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Research on Solid Waste Recycling at the Forest Products Laboratory
by H. E. WAHLGREN

The Environmental Decade

In the late 1960's a large segment of the American public became alarmed at what was seen as wasteful depletion and polluting use of our natural resources. The hue and cry that was raised carried us into "the environmental decade" a time for positive action to solve the perplexing problems that beset man in an increasingly crowded world.

We at the Forest Products Laboratory participated in the great environmental discussions of the last few years . . . and we listened. We heard many statements about the role of forests and forest products in the environment that were based on emotionalism and fancy rather than fact. But we also heard many people who had a sincere desire to acquire and contribute sound knowledge.

Some of our priorities and procedures have changed, but our basic concepts of timber conservation have not changed. Forests must continue to provide multiple benefits and thousands of products to the American people. Timber must be harvested and processed with the least possible waste and pollution. To follow any other course invites disastrous consequences through increased use of nonrenewable substitutes for wood and excessive pollution from their processing. The central problem today is how to use our timber wisely for the greatest good with the least possible detrimental effect on the environment.

New Responsibilities

With this challenge the Forest Products Laboratory took a hard look at its goals and initiated firm steps toward redefining its mission. A mission was defined, one that is concerned with people, their needs and their well being. Basically, the mission is aimed at achieving better utilization of the timber resource. Increased wood utilization research can reduce damage to the environment, and do much in the decade ahead to alleviate the timber supply problem now faced by our Nation.

As a result of this soul searching, the Forest Products Laboratory has defined ten research areas that now are the framework on which our research program is built. One of these areas is concerned with recycling wood fibers. This research, conducted by my associates at the Laboratory, is the basis for this article.
Solid Waste and Recycling

We in the United States have the highest per capita consumption of power, the highest per capita consumption of raw materials, and also the highest per capita production of waste of any other nation on this earth.

The solid waste problems of our cities have received much attention recently, and rightly so. They are very real problems that affect all of us. According to the Bureau of Solid Waste Management, American cities collect and dispose of more than 350 million tons of solid waste annually at the staggering cost of $4.5 billion. The Bureau also estimates that this lost resource would be worth at $1 billion per year if it was reclaimed and reused. The real solution of the acute solid waste problem is not disposal, but waste recycle.

Discarded paper products constitute an important part of the city solid waste. To most people, wood fiber product recycling means simply converting wastepaper into paper again. Our scientists, however, take a much different view of what recycling should mean, as it relates to wood and wood fiber products.

The raw material we want to use includes the trash discarded where masses of people congregate—manufacturing and converting plants, stores, offices, hotels, schools, and hospitals.

Most people overlook the fact that much larger quantities of recyclable solid wood waste exist. There are residues from urban forestry; there is demolition waste and related construction debris; there is primary manufacturing residue; and there are general discards such as dunnage material and railroad ties. Virtually all of this waste is left for destruction or decomposition in landfill, open dumps, or incineration plants. Despite increasingly stringent laws, more than 80 per cent of city solid waste still goes into open dumps; and all too frequently, organic material is burned, contributing to air pollution.

Enough information is available to make a “guess-timate” that all of this waste represents the equivalent of nearly 5 billion cubic feet of annual timber cut in the United States. This figure becomes significant when we realize that projections of demand for wood products indicate that the United States will not have an adequate timber supply in the future, perhaps as soon as the mid-1980’s. We must get more heavily involved in recycling wood fiber if we are to maintain the forest resource in a desirable state.

There is nothing new about paper recycling; it has been practiced in the United States for some 60 years. Back in 1944-45, the paper industry under a variety of restraints recycled 35 per cent of the paper consumed. With today’s practices of collecting, sorting, and transportation, just under 20 per cent is recycled and prior to the present pressures to increase recycling, this percentage was projected to decrease further.

![Diagram](M 138 685)

Figure 1.—Target system for removing wood fiber products from municipal solid waste.
RECYCLING SYSTEMS

While present recycling systems deserve our support, they do little for mixed wastepaper in household refuse; and this accounts for approximately one-third of the 56 million tons of paper and paperboard consumed annually in the United States.

Present systems also do very little about the mountains of solid wood waste in our cities. About 100 mills in the United States currently use wastepaper to some extent. The commercial systems used by all these mills have one thing in common. The wastepaper they use is not allowed to get into trash; it has been sorted out before the waste reaches a mixed stage. Collection of newspapers or used corrugated containers at supermarkets for resale to mills are two examples. Reclaiming wood fiber after it is mixed with many other materials, as in municipal waste, is a vastly more complex problem.

FPL TARGET SYSTEM

The first Laboratory concern was with household waste. More recently, the program has included urban solid wood and wood fiber waste. An important factor was that the City of Madison had a refuse reduction plant and the City officials were very receptive to a cooperative undertaking. Leading up to our present installation of demonstration pilot-size equipment at the Madison refuse reduction plant were a series of studies identifying the processing components and settling on procedures for crude and refined separations. What did we learn?

We found that Madison’s household trash was 47 per cent paper and paperboard. There was no good way, however, to distinguish paper grades other than the fact that 40 per cent of the fiber was groundwood, the major constituent of newsprint.

To shed light on the grades of paper which made

Figure 2.—Forest Products Laboratory equipment for the study and demonstration of techniques for separating materials in mixed household refuse.

(M 139 833)
up citizen discards, a study was conducted with Laboratory employees. Our employees, admittedly a biased sample, were asked to volunteer to separate and bring to the Laboratory all of the paper they would normally discard as trash in a period of 14 consecutive days. Approximately 35 per cent agreed to participate in this experiment in April of 1970.

The volunteers were given limited instructions and asked to separate their paper product discards into four categories: newsprint, magazines, strong papers and paperboards, and all others. The material was weighed and then resorted by experts.

This experience taught us a lesson that except for newspaper, people are reluctant to separate their trash and any dependence on their effort to sort paper would cause surprises and upsets to any retrieval system based in presorting by the user. Total paper discards amounted to 183 pounds per person per year consisting of 47 per cent newspapers, 13 per cent magazines, 12 per cent strong papers, and 28 per cent all others.

Our next step was to evaluate the steps that seemed necessary to recover and upgrade wastepaper from municipal solid waste. Figure 1 is a simplified version of our “Target System” for retrieval of paper from household refuse. A cooperative agreement was signed with the City of Madison and all parts of the target system have been assembled and are being tested on a pilot scale.

PILOT FACILITIES

Waste material, as collected in the City by conventional trash pickups, is first reduced to a fairly uniform size in hammermills. The hammermills are operated by the City of Madison at the first refuse reduction plant established in the United States.

The hammermills break glass, flatten metal cans, and shred paper. Normally, Madison desposes of some 150 tons of milled refuse per day in an advanced sanitary landfill. It apparently requires no daily cover, and reduces the amount of land needed for disposal by approximately 40 per cent.

Our scientists, however, want to reduce disposal problems much more through recycling. Our separation pilot plant adjacent to the hammermills is the first flexible, dry separation system for mixed refuse to be installed anywhere in the world on any scale. The separation equipment is not intended to process all of Madison's refuse, but rather to test and demonstrate techniques.

The system is designed to use air currents to separate light materials from heavy materials and to separate the paper into several types. Equipment includes two fans, two cyclone units, an air classifier, a dry screen, and conveyors and collection bins. Briefly, the system works like this: Fans set up a vacuum to draw off portions of the milled refuse. The vacuum system was chosen because it draws off paper and sheet plastic preferentially. The air currents set up by the vacuum move the particles through a cyclone to an air classifier, which separates material by particle size and weight. Particles are then carried by air currents to a second cyclone, where air is evacuated. The material flows from this unit to a vibrating screen (Fig. 2). Here dirt and other undesirable material is removed and the paper particles can be separated into several sizes.

This system has been recently assembled. Initial testing aims at making basic separations of the lighter materials from the heavy. As the research progresses, the paper will be cycled back to the air classifier and attempts will be made to separate it into several grades.

Parts of this system can be arranged in 14 different ways. The optimum system for Madison will be determined, and alternate arrangements studied, since solid waste varies from city to city. All separation equipment in the pilot plant is available commercially, but is is arranged in a novel way to achieve our purposes.

Recently, the system was used to process 3,000 pounds of household refuse from a city in Indiana. The separated paper was sent to a mill in Ohio that had the necessary fiberizing equipment, and the material was successfully converted to fiber. Another commercial plant used the fiber to make specimens of dry-formed hardboard for evaluation. The Laboratory is now testing these specimens, and other hardboards made from waste railroad ties, pallets, and diseased elm trees. Data from boards made with these materials, singly and in various combinations, will then be compared to commercial standards for hardboard made from virgin fiber. Why dry-formed hardboard? First because its production is virtually a pollution-free process. Second, conversion of waste to products usable in housing can make an important impact on the timber supply situation. Within the general fiberboard category are such products as siding for homes, insulation board, paneling, ceiling tile, and furniture core stock.

This then is one approach Forest Products Laboratory scientists are taking in recycling wood fibers. We think this research can make an important contribution to the solution of solid waste problems. We further believe that increased recycling can give resource managers some elbow room to help them provide an adequate supply of products from American forests forever.