Pollution from the Pulp and Paper Industry in the Willamette Valley

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The pulp and paper industry has been a part of the Willamette Valley since major population and industrial growth began in the valley. However, the paper industry has also been a large source of pollution. As a whole, the paper industry has made vast improvements environmentally since the first mills were built. However, it is important that the industry continue to reduce pollution and eventually move to zero-effluent mills.

Since 1886 paper production has been an integral industry in the Willamette Valley. The first mills were small and produced mainly newsprint (Hall). These mills used sulfite or groundwood pulping processes. By 1936 there were five paper mills on the Willamette River or on its tributaries. These mills were the Hawley mill in Oregon City, the Crown Willamette mill in West Linn, the Oregon mill in Salem, another Crown Willamette mill in Lebanon, and an inactive Spaulding mill in Newberg. These mills continued to use sulfite and groundwood processes (Gleeson and Merryfield).

After World War II several companies opened Kraft mills in the Willamette Valley. In 1949, Weyerhaeuser built a mill in Springfield and in 1969 the American Can Co. opened a mill in Halsey (Hall). By 1969 the pulp and paper industry in the northwest employed approximately 22,000 people with a payroll of about $206 million a year. The industry produced about 5.9 million tons of wood pulp and many tons of paper products (Hall). In 1972, only the Halsey, Springfield, West Linn, Lebanon, and Salem mills remained. The Halsey mill used a bleached

Kraft process and had primary and secondary waste water treatment as well as solid waste removal. The Springfield mill used an unbleached Kraft process, had primary and secondary treatment and solid waste removal, and used spray irrigation of hot process water. The West Linn mill used a groundwood process and had only rudimentary primary treatment. The Lebanon mill used unbleached ammonium sulfite. The Salem mill used a calcium-base sulfite process and had primary and partial secondary treatment and solid waste removal (Allan).

There are several pulping processes: groundwood, chemical, neutral sulfite, semichemical, acid sulfite, and alkaline sulfate (Kraft) pulping. Chemical and neutral sulfite semichemical processes are not used by mills in the Willamette Valley. In groundwood pulping, bolts of barked wood or wood chips are pressed against rotating, corrugated stone disks that are under a flow of water. The wood is reduced to pure fiber, which is washed away to be dried into sheets of pulp. Groundwood pulping is the cleanest, cheapest, and least harmful process. There is no smell or chemical discharge.

Chemical pulping uses acid or alkaline sulfur solutions to dissolve the non-cellulose materials in the fiber. Effluents from these mills affect the color, temperature, pH, chemical content, and foaming tendencies of the waterway in which they are discharged (Allan).

In acid sulfite pulping, wood chips are cooked with acid liquor, sulfurous acid and a sulfur compound made of calcium, sodium, ammonium, or magnesium bisulfate. The mixture is cooked at 125 to 160 degrees centigrade for six to twelve hours (Allan). When the wood chips are reduced to pulp the mixture is washed until only cellulose material remains.

Kraft (alkaline sulfate) pulping cooks woodchips in alkaline liquor made of sodium hydroxide and sodium sulfate. The chips are either cooked in batches for two and half to five hours at 176 degrees centigrade or processed continually. Continual processing produces much less waste than the batch method. The used “black liquor” is removed from the pulp and burned in the recovery furnace. There the inorganic chemicals are converted to molten smelt and the organic solids are oxidized to carbon dioxide and water vapor. The steam and gases from the combustion process are reused.

Currently in the pulping process the mills take a fiber source and cook the fiber in sulfur compounds at high temperatures and pressures to separate the cellulose fibers from the natural glues, like lignin, that hold the fiber together. After the distillation the pulp is washed so that only the cellulose fibers remain. These fibers are bleached and turned into paper products. The bleaching process uses chlorine-based bleaching chemicals. The washing water is sent to a recovery boiler. There the chemicals are recovered for reuse and the heat from the boiler used for power. Wastewater released from the plant contains organic material from the wood chips, pulp, and cooking process and contains chlorinated organic compounds from the bleaching process (Gunningham).

Each process produces different amounts of pollution. Waste that enters the river from the groundwood process contains only suspended wood wastes and water-soluble wood compounds. The process produces a biological oxygen demand (BOD) load of 30 to 60 pounds per ton. Waste water from acid sulfite pulping contains over 55 percent of weight of the wood in organic materials and thousands of gallons of chemicals. Untreated, the effluent has a BOD of 550 to 750 pounds per ton of pulp—the highest load of any pulping process. In 1972 about 10 percent of the United States pulping industry used acid sulfite pulping. The amount of waste from the Kraft process is about one twentieth of that of the sulfite process. Bleached Kraft has a BOD load of 65 pounds per ton and unbleached has a load of 30 to 40 pounds per ton. In 1972 about 60 percent of the pulp industry used the Kraft process.

In 1936 the major sources of pollution from the pulp mills were sulfite liquor, white water, sulfite mill waste, and spent bleach liquor. The main cause of pollution was from the sulfite liquor, which accounted for 92 percent of the total oxygen demand of paper production waste (Gleeson and Merryfield). The Oregon City and Salem mills used Chloramine and Alum Chloramine respectively to treat raw waste water. The other two mills had no treatment. None of the mills treated sulfite liquor. Recommendations at that time were that the control of fiber discharges should be more closely monitored, that the pollutant load should be reduced by 30 percent in low water periods, that aeration ponds be used to treat sulfite liquor, and that all members of the paper production should be made aware of the problems any expansion in the industry would cause during low water periods.

By 1969 the major pollution concerns with pulp mills were related to the BOD load from carbohydrate materials produced in the puling and bleaching process and from process derivatives like lignin and tannin. Another problem was with fiber waste. Primary treatment at all mills had been required since 1968. Secondary treatment was not required until 1972 and tertiary treatment was considered too expensive and unlikely to be required in the near future. The fiber waste blanketed benthic life, which eliminated food for fish; went through anaerobic fermentation, which produced toxins; and aggravated the slime problem in the lower Willamette. During the 1950's and 1960's BOD and suspended solid levels in mill effluent was so high that all species of fish downstream from the mill were killed and the only aquatic life that survived was worms that could tolerate the depleted oxygen levels.

In 1972 primary treatment, using settling ponds and clarifiers, was in place in all mills in the Willamette Valley. This removed 75 to 95 percent of solid waste. Most mills had secondary treatment using holding ponds, aerated lagoons, and activated sludge. The secondary treatment had an 80 to 95 percent BOD reduction. None of the Willamette Valley mills had tertiary treatment. At this time the Halsey mill was considered the cleanest mill in the nation. In addition to primary and secondary treatment, the mill sent all residual sawdust and woodchips, about 250,000 tons per year, back through the pulping cycle. The mill was located three miles from the bank of the Willamette River as opposed to directly on the bank like other mills. The Lebanon mill also had additional treatment using a spent liquor evaporating and drying system, which helped to reduce BOD levels. A 1970 study of the Lebanon mill reported that, "bacterial slime infestations generally extended to about six miles below the introduction of the untreated waste and a significant depression in the dissolved oxygen concentrations of the stream…during the summer months" (EPA Aerated Lagoon Treatment 6-7). The Lebanon mill is located on the South Santiam River, a tributary of the Willamette River, and has a sizable anadromous fish run (EPA Aerated Lagoon Treatment). Pollution from the Halsey mill had a BOD of only 414 pounds per day; the mill at Salem, 9,800 pounds per day in the summer and 150,000 in the winter; at Lebanon, 4,500 pounds a day plus 2,945 pounds of suspended solids; at West Linn, 17,000 pounds per day plus 8,426 pound per day of suspended solids, and at Springfield less than 3,000 pounds per day in the summer and less than 4,000 in the winter (Allan).

In the 1980's chlorine bleaching agents were commonly used in the bleaching process. These were found to help form highly carcinogenic dioxin compounds (Gunningham). The organochlorines are also part of the mill effluent that enters the Willamette. These damage animal neurological and endocrine systems. Additionally, polychlorinated dioxins and furans produced by mills are highly toxic and bioaccumulative (Turoski). The polychlorinated phenols produced by mills are mildly toxic, but also highly bioaccumulative (Turoski). The accumulation of these compounds in aquatic biota could lead to contamination of other organisms that are not directly exposed to mill effluent.

In the 1990's chlorine dioxide was replaced with elemental chlorine in the bleaching process, which substantially reduced dioxin loads. (Gunningham) Today BOD levels are much less than they were in the early days of paper mills; however, they still decrease oxygen levels, which in turn decreases aquatic species diversity. Mill effluent is also much less toxic as a result of primary and secondary treatment, but adverse effects have been observed in aquatic biota as a result of exposure to mill effluent. Some of the effects include "problems with enzymes involved in normal growth and development (including changes in the blood levels of reproductive hormones), changes in secondary sex characteristics,…changes in population structure (such as age a maturity and ratio of females to males)," and changes in community structure such as a decline in species diversity (Gunningham 13).

Although many mills have moved from using elemental chlorine to chlorine dioxide as a bleaching agent, environmentalists urge the shift to a totally chlorine-free (TFC) bleaching process. Some alternatives to chlorine are oxygen, hydrogen peroxide, ozone, or enzyme bleaching systems. In order for these systems to work, new technology is required to remove the lignin in the fiber before the bleaching process. The industry has been opposed to this new process because there is little difference environmentally between the chlorine dioxide process and the TFC process and because TFC mills are highly economically inefficient. However, a move to TCF processes would be an important step toward closed loop production that is effluent free (Gunningham). In Europe many mills have already started to make the move to a closed loop process.

A study about the effects of elemental chlorine free processes versus TCF processes lists some proposals on how to further minimize environmental effect (Servos). The study suggests that new technology used in mills should "include systems for spill prevention and recovery, closing the screen room process, equipment for extended cooking and/or oxygen delignificaton, and change [the] bleach plant operations to a more closed operation…if the effluents can be recovered" (Servos 686). More detailed suggestions include using chlorine dioxide or oxygen-based chemicals in the bleaching process, or using cleaner bleaching systems such as ozone bleaching with a filtrate recycle or recycling spent bleach liquor from the chlorine dioxide process (Servos).

With current technology, mills produce about 50 percent less effluent than mills in the 1970s (Turoski). However, closed loop mills can reduce mill effluent to almost zero. These mills would use new technology in the chemical recovery stage as well as addition end process treatment. Some of the end process treatments suggested are the use of ultra filtration along with evaporation or incineration and precipitator management or the use of ozone bleaching, pressurized peroxide, peracetic acids, enzymes, or chelating agents. These systems produce only a small amount of effluent, which is then sent back to the chemical recovery stage to be recycled.

In 1989 the EPA began to address the issue of dioxins. The result was the "cluster rule," proposed in 1993 and effective 1998, which established limits from dioxins and absorbable organic halides (AOX) levels based on a consideration of the best economically feasible technology. The new rule also offered economic incentives and other benefits if the mills had more stringent standards then required by the EPA (Gunningham). The EPA proposed oxygen delignification as the best available and economically feasible technology. This represents a major step in cleaning up the remaining pollution from pulp and paper mills. However, the paper industry believes that “Incremental change, not mandated full-step high-capital changes, will ultimately lead to the widest number of possibilities [for closed mill technology]” (Turoski 257). Currently the regulation issues are centered on the identification of potential sublethal toxicity in aquatic biota and continued reduction of mill effluent into waterways (Servos 661).

The paper and pulp industry has come a long way since the first days of production with no thoughts about the environment. Nationally, the paper industry is also a main source of pollution. In 1986 the industry was the nation’s third largest polluter (William). However, paper products are something that we take for granted in our everyday lives. It is important that further steps be made to reduce pollution and ultimately to implement closed mill systems in order to maintain environmental quality around pulp and paper mills. In the Willamette Valley, the river plays a large part in all of our lives. It is important that we maintain a balance between the economic benefits brought by the paper industry and the impact of the industry has on the river and the surrounding environment.

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