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Design for Disposal

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What liquid is thick, brown, oily, acidic, toxic, and foul smelling?

Water. Water which has been used in a wood preserving plant.

The purpose of wood preserving, to prolong the usefulness of the wood until nature has replaced the tree, is an ecologist's dream. The resulting wastewater with its dense combination of contaminants is an ecological nightmare.

Wood preserving was first used in this country by the railroad companies. Railroad crossties and utility poles are still two of the major products treated by wood preservers. The most common preservative for these products is creosote mixed in heavy oil which leaves the wood with a dark brown color and strong odor.

Treatment of wastewater--15,000 gallons per day at an average plant--is expensive, complex, and largely ignored by wood preservers throughout the U.S. Untreated wastewater is often discharged into municipal systems or into rivers, but new state and federal regulations have made disposal of untreated wastewater more difficult. Extensive environmental legislation has been passed which will mean more regulations, monitoring programs, and discharge limitations for the industry.

Researchers at Texas A&M University have developed a wastewater treatment scheme which is technically simple and economically feasible for even the smallest wood preserving plant. Dr. Tom Reynolds, professor of environmental engineering, and graduate student Pete Shack have studied a design which would dispose all the wastewater from any size wood preserving plant, although it is most feasible for medium to small plants.

The disposal system designed by Reynolds and Shack is a very simple operation called atmospheric evaporation. The system is designed to evaporate all of the wastewater generated by a preserving plant. The real advantage of this system over others, according to Shack, is that no wastewater is discharged back into the streams. It is especially effective in the Southern climates

of the U.S. where 65 percent of the wood treating plants are located.

Dirty, Messy Process

The researchers studied the wood preserving industry and analyzed the industrial processes used before designing a system of wastewater disposal. Shack describes wood preserving as "a small industry dealing with a very dirty, messy process." According to him, the wastewater from the 387 plants which make up the industry equals the amount of wastewater from a city of 4 or 5 million people. Wastewater from wood preserving is up to 100 times more contaminated than municipal wastewater.

Pollution control procedures must not only be economical but also simple to operate because the industry's size and profit margin are small and because the majority of employees are unskilled. The majority of the plants employ less than twenty persons per plant. More than 80 percent of the total industry employees are production workers.

According to a 1974 survey of 270 plants, 40 percent of the plants intend to change their methods of wastewater treatment or disposal. Presently 31-50 percent store untreated wastewater in holding ponds, 17 percent release untreated wastewater into municipal sewers, and 6 percent discharge it into rivers. Other plants treat the wastewater with biological treatment, evaporation, or chemical treatment before discharging it.

Preserving Process

The process of preserving wood is relatively simple in concept. The outer layers of wood are impregnated with a solution inhibiting the growth of micro-organisms which cause decay.

Although creosote in heavy oil is still the most common preservative, in recent years there has been a growing demand for wood preserved with fire retardants and for wood processed with new preservatives such as pentachlorophenol. Pentachlorophenol is dissolved in diesel oil which is much thinner, penetrates the wood more easily, and leaves the wood its natural color. Both creosote and pentachlorophenol can be used at the same plant; in fact all of the plants Reynolds and Shack studied were treating with both preservatives.

Application of any type of preservative is done by soaking or by pressure impregnation. Ninety-one percent of the plants now in operation use the pressure treatment. The Reynolds and Shack study dealt primarily with preservatives using pressure impregnation.

There are many variations to pressure impregnation, but basically either steam or pneumatic pressure is applied forcing the hot preservative into the outer layers of the wood. Pressure is applied to a load of wood in a steel cylinder. This same cylinder can also be used for preparatory operations such as drying the wood, preconditioning, and cleaning. Steam is used in the cylinder to heat the preservative, to maintain pressure in the cylinder, to prepare the wood for treating and to clean the treated wood.

A code of specifications for wood preservation has been issued by the American Wood Preservers Association. Specifications include the quality of preservative and amount of preservative which must be impregnated. Measurement is by pounds of preservative per cubic feet of wood. Impregnation of the oil depends on the moisture content of the wood, the temperature of the preserving solution, and the amount of pressure exerted.

Although subprocesses vary greatly from plant to plant and for different types of wood and preservative, there are 6 basic steps for all pressure impregnation methods:

- 1. Debarking and trimming
- 2. Seasoning or drying
- 3. Preconditioning
- 4. Preserving or impregnation
- 5. Cleaning
- 6. Cooling

Each step in the process produces a different type of wastewater with varying characteristics. The wastewaters can be classified as oily, dirty, or clean. Oily wastewaters contain emulsions of preserving oils and are generated by the impregnation and cleaning steps. Dirty wastewater includes some process wastes, plant runoff, equipment cleaning wastes, and sapwater. Sapwater is extracted from the wood during drying and contains wood sugars, lignins, and other materials such as acetic acid. Relatively clean water comes from cooling waters, condensers, and runoff from plant roofs. It is suitable for recycling, but is normally added to the dirty and oily wastewaters for disposal.

The combination of high organic contaminants, emulsified and free oils, and toxic materials make the wastewater difficult to treat. Many treatment processes cannot tolerate excessive oils, and the toxic materials and high organic contamination impair biological treatments. A combination of processes is therefore necessary to effectively treat the wastewater from any wood preserving plant.

New Disposal Design

Reynolds and Shack combined four treatment technologies in their disposal design:

- 1. Equalization
- 2. Gravity separation
- 3. Coagulation and sedimentation

- 4. Evaporation

The first three can be accomplished in the same large tank, called a batch treatment tank. A prerequisite for most types of treatment is equalization, which simply averages out the flow and contamination of wastewater. This is done by holding the wastewater in a tank in order to release it in a steady flow.

The second step, gravity separation or settling, is commonly used by plants to recover some of the valuable preservatives for reuse. It is accomplished by holding the wastewater in a large tank for at least 24 hours while preservatives settle to the bottom or float to the top. Up to 90 percent recovery of preservatives can be accomplished just by allowing the oil and water to separate.

The remaining oil is in such fine droplets it appears homogenous. This oil and many other pollutants can be coagulated by adding a chemical such as lime. The coagulated waste removed from the water is called sludge and should be disposed of in a sanitary landfill where there are safeguards against contamination of ground water.

Shack feels that in the future no matter what disposal method a plant uses, it will be forced by law to separate and coagulate its wastewater. Presently fewer than half of the wood preserving plants coagulate the emulsified oils before disposing of their wastewater. After coagulation, the wastewater resembles weak tea in color, but has a strong odor and is still toxic.

After the wastewater has been equalized, and had the oil removed by gravity separation and coagulation, it is evaporated into the atmosphere. This system employs a pond, recirculation pump, and spray nozzles to spray water into the air for faster evaporation.

Costs of the system are essentially those of a holding tank for gravity separation (if the plant does not already have one), a tank for coagulation and sedimentation, chemicals for coagulation, extra land for holding pond and area for wind drift, and energy for pumping water in the spray cycle.

Laboratory Tests

Shack devised an apparatus to use in the laboratory to study the evaporation of the wastewater. This allowed the rate of wastewater evaporation to be evaluated along with the rate at which organic contaminants are evaporated.

Another laboratory study dealt with possible air polution from evaporating the wastewater. Under normal atmospheric conditions, Shack estimates that the air would meet the national ambient air quality standards only 300 feet from the evaporation pond. Under the worst atmospheric conditions, the air would meet the standards one-fourth of a mile from the pond. Shack feels that any potential air pollution problem can be handled by pond location and careful management.

Shack designed this system while completing his M.S. degree in civil engineering. Now with an engineering firm in Austin, he plans to present his findings to the annual meeting of the American Wood Preservers Association.

Even though this study was limited to oil borne preservatives on southern pine, the design can be applied to other processes and to other woods. According to Reynolds, "the atmospheric evaporation system is not a cure-all for every wood preserving plant. The system is most feasible when the plant is relatively isolated from a city collection and treatment system and where air pollution problems do not exist." Reynolds and Shack will report their results to the National Conference on Treatment and Disposal of Industrial Wastewaters to be held in April. This conference is sponsored by the U.S. Environmental Protection Agency, the University of Houston, Gulf Coast Waste Disposal Authority, and Information Transfer Inc.

Both researchers feel that their design can easily be adapted to other small industries with wastewater disposal problems.

Atmospheric Evaporation . . . like nature's own disposal method

Atmospheric evaporation of wastewater is not limited to the wood preserving industry in Texas.

The first total evaporation disposal system on the Gulf Coast and one of the first in the petrochemicals industry has been constructed in Brownsville. The Union Carbide plant there has built a $6.5 million zero-discharge system for its process wastewater.

Plant Manager Bill McManus explains the system as "somewhat like nature's own method for handling wastes."

All process wastewater will be collected and pumped into a 100-acre evaporation pond. In the pond, liquid waste materials will be oxidized to harmless carbon dioxide and water. In Brownsville's arid climate the water simply evaporates from the pond--with aerating pumps used to speed the oxidation and evaporation process as needed--leaving small quantities of solids behind. Extensive soil studies have been made to test the permeability of the ground at the pond site to be sure there is no problem from leakage of any chemical wastes.

Studies indicate that it will take almost 20 years before there is any substantial buildup of solids in the evaporation pond. At that time solids can be dredged out and safely landfilled. After evaporation, the pure water returns to the earth as clean rainfall, free of any wastes.

The manager explained that construction started in 1976 on the four-section oxidation and evaporation pond in a site behind the chemical plant. Nine-foot dike walls surround the pond. An expanded process wastewater and rainwater collection system is under construction to gather all process and sewer wastewater for the evaporation pond.

Another phase of the new system will involve changes made within production units at the plant to reduce the hydraulic and organic waste loads and to eliminate cooling water from the process wastes going into the new system. All water which is used or produced in actual chemical reaction processes will be contained in the evaporation pond. Cooling water, which is not in contact with chemicals and is used only for cooling in heat exchangers, will be discharged at a safe temperature.

"The new evaporation pond will offer a substantial energy savings compared to other systems which were considered," said McManus. "This method uses only small horsepower pumps as compared to competitive plans which would have required major amounts of electric power."

When it is completed this year, the system will meet the zero-discharge standard established by the Federal Water Pollution Control Act in 1972. The, stated goal of this act is to eliminate the discharge of pollutants into navigable waters by 1985.