North America. Granular Technologies, Inc. (Granutech) pelletizes the recycled tissue mill's sludge for use as an inert carrier for agricultural pesticides and herbicides. The technology does not produce any waste by-products. The sludge is dewatered and pelletized without the addition of any other materials, according to Steve Anderson, Granutech's manager.

Other potential products that may be developed from the technology include kitty litter and absorbent materials to clean grease and oil spills.

Conclusion

Recycled paper can be produced without any deinking sludge. Mohawk Paper Company in upstate New York, for example, manufactures recycled paper from waste paper that has not been deinked. The company uses this fact to its marketing advantage. According to Scott Petrequin, senior vice president at Mohawk, customers have adjusted to the "ecology spots" on the company's recycling printing papers.

But Jerry Goodman, executive vice president of Ponderosa Fibres of America, the largest manufacturer of recycled market pulp in the world, asserts that nondeinked recycled paper is made principally with "direct entry grade" feedstock (i.e., white envelope cuttings, unprinted cup and plate stock, hard white shavings), clean waste paper that is rarely landfilled. "I strongly suspect that if a mill is making an acceptable product and is not deinking, then obviously there wasn't much ink on the paper to start with," he said. "If you don't have to process the paper, why are people spending $40 million for a deinking system?"

The production of most recycled newsprint, tissue, and printing and writing papers does require deinking.

Although sludge generated by deinking mills does not appear to be toxic or harmful, its volume makes disposal a growing problem. While dioxin may be present in recycling mill sludge and effluent, the deinking process itself does not contribute to the presence of these organochlorines. They are a result of the chlorine bleaching conducted during the virgin papermaking process. The overall benefits of recycling appear to outweigh any potential environmental liability caused by the deinking sludge. In present applications, sludge has some proven benefits, and significant research and development is currently underway to discover other commercially viable uses.

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