This report presents a summary and commentary on pollutants, abatement technologies, and regulations in the wood products industries. Information was primarily obtained from a study performed by Battelle Laboratories for the U.S. Environmental Protection Agency and available effluent guidelines development.

Water pollution abatement legislation has established guidelines based on Best Practicable Control Technology Currently Available (BPCTCA). These guidelines primarily address conventional pollutants, including five-day biochemical oxygen demand (BOD5), total suspended solids (TSS) and pH. In addition, guidelines based on Best Available Technology Economically Achievable (BATEA) and Best Conventional Pollutant Control Technology (BCPCT) are currently being established to address conventional, priority (toxic), and nonconventional (neither conventional nor toxic) pollutants.

Existing external air pollution control devices, in conjunction with internal process controls, can be effective in the reduction of air pollutants, especially particulates and sulfur dioxide. Air pollutants often limited by state governments include particulates and sulfur dioxide, as well as total reduced sulfur (TRS) compounds. Generally, southern states have stricter particulate standards, while northwestern states have stricter reduced sulfur compounds standards. The major impacts associated with these pollutants are odor problems and potential respiratory effects.

Solid waste generation in the wood products industry consists primarily of wood wastes, wastewater treatment plant sludge and refuse generated by personnel activities. Although many wood wastes are burned for heat recovery, sludge and refuse are typically disposed of in landfills. Since sludges generated by the wood preserving segment are considered a hazardous waste under RCRA (May 1980), new landfilling practices will need to be met by the industry for disposal.

The full report was submitted in fulfillment of Contract No. 68-03-2606 by the Edward C. Jordan Co., Inc., under the sponsorship of the U.S. Environmental Protection Agency. The report covers the period May 1, 1978, to June 1980, and work was completed as of June 1980.

This Project Summary was developed by EPA's Industrial Environmental Research 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

Objectives
This report is a summary and commentary on pollutants, abatement technologies and regulations in the wood products industries. Summarized in this document are:

1. Wastewater effluent, air emissions and solid waste generated by the wood products industries, and associated environmental impacts;
2. Abatement technology and associated effects and economics; and
3. Pertinent existing and proposed legislation and its relation to items 1 and 2 above.
The primary basis of this report is a study performed by Battelle Laboratories for the U.S. Environmental Protection Agency (EPA). Available information from effluent guidelines development and other sources has been used to update and expand data from the Battelle effort.

The wood products industries, for the purpose of this report, have been broken down into two main groups: 1) the pulp, paper, and paperboard industry; and 2) the other wood products industries. A brief description of each and its subcategories is presented in the following paragraphs.

**Industry Description**

**Pulp, Paper, and Paperboard**

At the time of this study, the pulp, paper, and paperboard industry consisted of approximately 730 operating facilities. Of these, 514 have been classed in specific subcategories, and the remainder are in miscellaneous subcategories composed of combined process or unique process mills. Operations vary from large integrated kraft pulp, paper, and paperboard mills producing over 1.8 million kilogram per day (2,000 tons/day), to small nonintegrated single machine mills making less than 0.9 kg/day (1 ton/day) of product.

There are three general classifications of mills: integrated mills, secondary fiber mills, and nonintegrated mills. At integrated mills, pulp is produced from wood and nonwood raw materials (e.g., hemp or flax); paper and board products are produced onsite. At secondary fiber mills, no pulp is produced onsite; most of its furnish is derived from wastepaper. At nonintegrated mills, the furnish consists of purchased wood pulp or other fibers. No pulp is made onsite, but some wastepaper can be used, as long as the mill does not have a complete deinking process.

Pulping processes at the integrated mills range from simple groundwood operations, using only mechanical defibration of full logs and limited bleaching operations, to the complex dissolving pulp mills employing extensive chemical pulping operations and attendant recovery systems coupled with multistage bleaching operations. Also included with the integrated pulp mills are those producing pulps from a variety of nonwood fibers such as flax, hemp, cotton, abaca, and sisal. Pulping operations include groundwood and modified groundwood operations, sulfite (acid) processes, unbleached and bleached kraft or soda processes (alkaline), and modified high-yield processes utilizing mild chemical treatments coupled with mechanical defibration.

Mills using secondary fiber are a large and growing segment of the industry. At these mills, wastepaper is utilized in various forms. At one extreme are processes involving the direct slushing of wastepapers with no additional processing, followed by conversion into coarse products such as construction papers, corrugating media and other coarse board stock. At the other extreme are mills using high quality wastepapers which subsequently are deinked by chemical means, screened, cleaned, and processed through multistage bleaching systems in a manner very similar to wood pulping. High quality deinking pulps are utilized in the production of fine quality tissue, printing, and business papers.

Fibers are purchased by nonintegrated mills, which manufacture a wide range of products. The products range from specialty board items through the highest quality fine papers.

The U.S. pulp, paper, and paperboard industry is concentrated in the northeastern, southern, and western states.

**Other Wood Products Industries**

The other wood products industries are diverse and are broken down in the following point source categories.

**Veneer/Plywood**

In 1972 there were approximately 593 veneer plywood plants operating in the United States. Of these, approximately 366 processed hardwood, and 227 processed softwood. Hardwood products are used for decorative purposes. Softwood products are used in structural applications.

The typical hardwood plywood plant is a small, privately owned mill producing 5 to 10 million ft² of product per year. This is in contrast to the production pattern in the softwood plywood section, which is typified by a mill with a 100 to 125 million ft² output per year. Furthermore, softwood plywood plants tend to be multiproduct operations owned by a broad-based forest products company.

**Particleboard**

The particleboard industry consists of approximately 74 plants. Producers range from large multi-forest product companies producing particleboard from their wood wastes, to relatively small furniture companies producing particleboard for captive consumption. The largest four firms control approximately 36 percent of the industry capacity.

Particleboards are board products that differ from conventional fiberboards. They are composed of distinct particles of wood or other ligno-cellulosic materials that are bonded together with an organic binder. The "particles" vary in size and must be distinguished from the fibers used in insulation and hardboard. Other terms used for particleboard include chipboard, flakeboard, silverboard, shaving board, and wood waste board.

**Millwork**

The millwork industry manufactures molding, doors and windows, and cabinetry. The industry is quite fractionated with the eight largest companies producing only 13 percent of the output in 1970. Among producers of molding, which accounts for 20 percent of the industry output, 35 companies possess approximately 80 percent of the capacity.

Some molding companies are integrated with sawmills, although most are separate. Local producers of windows, doors, and cabinetry are usually small operations. The total number of plants is not well-documented.

**Structural Wood Members**

In 1972, 642 firms were actively engaged in the manufacture of structural wood members and were reported to be operating 678 establishments. The industry is quite diverse, with the top 50 companies supplying only 46 percent of the total shipments. This industry is primarily engaged in the manufacture of laminated or fabricated trusses, arches, and other structural members of lumber.

**Wood Furniture and Fixtures**

The large number of products included in this group prohibits a listing of each. The processes include the machining and fabrication (fastening or gluing) of primary forest products such as lumber, plywood, and board.

**Gum and Wood Chemicals**

Major products from this industry include: wood turpentine, wood rosin, tall oil, fatty acids, gum rosin, gum turpentine, and pure oil. Twelve major companies account for the majority of production in this industry. The more efficient use of resins for sizing in the paper industry and decline in the use of gum for naval stores indicate a downward trend for this industry in the future.

**Wood Preserving**

There are approximately 415 companies engaged in wood preserving in the United States. Fifty percent of the industry capacity is controlled by ten companies. Over three-quarters of the plants are concentrated in two distinct regions. One area extends from east Texas to Maryland and corresponds roughly to the natural range of...
The second, smaller area is located along the southern pines, the major species utilized. The second, smaller area is located along the Pacific Coast, where Douglas fir and western red cedar are the predominant species.

The wood preserving industry applies chemical treatment to round or sawn wood products for the purpose of imparting insecticidal, fungicidal, or fire resistant properties to the wood. The three most prevalent types of preservatives used in wood preserving are creosote, pentachlorophenol (PCP), and various formulations of water-soluble inorganic chemicals, the most common of which are the salts of copper, chromium, and arsenic. Fire retardants are formulations of salts, the principal ones being borates, phosphates, and ammonium compounds.

Eighty percent of the plants in the United States use at least two of the three types of preservatives. Many plants treat with one or two preservatives plus a fire retardant.

Insulation Board

There are 16 plants in this subcategory that use wood as the predominant raw material. Insulation board is a form of fiberboard, which in turn is a broad generic term applied to sheet materials constructed from ligno-cellulosic fibers. Insulation board is a "non-compressed" fiberboard, which is differentiated from "compressed" fiberboards, such as hardboard, on the basis of density. Densities of insulation board range from about 0.15 to a maximum of 0.50 g/cm³ (9.5 to 31 lb/cu ft).

Hardboard

There are 16 wet process hardboard mills in the United States. Hardboard is a form of fiberboard, which is a broad generic term applied to sheet materials constructed from ligno-cellulosic fibers. Hardboard is a "compressed" fiberboard, with a density over 0.50 g/cm³ (31 lb/cu ft). The thickness of hardboard products ranges between 2 and 13 mm (nominal 1/12 to 7/16 in.).

Production Trends

Pulp, Paper and Paperboard

Pulp, paper, and paperboard production capacity have exhibited moderate but steady growth in recent years.

Other Wood Products

Lumber production has fluctuated with no trend in recent years. Particleboard production peaked in 1973 and then began declining. Hardwood plywood production steadily declined, while prefinished hardwood plywood made from purchased pulp increased dramatically over the past decade. Softwood plywood production experienced steady gains over the same period.

Pollution Abatement Costs

According to an advance report from the U.S. Department of Commerce, Bureau of the Census, United States manufacturing establishments spent $3.586 billion on pollution control in 1977. This total represents a 2 percent increase over 1976 capital expenditures. Operating costs for pollution abatement totaled $5.485 billion in 1977, representing a 21 percent increase over the 1976 total of $4.359 billion. Costs incurred by the lumber and wood products industry (SIC 24) and the paper and allied products industry (SIC 26) are summarized in the full report.

There was a slight reduction in capital expenditures for pollution control by the paper and allied products industry in 1977. This indicates that many mills have already completed the construction of required environmental control systems. Pollution control operating costs rose by 28 percent for the paper and allied products industry from 1976 to 1977. Most of the costs incurred relate to air and water pollution control efforts.

Summary, Conclusions, and Recommendations

Water Pollution

Water pollution abatement legislation has resulted in the establishment of effluent limitations guidelines based on best practicable control technology currently available (BPCTCA). These guidelines primarily address conventional pollutants, including 5-day biochemical oxygen demand (BOD₅), total suspended solids (TSS) and pH. In addition, guidelines based on best available technology economically achievable (BATEA) and best conventional pollutant control technology (BCPTC) are currently being established to address conventional, priority (toxic), and nonconventional (neither conventional nor toxic) pollutants.

Conventional Pollutants

Pulp, Paper, and Paperboard Industry

Annual average discharge information for calendar year 1976 indicates that at least one pulp and paper mill in each industry subcategory was meeting the BPCTCA guidelines which went into effect in July 1977. The sampling period reflected a time of construction and/or startup of many effluent treatment facilities. Therefore, it is expected that many more mills are currently meeting the BPCTCA guidelines.

Primary/biological effluent treatment is widely used in the wood products industry. These systems achieve approximately 80 percent removal of BOD₅ and TSS prior to discharge. Various additional effluent treatment systems may be installed to further reduce conventional pollutants. Chemical clarification, for example, may serve as a tertiary treatment after biological treatment. One such system has been successfully installed in a chemi-mechanical pulp and paper mill and is achieving annual average final effluent BOD₅ and TSS concentrations of 12 mg/l each. Specific studies are recommended to further establish optimum design characteristics for chemical clarification of various wood products effluents, and associated sludge production, costs, and other aspects of non-water quality impacts of the technology.

In many cases, the installation of production process controls can reduce the flow and/or pollutant load to effluent treatment systems and the final discharge. Examples of these controls are spill collection systems to minimize the potential for shock loading, countercurrent pulp washing for flow reduction, and liquor evaporation for material and heat recovery as well as flow and pollutant reduction. The cost-effectiveness of production control alternatives should be carefully compared to that for effluent treatment technologies at specific facilities.

Conventional pollutants currently being discharged have been shown in two specific studies to have minimal effects on receiving waters after mixing. This impact, however, is dependent in part on the relative flows of effluent and receiving water. A mill discharging to a small stream may have a greater impact than a similar discharge to a larger stream. Additional site-specific evaluations are needed to verify the magnitude of this phenomenon.

Existing effluent guidelines for TSS do not distinguish between settleable and nonsettleable solids. The impact associate with each, however, can vary. For example, settleable solids are more readily removed by treatment, while those not removed may tend to deposit on the stream bottom. This can have adverse impacts on water quality, benthic organisms, and stream aesthetics. Nonsettleable solids, on the other hand, are not easily removed by conventional treatment and tend to remain in suspension long after being discharged. As such, they can impact water quality far downstream of the mill. Additional data relating the actual magnitude of these impacts is needed.

Other Wood Products Industries

Conventional pollutant discharges from other wood products industries are usually
Priority (Toxic) Pollutants

Wood Products

Priority (toxic) pollutants (49, 18 in wood preserving, also arsenic) known to be present in wood products industries waste include chloroform (from pulp bleaching); heavy metals (chromium, copper, lead, mercury and zinc) from papermaking additives and wood preserving; PCBs (from waste paper); and pentachlorophenols (PCP) and PNA (from wood preserving).

Existing biological treatment has detoxified effluents between 60 and 80 percent of the time. Periods of toxic discharge have been associated with mill upsets. These toxicity reductions can be improved through the use of flow equalization and production process controls. The detoxification efficiency can be further enhanced by installing technologies such as foam separation, chemically assisted clarification, or carbon adsorption in addition to biological treatment.

Chemical coagulation of wood preserving wastes with 150 mg/l alum on a laboratory scale was shown to be capable of a 50 to 75 percent PCP reduction. This resulted in final effluent PCP concentrations of 3 to 10 mg/l.

Additional research is recommended to further establish the treatability of various wood product effluents, the optimum design parameters of applicable technologies; and the cost and other non-water-quality aspects for installing selected technologies.

Nonpoint Source Pollution

Nonpoint source pollutants from silvicultural activities include sediment (TSS) and its associated BOD5, nutrients, herbicides, rodenticides, and insecticides. These can impact the receiving waters nearby. Nutrients from fertilization can alter the trophic state of these waters. Proper management practices, including buffer strips adjacent to streams and the avoidance of direct chemical application to surface waters, can minimize adverse water quality impacts from nonpoint sources. Continued monitoring is recommended to ensure that these practices are being adhered to and that no significant adverse impacts occur.

Air Pollution

Existing external air pollution control devices, in conjunction with internal process controls, can be effective in the reduction of air pollutants, especially particulates and sulfur dioxide. Air pollutants often limited by state governments include particulates and sulfur dioxide, as well as total reduced sulfur (TRS) compounds. Generally, southern states have stricter particulate standards, while northwestern states have stricter reduced sulfur compounds standards. The major impacts associated with these pollutants are odor problems and potential respiratory effects.

Pulp, Paper and Paperboard Industry

Pulp, paper and paperboard mill recovery furnace operations are those likely to be affected by stringent regulations. The initial kraft mill furnace designs did not seriously consider the control of reduced sulfur emissions. Particulate discharges from overloaded furnaces are great, and the sulfur dioxide emissions from sulfate mill recovery furnaces are often too high to meet the standards of some states. Secondary odor controls or replacement of the furnace are probable requirements for meeting state standards. In the case of odor, the sensitivity of the human nose to TRS is so high, that it is almost impossible to completely eliminate this impact.

The pulp, paper and paperboard industry, because it is a large offender, has done a significant amount of groundwork for the other wood products industries in the field of air pollution control. Hydrocarbon and carbon monoxide emissions of the veneer/plywood industry can be incinerated, and particulate emissions of the particleboard industry can be controlled by conventional pollution control devices. These are the same means of control used in the pulp and paper industry.

Air emissions from the wood preserving industry can exceed current air pollution regulations. The sources of emissions are: a dense plume of volatilized organics when a pressure vessel is opened and the newly treated wood is removed and cooled; and particulate emissions from the vacuum exhaust, as well as in the exhaust during steam cleaning. A control technology to reduce the volatilized organics is to reduce the temperature of the newly treated wood as it is removed from the pressure vessel. This is accomplished by the placement of spray nozzles just off the open end of the pressure vessel, to create a water blanket to cool the wood as it is slowly removed.

Outdated kraft mill recovery boilers are likely to be the major factor in mills not meeting state air pollution standards. Replacement of the boilers may be the only way to meet reduced sulfur compounds and particulates standards, but such replacement will be expensive. An economic analysis which would include a survey of furnaces needing replacement based on age and emissions, an estimate of replacement cost, and examination of the industry's ability to absorb the cost is suggested.
The use of cross-recovery systems in sulfite and NSSC mills may produce significant sulfur dioxide emissions. A study may be needed to evaluate the impact of these emissions and to evaluate the applicable control technologies. One technology that should be investigated is the use of regenerable stack gas desulfurization processes.

**Solid Wastes**

Solid waste generation in the wood products industries consists primarily of wood wastes, wastewater treatment plant sludge and refuse generated by personnel activities. Although many wood wastes are burned for heat recovery, the most common means of sludge and refuse disposal at present is landfilling.

There is no consolidated information concerning the practices at the landfill sites for these wastes. Once the current evaluation efforts have resulted in classification of landfills in the U.S., it should be verified that the wastes from this industry are being placed in adequate sites.

If chemically assisted clarification were implemented on an industry-wide basis in the pulp, paper, and paperboard industry, it is estimated that wastewater treatment plant sludge production would increase by approximately 20 to 30 percent (dry solids basis). This sludge would probably be difficult to dewater and dispose of, and would have environmental and economic impacts. A study is needed to determine the magnitude thereof.

Additional investigation should be performed in the area of energy recovery from solid wastes (including sludges). The potential energy savings, economic cost, and air emissions must be balanced against the economic and environmental costs of landfilling. Also, alternate solid waste disposal and utilization technologies (such as composting) should be investigated further for use in the wood products industries.

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The complete report, entitled “Multimedia Pollution Assessment of the Wood Products Industries,” (Order No. PB 84-160 266; Cost: $23.50, subject to change) will be available only from:

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