Gasohol from Wood Is Not Yet Economically Feasible

By ANDREW J. BAKER, *Forest Products Laboratory, Madison, Wisconsin*

Use of wood as a source of ethyl alcohol, which is added to gasoline to make gasohol, has received growing interest in the past several years. The reason? Wood contains about 65 to 80 percent carbohydrates which can be changed into sugars by the process of hydrolysis. The sugars can then be fermented into ethyl alcohol. At the present time, however, no commercially available, cost-effective way exists to derive this alcohol from wood.

Hydrolysis

Wood hydrolysis basically involves heating wood in water with an acid catalyst to break down the, carbohydrates. Various kinds of sugars are produced depending on wood species, but glucose and mannose are the only ones that can be used to make ethyl alcohol. Glucose is the most common in any type of wood and accounts for about 50 percent of what is produced from hydrolysis.

The wood sugars are recovered from the hydrolysis solution which is neutralized with lime. The sugars are then fermented into alcohol. Remaining residue, about 30 percent of the wood, is made up of lignin and unhydrolyzed carbohydrates which can be burned directly to provide part of the heat for the hydrolysis process.

Yield of ethyl alcohol ranges from a low of 35 gallons per ton of dry hardwood species to a high of 60 gallons per ton of softwoods. Hardwoods have fewer fermentable sugars than softwoods, and the hydrolysis process is more complicated with hardwoods.

There are three types of hydrolysis under development: the diluted acid method, the concentrated acid method and lignin extraction followed by the diluted acid method.

Diluted Acid Hydrolysis. Conditions necessary for a dilute sulfuric acid hydrolysis process are temperatures in the range

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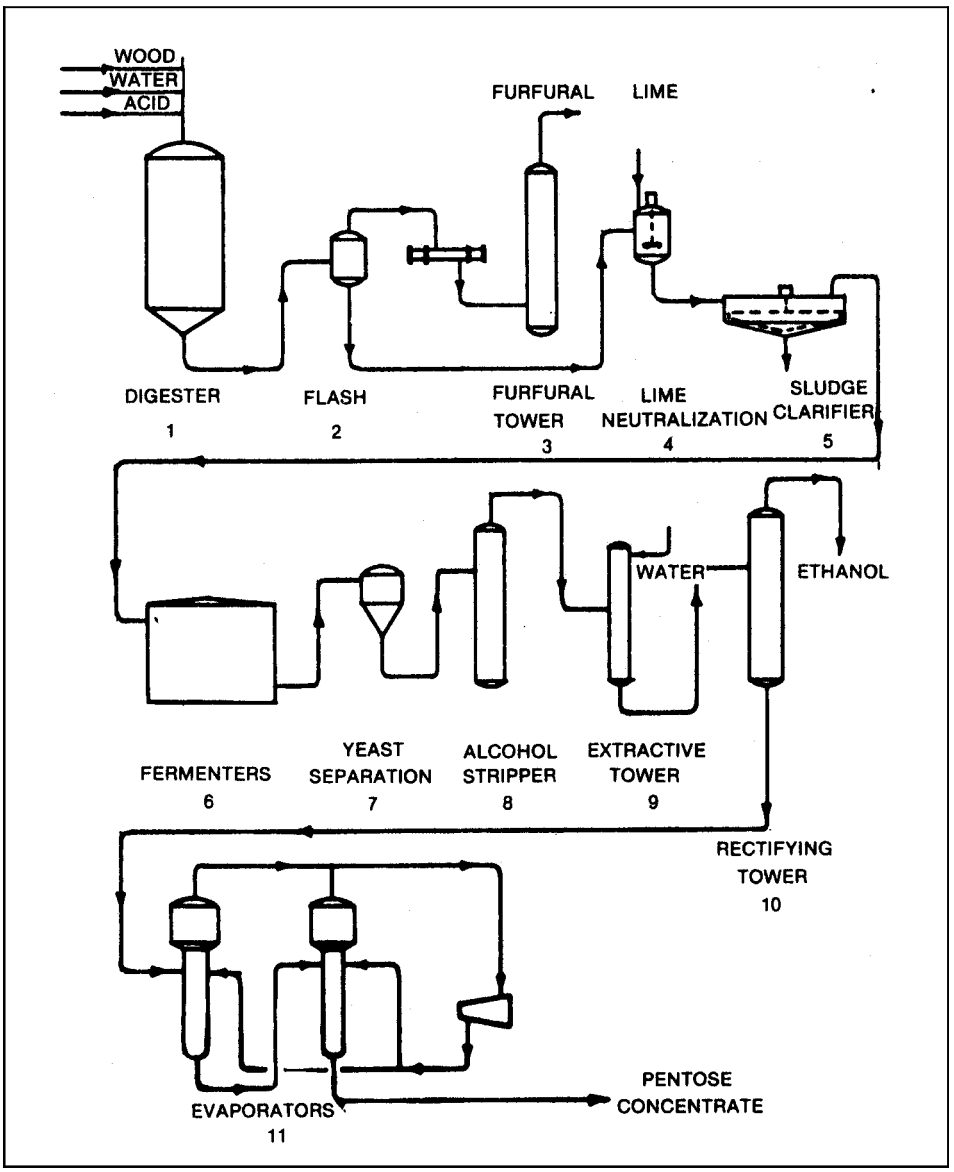
Ethanol from Waste Wood Madison Process

Process Steps

1. **Cellulose Converted to Sugar by Acid Hydrolysis Under High Pressure and Temperature.**
2. **Sugar Solution Flashed.**
3. **Furfural In Flash Condensate Recovered.**
4. **Sugar Solution Neutralized.**
5. **Calcium Sulfate Separated.**
6. **Sugars (6 Carbon Type) Fermented to Ethanol and Carbon Dioxide.**
7. **Yeast Separated for Re-Use.**
8. **Ethanol Stripped from Dilute Liquor.**
9. **Contaminants Extracted from Ethanol.**
10. **Ethanol Concentrated to 190 Proof.**
11. **Sugars (5 Carbon Type) Concentrated.**



of 340° to 440°F at corresponding steam pressures of 100 to 375 pounds per square inch. Cooking times range from several minutes at the lowest temperature to less than one minute at the highest temperature. Conditions have to be selected on the basis of many variables such as species, cooking vessel design, and total product and byproduct considerations.

Concentrated Acid Hydrolysis. If a concentrated acid process is used, such as 40 percent hydrochloric acid, temperatures as low as 100°F and cooking times of three hours can be used. Again, the most desirable condition has to be selected on the basis of many variables of the process.

Lignin Extraction Method. The lignin extraction processes remove lignin and unusable sugars forst with a mild treatment of the wood with a lignin solvent such as 50 percent ethyl alcohol in acidic water. This can be done at 350°F in about one hour. When the alcohol is evaporated from the treating solution, dissolved lignin settles out and unusable sugars remain in the solution separate from the other sugars. Residue from the alcohol extraction then can be acid-hydrolyzed to glucose and mannose as is done with the other hydrolysis processes. It can also be hydrolyzed with special enzymes to glucose. This enzymatic process requires low temperatures of 70° to 100° but times ranging from 12 hours to three days to obtain glucose from wood carbohydrate.

Economics of Wood Alcohol

All three of these processes work in the laboratory. They are, however, complicated and require expensive equipment to withstand corrosive acids and high temperatures and pressures. Also it would only be economically feasible to operate a large wood-alcohol plant. Such a factory would require an investment in the range of $50 to $100 million. These figures depend on the process selected and the byproducts recovered.

High investment and operating costs are prime reasons that no market exists for wood used as a source of ethyl alcohol. Because of the dificulty in hydrolyzing wood and the need for high-pressure equipment, this process is not forseen as a practical method of making ethyl alcohol on a small scale as is being advocated for certain grains and tubers.

Current economic factors are,of course, subject to change. The supply of grain available for gasohol might well diminish with increasing world food demands. And research at the U.S. Forest Service's Forest Products Laboratory and elsewhere continues to seek ways to make wood-based alcohol a more attractive investment possibility. At the present time, however, traditional markets such as plywood, pulpwood and sawtimber remain the most reliable outlets for forest farmers timber. □