

Trash-to-cash process

From the stuff we discard, fuel

Purdue scientists hope to reduce America's dependence on oil with a trash-to-cash process that turns plant stalks and leaves into fuel.

The process can convert cornstalks, wood shavings, and other waste plant material into alcohol and a host of other useful products.

Grain alcohol now being blended with gasoline to make gasohol costs about \$1.50 a gallon. By using plant waste as a low-cost raw material, the Purdue scientists hope to make alcohol that is competitive in price with gasoline. They estimate that a cost of 80 cents to \$1.10 a gallon is possible, depending on raw material cost and the return from sales of by-products.

The research is underway in Purdue's Laboratory of Renewable Resources Engineering (LORRE), headed by George T. Tsao, professor of chemical, food, and agricultural engineering.

To develop its successful process, the LORRE group had to breach one of nature's "fortresses" that resisted scientists for more than a half century. No one had been able to discover an economical means of breaking up the rigid structure and tight chemical bonds that lock the potentially useful substances—stalks, leaves, and other unused portions of food crops and forests—together.

Plants are composed largely of cellulose and lesser amounts of the close chemical relative hemicellulose. The hard crystalline structure of these substances

resists dissolving chemicals. Lignin—a tough, glue-like material—binds the crystals together.

In 1974 Tsao and his associates began experimenting with solvents, acids, and enzymes combined with crushing and grinding operations. Their goal was to better the previous processes—which had been able to convert only about 35 to 50 percent of the cellulose bound up in plant material into useful materials.

In 1977 the Tsao group achieved a breakthrough with a process that permits recovery of almost 100 percent of the cellulose. When cellulose molecules are free, they are easily converted to a single sugar, glucose. This sugar can then be converted into alcohol or other products.

Since the breakthrough was achieved, the scientists have been refining the process and working on the problems of scaling up from laboratory procedure to industrial operation. The work has been supported by grants from the Department of Energy and appropriations from the Indiana General Assembly.

A pilot plant, needed to work out final details of the operation, should be under construction by a commercial producer in 1980, Tsao says.

America's farms and forests produce one billion tons of plant waste each year. In theory, at least, that is enough to fill the nation's fuel requirements now filled by petroleum. Tsao believes that by bringing marginal land into production

and using shallow waters to produce algae for cellulose, even more alcohol could be produced. The process can use other raw materials such as scrap paper and livestock manure.

Tsao envisages alcohol production being carried out at numerous small plants, where farmers could haul their cornstalks and other materials for conversion. The cost figure for alcohol from trash is based on a payment to farmers of \$30 a ton.

In the process developed at Purdue, cornstalks or other plant materials are mixed with dilute sulfuric acid. The acid dissolves the hemicellulose, which is then washed out of the mixture. The hemicellulose reacts with water to form a simple sugar which can be converted to alcohol or other products. The dry material goes to a tumbler which agitates it together with concentrated sulfuric acid. Slushing in the strong acid dissolves the cellulose. Acid, cellulose, and lignin then are separated.

An alcohol bath causes the cellulose to precipitate out of the mixture. The acid is recovered to be used again, and the lignin is dried to be used as fuel.

The cellulose is dried and recombined with dilute sulfuric acid. This final acid bath breaks down the cellulose into glucose which can be fermented and converted into alcohol.

Lignin is a good-quality fuel and can be burned to provide some of the heat needed to operate the plant, Tsao notes.