WIDE RANGE OF FEEDSTOCKS

PULP AND PAPER INDUSTRY'S DIVERSE ORGANICS STREAM

By-products from the pulp and paper industry fall into many categories — from industrial sludges that are land applied or composted to postconsumer fibers that are part of organics composting programs.

Conni Kunzler

T HE PULP and paper industry generates a variety of organic residuals — from paper mill solids and wood ash to postconsumer recovered fiber — that are suitable for beneficial use via land application and composting. In 1999, 47.3 million tons of paper were recycled, primarily into new paper and paper products. Over three million tons were used beneficially for land application and just over 300,000 tons were recovered via composting.

The pulp and paper industry is represented by all types of mills — from those with a feedstock that is 100 percent recovered paper to those that use only wood fiber, and every combination in between. In 1999, recovered fiber’s share of total fiber consumption at U.S. mills was 36.5 percent. This is up from 36.1 percent in 1998 and 25 percent in 1988.

Production processes as well as paper grade manufactured vary greatly among mills. Therefore the types and amount of residuals produced also vary. Typically, however, pulp and paper mill by-products include wastewater treatment residuals (commonly referred to as sludge), wood ash, causticizing area waste, secondary fiber rejects and paper mill rejects.

The National Council for Air and Stream Improvement (NCASI), a nonprofit environmental research organization funded by the forest products industry, gathers data every five years on the solid waste management practices of the U.S. paper industry (2000 data will be available in 2002). In 1995, according to NCASI, the pulp and paper industry produced about 5.8 million dry tons of wastewater treatment residuals. Of this, about half was beneficially used — 26 percent recovered for energy, 12 percent directly land applied, and one percent composted.

Wastewater treatment residuals include solids from primary treatment, secondary treatment or both combined. Primary treatment solids vary in composition depending on the type of mill but can include fiber, clay, inks and dyes, boiler ash, and other materials removed in separation of solids from raw wastewater. Secondary solids are comprised of microbial biomass from the biological treatment of wastewater.

Approximately 2.8 million tons of wood ash were produced in the pulp and paper industry in 1995; 28 percent was used for land application and construction, and less than one percent was composted. Higher residual ash content is more likely at deinking mills and those that produce a coated paper. Wood ash comes from the use of wood as a fuel in mill power boilers. Coal and other solids such as paper mill sludge or even tires also may be burned, resulting in a multifuel ash.

Causticizing area waste — lime mud, green liquor dregs, and slaker grit — are produced at kraft pulp mills as a chemical recovery processing by-product. These residuals have a high pH (8.4 to 13.0) and a lot of calcium. About 100,000 tons/year are applied directly to agricultural/silvicultural land. About 1,500 tons were used in compost in 1995.

Paper mill rejects include dirt, other contaminants, and some short fibers. These residuals do not include “broke,” which is paper trimmings and off-spec paper often put right back into the papermaking process. In 1995, approximately 17,000 tons of paper mill rejects went to composting.

More than three million tons of paper and pulp residuals (closeup view shown at left) were beneficially used for land application in 1999, with 300,000 tons recovered via composting.

BENEFICIAL CHARACTERISTICS OF RESIDUALS

Land application of pulp and paper residuals provides plant nutrients and organic.
On slopes in the Northwest (far left), juniper trees—which are considered a nearly unusable weed that can only be cut and left to burn or rot—are processed with a portable band mill (left). David Sintay (below) stands alongside furniture and paneling made from juniper wood that has been resawn and dried.

a way could be found to harvest the fiber economically. Juniper, explains Willis, is a beautifully grained, strikingly colored, hard wood that looks much like Australian Cypress but is generally a bit lighter and much less expensive. The wood dries well and, once dry, does not expand and shrink excessively. It also takes stains and finishes well.

Despite its beauty and usefulness, harvest levels have traditionally been low. "That's mostly," Willis says, "because the tree is difficult to harvest and mill economically. The complication is that it is difficult or impossible to assess quality until a log is actually processed." To obtain good lumber, logs must be milled soon after felling; before they dry excessively and unevenly.

To solve the production problems posed by Juniper, the Sintays utilize a portable band mill—a Wood-Mizer Products mill. Juniper logs are broken down right where they are harvested, producing cants (wood timbers later resawn down to desired dimensions) that can be inspected for quality on site and hauled to processing facilities elsewhere.

The Sintays' Wood-Mizer is a hydraulic unit with electronic controls so one person can easily saw several thousand board feet of logs per day into cants with the machinery doing the work of lifting the logs into place, rotating the logs, and sawing them into precisely sized dimension lumber. The portable saw is moved to an area scheduled for juniper removal, where select trees are dropped, logs removed, and cants are sawn. They are taken to the company's processing facilities in John Day, where lumber is resawn and dried then turned into high quality furniture, flooring, paneling, and other products.

MATERIALS HANDLING METHODS

By breaking down the logs where they are harvested, the quality of the potential lumber can be checked on-site so only good wood is transported to the secondary processing facility. Unusable material is stacked and left behind to provide wildlife habitat. The cants, which consist of almost entirely usable fiber, are now valuable raw materials that can be economically transported and processed. The application may have tremendous environmental consequences in, for example, the dangerously overgrown pine forests of the interior American West. Those forests, it is almost universally agreed, must be thinned to restore them to the condition they were in before settlement but the thinning is difficult and expensive due to the small size of the fiber that needs to be removed. At least some of that small diameter material could be sawn into cants in the woods, just as the Sintay brothers do with juniper, and then transported to mills as a high value, and highly desired, product rather than cut and disposed of as is presently the case. Sale of the wood could help reduce the costs of treatment.
matter to soils and crops. Table 1 lists the concentrations of major nutrients for selected pulp and paper mill residuals. Municipal biosolids (wastewater treatment sludge) is included for comparison. As the table shows, the paper residuals have relatively low concentrations of most nutrients (calcium and magnesium are exceptions). However, the nutrient concentrations depend on the source of the residuals (primary versus secondary sludge) and the specific mill. In general, primary sludges have lower nutrient concentrations than secondary sludges. The wastewater treatment processes that generate secondary sludge concentrate some nutrients. In addition, nutrients, particularly nitrogen, are commonly added to aid in wastewater treatment. Of the causticizing residuals, green liquor dregs contain the highest nutrient concentrations (except calcium). All causticizing residuals tend to have a high calcium concentration and a high pH. With their high pH, causticizing residuals and wood ash serve as good liming agents. Perhaps the primary value of pulp and paper mill residuals to soils is the organic matter. Most pulp and paper residuals contain moderate to high levels of organic matter. Again, it depends on the mill and type of residuals produced. Exceptions include wood ash and a few other residuals with a high ash content. The organic matter imposes soil structure, soil biology, and moisture retention and helps to prevent nutrients from leaching. However, because of the low nutrient concentration, land application of paper mill residuals can lead to temporary immobilization of nutrients in the soil. This is particularly important for nitrogen. The carbon to nitrogen (C:N) ratio of pulp and paper residuals is typically high (see Table 2), reflecting the fact that these residuals originate from wood products. Secondary sludge, with more nitrogen, tends to have a more moderate C:N ratio. Therefore application rates must be limited and/or supplemental fertilizer needs to be supplied. The high C:N ratio is one reason in favor of composting pulp and paper mill sludge (composting lowers the C content).

The important composting characteristics of several pulp and paper mill residuals are listed in Table 2. Excluding wood ash, these residuals have an ideal to slightly high moisture content for composting. Again excluding wood ash, the electrical conductivity (EC) is very low but the pH varies greatly. C:N ratios vary widely depending on the source of the residuals. Because of the low nitrogen concentration (high C:N ratio), pulp and paper residuals are composted with high nitrogen feedstocks. Several composting facilities include wood ash in their feedstock mixture to decrease the moisture and increase the mineral content of the mix. Wood ash is also thought to reduce odors by adsorbing odorous compounds. (See "Wood Ash Finds Niche In Biosolids Composting," January, 1997).

**COMPOSTING WASTEWATER SOLIDS**

William Thacker, a senior research engineer at NCASI, is conducting a survey on the experience with composting paper mill by-products. According to his research, about two dozen mills have one or more materials composted. In most cases the materi-

### Table 1. Major nutrients in selected pulp and paper mill wastewater sludges and causticizing residuals

<table>
<thead>
<tr>
<th>Material</th>
<th>Nitrogen (N)</th>
<th>Phosphorus (P)</th>
<th>Potassium (K)</th>
<th>Calcium (Ca)</th>
<th>Magnesium (Mg)</th>
<th>Sulfur (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean*</td>
<td>Range</td>
<td>Mean*</td>
<td>Range</td>
<td>Mean*</td>
</tr>
<tr>
<td>Primary sludge</td>
<td>0.51-9.0</td>
<td>2.7*</td>
<td>0.01-4.0</td>
<td>1.6*</td>
<td>0.12-10</td>
<td>2.2*</td>
</tr>
<tr>
<td>Secondary sludge</td>
<td>6.2-67.5</td>
<td>23.3*</td>
<td>0.03-16.7</td>
<td>4.2*</td>
<td>0.37-60</td>
<td>1.37</td>
</tr>
<tr>
<td>Combined paper sludge</td>
<td>1.1-59</td>
<td>8.5*</td>
<td>0.1-25.4</td>
<td>6.7*</td>
<td>0.61-16</td>
<td>0.66</td>
</tr>
<tr>
<td>Combined pulp sludge</td>
<td>1.4-41</td>
<td>29</td>
<td>1.3-5.8</td>
<td>3.4</td>
<td>0.8-3.4</td>
<td>0.46*</td>
</tr>
<tr>
<td>All sludges (ME)</td>
<td>0.1-61</td>
<td>11.1*</td>
<td>0.01-3.1</td>
<td>0.85*</td>
<td>0.15-265</td>
<td>0.96</td>
</tr>
<tr>
<td>All sludges (AL)</td>
<td>3.0-15.5</td>
<td>8.76</td>
<td>0.19-2.57</td>
<td>1.2</td>
<td>0.03-2.7</td>
<td>0.44</td>
</tr>
<tr>
<td>Lime muds</td>
<td>2.0-3.0</td>
<td>1.78</td>
<td>1.0-5.7</td>
<td>2.83</td>
<td>&lt;0.2-1.16</td>
<td>0.44</td>
</tr>
<tr>
<td>Green liquor dregs</td>
<td>1.6-4.2</td>
<td>2.7</td>
<td>0.13-11.7</td>
<td>0.67</td>
<td>0.33-11.5</td>
<td>4.63</td>
</tr>
<tr>
<td>Sicker grits</td>
<td>1.9-6.0</td>
<td>0.67</td>
<td>0.23-1.68</td>
<td>0.81</td>
<td>1.32-6.98</td>
<td>2.70</td>
</tr>
<tr>
<td>Municipal biosolids (for comparison)</td>
<td>&lt;1.9-210</td>
<td>32.0</td>
<td>&lt;1.9-159</td>
<td>14.0</td>
<td>0.2-650</td>
<td>23</td>
</tr>
</tbody>
</table>


Notes: *Indicates the median value. Otherwise the mean value is given; 1From NCASI survey of 54 mills, all sludges includes primary and secondary sludges; 2From survey of Wisconsin pulp and paper residuals; 3From survey of 5 mills in Alabama; 4From survey of 7 mills in Maine, all sludges; 5From survey of 7 mills in Alabama, all sludges; To convert g/kg to percent, divide by 10

Depending upon the specific mill, pulp and paper residuals contain moderate to high levels of organic matter with relatively low concentrations of most nutrients.
At its Otsego, Michigan mill, the Menasha Corporation operates a 50-acre compost site that produces a soil amendment from sludge and hardwood fines, and a topsoil made from sludge and sand. “We feel good that we have a green process here,” says a Menasha manager. “It’s true cradle to grave, and it’s good stewardship.”

1998). At its Otsego, Michigan mill, which produces corrugated medium, Menasha has partnered with Jim Glas of Renewed Earth, Inc. to compost about half of the 60,000 cubic yards of paper mill sludge produced each year on a 50-acre site next to the mill. The other half is land applied.

“We haven’t landfilled one drop of sludge since 1974,” says Dave Merkel, technical manager with the Menasha Paperboard Division. “We started experimenting with composting in 1992 and then worked on permitting, and went into full-scale production about four or five years ago.” The operation produces a soil amendment from paper mill sludge and hardwood fines, and a topsoil made from sludge and sand. “Our products are sold mostly to landscapers, golf courses, departments of transportation, and a host of other government agencies and private businesses,” says Merkel.

The mill, which uses both recycled corrugated and wood chips to manufacture its end product, turns out a sludge that is beneficial and highly conducive to composting. “It has worked out well for us,” says Merkel, “and we feel good that we have a green process here. It’s true cradle to grave and it’s good stewardship.”

**COMPOSTABLE POSTCONSUMER PAPER**

According to the American Forest & Paper Association (AF&PA), over 6.5 million tons (less scrap) of compostable postconsumer paper and paper products are produced annually. This includes paper yard bags, waxed corrugated containers, milk cartons, paper plates, cups, napkins, and towels. A study conducted by BioCycle for AF&PA in 1999 concluded that 300,000 to 325,000 tons of postconsumer paper were composted. This is up about 60 percent from the 1998 estimate of 200,000 tons.

The estimate includes paper composted in the municipal and institutional, industrial and commercial sectors as well as paper yard bags.

Waxed corrugated cardboard from supermarkets, meat packing plants, produce distribution centers, and furniture and appliance distributors accounts for much of what is composted. To help link these sources to composters able to take such fiber, AF&PA established an online directory in 1998 (www.afandpa.org). The searchable directory contains contacts for nearly 100 composters who accept paper feedstocks, as well as other categories of processors. Composting and other recycling sites can be added online.

The volume of waxed boxes destined for composting is likely to decrease slightly in the future. “New innovations in the paper industry are eliminating the need for wax coatings in some applications,” says Dave Stuck, executive director of the Containerboard and Kraft Paper Groups at AF&PA.

“For example, when transporting broccoli, there is a new innovative corrugated box that eliminates the need for icing and therefore the waxing of the box.” Nonwaxed boxes can be recycled with other corrugated, thus eliminating the need for an alternative management method such as composting.

Milk cartons, generated primarily at schools and homes, can be recycled at about a half dozen mills across the country. Many communities and schools, however, are not near a mill that accepts beverage cartons, and these are finding a home at composting facilities. For example, the city of Plano, Texas collects beverage cartons from seven schools and 20 businesses. Organics are picked up daily by an automated, double-sealed truck and taken to the city’s composting site 45 minutes away. According to
A 1999 AF&PA study showed that high quality compost can be produced using laminated paper products, including milk cartons, as feedstock.

Heidi Smalley with the city of Plano, when the composting program is fully implemented, organics will be collected from 70 schools and businesses.

A 1999 AF&PA study conducted in conjunction with Dartmouth College's composting program showed that high quality compost can be produced using laminated paper products, including milk cartons, as feedstock. The study also found that paper products such as cups, plates, and bowls recovered from an institutional food service setting degrade at a rate consistent with other organic constituents.

Napkins, towels, tissue, and other soiled papers -- as well as paper beverage cartons -- also are included in residential organics collection programs. Residential food, soiled paper, and yard trimmings compostables collection is part of the city of San Francisco's "Fantastic Three" program which started in April, 1999 and has grown to more than 15,000 households plus businesses (see "San Francisco Takes Residential Organics Collection Full-Scale," February, 2000). The program is anticipated to expand city wide to more than 128,000 households over the next three-and-a-half years. "The paper products provide a carbon rich balance to the feedstock and help absorb liquids," says Jack Macy, organics recycling coordinator for the city of San Francisco. "In fact, we encourage people to wrap their food in newspaper or used paper bags to keep the containers for compostables clean."

Some communities also are composting other types of papers, often for lack of a recycling market within an economical distance. For example, a pilot program in Austin, Texas that began in September is collecting boxboard at curbside along with yard trimmings for composting. "We have a market for our other papers, but not for this, so we are having residents put out their boxboard in paper grocery bags along side any yard trimmings they might have," says Sam Farias, senior planner for the city of Austin. "We have been testing the composting of this material with the yard trimmings."

WOOD RESIDUES

As a result of technological innovations over the past 20 years, about 95 to 99 percent of wood fiber that goes into mills is utilized. Secondary fiber that is not processed into products is generally used as fuel. "The pulp and paper industry is not really a source of scrap wood for composters or other processors," says Brad Williams, manager of AF&PA's Timber Management and Supply group. Therefore, the primary sources for used and scrap wood are the municipal waste stream, construction and demolition activities, deconstruction, pallets, primary timber processing, and land clearing for utilities, highway construction, and other projects.

According to the U.S. Department of Agriculture's Forest Products Lab in Madison, Wisconsin, 162 million tons of waste wood were generated in 1998, (see "How Woody Residuals Are Recycled in the United States," December, 1999). About 132 million tons were recovered, combusted, or not usable. Another 29 million tons were available for recovery. To help communities and businesses with wood residues and by-products connect with processors that recover these materials and use them for new products, in 1996 AF&PA initiated the National Wood Recycling Directory. Updated in 1999, this online directory (www.afandpa.org) contains over 700 processors.

DIVERSION ORIENTATION

The paper industry has always seen land application, composting and other beneficial uses for pulp and paper as great options for paper fiber that cannot be traditionally recycled. "The goal, really, is to keep fiber out of the landfill and put it to use," says Williams. The most accessible fiber streams -- and the most amenable for composting -- are wastewater treatment residuals and wood ash, and postconsumer paper and paper products. The value and precedent for land application and composting these materials continues to grow. They have proven to be a good source of carbon, organic matter and nutrients.

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