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The New York Times

New England Final

Boston: Sunny with increasing clouds and a high near 65. Tonight, spotty showers then partial clearing, low 42. Tomorrow, partly cloudy, breezy and cooler, high 52. Details on page 44.

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THREE DOLLARS

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New Technology Turns Useless Agricultural Byproducts Into Fuel for Autos

By MATTHEW L. WALD

JENNINGS, La., Oct. 20 — The plant was opened in 1977 to refine crude oil into gasoline, but when that proved unprofitable, it was converted in 1981 to run on molasses, and then in 1987, on grain. Bankruptcy followed.

Now, with rust on its tanks and pipes and grass growing through the gravel on its paths, construction workers are converting it yet again, to make fuel alcohol from agricultural garbage.

The plant's product, ethanol, which can be blended with gasoline to power cars and trucks or used on its own to power modified vehicles, has been produced around the country for years using corn and wheat and other high-quality, high-cost ingredients, but never with economic success. But the new owners of the plant here, BC International Corporation, with a subsidy from the United States Energy Department and help from a genetically engineered, patented type of bacteria, hope they are on the cusp of a new era.

"It is a bio-refinery," said Stephen J. Gatto, president and chief executive of the company. Exactly 25 years after the beginning of the Arab oil embargo, the Energy Department believes that Mr. Gatto's company may have a way to replace crude oil with garbage. BC International will be the first to try on a commercial scale.

"The input costs are close to zero," said Dan W. Reicher, Assistant Sec-

retary of Energy. "In some cases they are less than zero, because people are paying to get rid of these materials." And if it works, he said, the technology could also reduce the accumulation of gases in the atmosphere that are thought to cause climate change, and could lower smog.

The plant here in this south-central Louisiana town will run on bagasse, a part of the sugar cane plant usually considered useless, as well as on rice hulls, a currently useless part of the rice plant. Later, it may digest saw-

Leftovers like rice hulls could create power and cleaner air, experts say.

dust as well.

Around the country, energy experts have their eyes on clippings from suburban lawns, prairie grasses and other woody materials, as fuel for the new process. "It's a lot cheaper to grow wood and grass than corn," said John E. Ferrell, director of the Office of Fuels Development at the Energy Department.

In the current generation of ethanol plants, the fuel is the corn kernel; plants using the new technology could digest the cob and the stalk as

well, Mr. Ferrell said.

These materials are made of cellulose, which contains large amounts of sugar, the basic ingredient required for alcohol production. But the sugar in cellulose is in a chemical form that traditional fermentation processes, which use yeast, cannot digest.

BC's plant uses the KO11 bacteria, also used in the pharmaceutical industry, to break down the sugars.

The natural bacteria on which KO11 is based likes to eat sugars and produces a chemical called acetic acid. But then came gene splicing. Dr. Lonnie Ingram, a microbiologist at the University of Florida's Institute of Food and Agricultural Sciences, borrowed four genes from another organism, *Zymomonas mobilis*, to make the bacteria produce alcohol instead.

Around the country, researchers are working with *Z. mobilis* to find other approaches, but BC International's will be the first commercial plant to make ethanol from woody material. The plant will take about 18 months to build and will cost \$90 million, including \$11 million from the Energy Department.

Existing ethanol plants do little to save energy or reduce carbon buildup in the atmosphere. They can use up to seven gallons of oil or its energy equivalent to produce eight gallons of ethanol, experts say. The energy is used by the coal in power plants and diesel fuel in tractors that plant, fertilize and harvest the corn, and in petroleum-based fertilizer.

HOW IT WORKS

A New Way to Make Ethanol

A new process using genetically engineered bacteria makes ethanol, a fuel for vehicles, from agricultural wastes instead of crops.

| PLANT MATERIAL | INITIAL PROCESSING | FERMENTATION | DISTILLATION |
|--|----------------------------------|---|----------------------|
| CONVENTIONAL PROCESS | | | |
| Grapes, corn, rice | Cooked to free sugars | Yeast makes alcohol | Purified for ethanol |
| NEW PROCESS | | | |
| Grape vine waste, corn stalks, rice hulls, waste paper, tree trimmings, yard waste | Treated with acid to free sugars | Genetically engineered bacteria, KO11, make alcohol | Purified for ethanol |

Source: BC International Corporation

But using waste for fuel — especially waste that might otherwise be burned and in the process dump carbon dioxide back into the air — could allow production of seven gallons of ethanol from one gallon of oil.

And whatever the feedstock, whether trees or grasses, using it makes room for new growth, which will draw carbon back out of the atmosphere. This would be true, backers point out, wherever ethanol from cellulose might catch on, in this country or abroad, especially the third world, where demand for motor fuel is rising.

In the United States, retail distribution of ethanol in its near-pure form — a blend of 85 percent ethanol and 15 percent unleaded gasoline — is minuscule. But it is more widely distributed as ETBE, a gasoline additive used to raise octane and to reduce carbon monoxide emissions. Ford and Chrysler expect to turn out hundreds of thousands of vehicles that can run on ethanol or gasoline, to take advantage of credits offered under the Federal fuel economy rules, so a market is growing.

The stumbling block has been price. To compete, ethanol has to

cost about one-fourth less than gasoline, because it has less energy per gallon. BC International sees an initial niche for ethanol as the basic ingredient of ETBE; later, the company says, it could compete with gasoline directly.

What would help, experts say, is using ingredients that are available free, or that others will pay to dispose of. In California, one area has banned burning of rice straw because of air pollution, and that could be a potential fuel for an ethanol plant, Mr. Gatto said.

The plant here, on the banks of the Mermentau River, is designed to produce 20 million gallons a year — less than a pint for every car in America — but several others using cellulose are planned around the country. One company, Masada Resource, of Birmingham, Ala., says it will break ground next year on a plant in Middletown, N.Y., that will use the cellulose in household garbage. In that case, sales of ethanol will not turn a profit but will help offset the cost of garbage disposal, in a region where a large landfill is scheduled to close soon. It will not use KO11, but a different proprietary process for rendering the cellulose into digestible form.

If the new technology does not revolutionize the fuels business, it would not be the first time, as the plant here bears witness. "It all depends on how good these bugs are, and what the price of oil is," Mr. Reicher said.