BioFacts

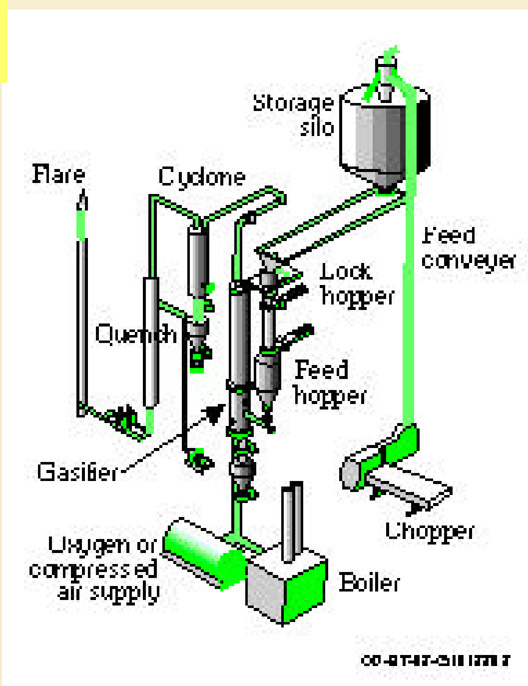
Fueling a Stronger Economy

Methanol from Biomass

What is Methanol?

Methanol is a liquid transportation fuel that can be produced from fossil or renewable domestic resources. In the United States, it is most commonly used as a chemical feedstock, extractant, or solvent, and as a feedstock for producing methyl tertiary butyl ether (MTBE), an octane-enhancing gasoline additive. It can also be used in neat (100% pure) form as a gasoline substitute, or in gasoline blends such as M85 (85% methanol and 15% gasoline).

The Renugas 11-tonne/day process development unit developed by IGT will be used to gasify bagasse at the methanol pilot plant in Hawaii.



The Resource

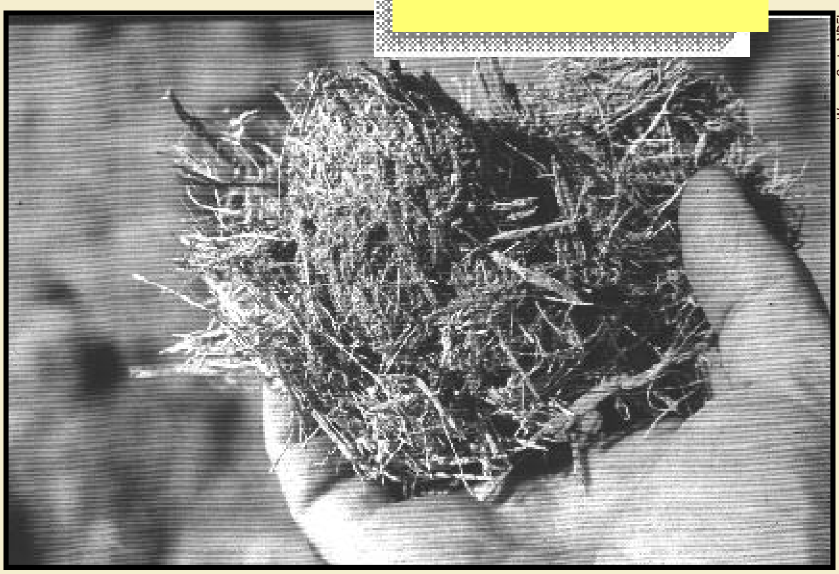
U.S. industry produces approximately 4.7 billion liters (1.2 billion gallons) of methanol annually. About 38% of this is used in the transportation sector, mostly in the production of MTBE. Most of the methanol produced in the United States today is made from natural gas. But methanol can also be produced from other feedstocks including coal, biomass, and residual oil. Cost-effective, efficient, and environmentally sound processes for producing methanol from biomass are being pursued by both government and industry researchers.

The U.S. biomass resource is an excellent, and renewable, feedstock for methanol production. The resource includes crop residues, forage crops (grasses), forest residues, short-rotation tree crops, and more than half of the municipal solid waste and industrial waste streams. Estimates of the biomass resource available for U.S. fuels production average 2.45 billion metric tons per year. One ton of feedstock can be converted to 721 liters (186 gallons) of methanol. As a renewable resource, biomass represents a potentially inexhaustible feedstock supply for methanol production.

The Production Process

Methanol can be produced from biomass through a thermochemical process known as gasification. The biomass is subjected to elevated temperatures and pressures (in some processes) to form a synthesis gas (syngas). The syngas (a mixture of carbon monoxide and hydrogen) is conditioned to remove impurities such as tars and methane, and to adjust the hydrogen-to-carbon monoxide ratio to 2:l. The syngas is then reacted over a catalyst at elevated temperatures and pressures to form methanol.

Sugarcane residue, called bagasse, is one of the first biomass feedstocks that will be converted to methanol. Bagasse is generated during the milling of sugarcane and is plentiful in places like Hawaii.



Warren Gretz, NREL

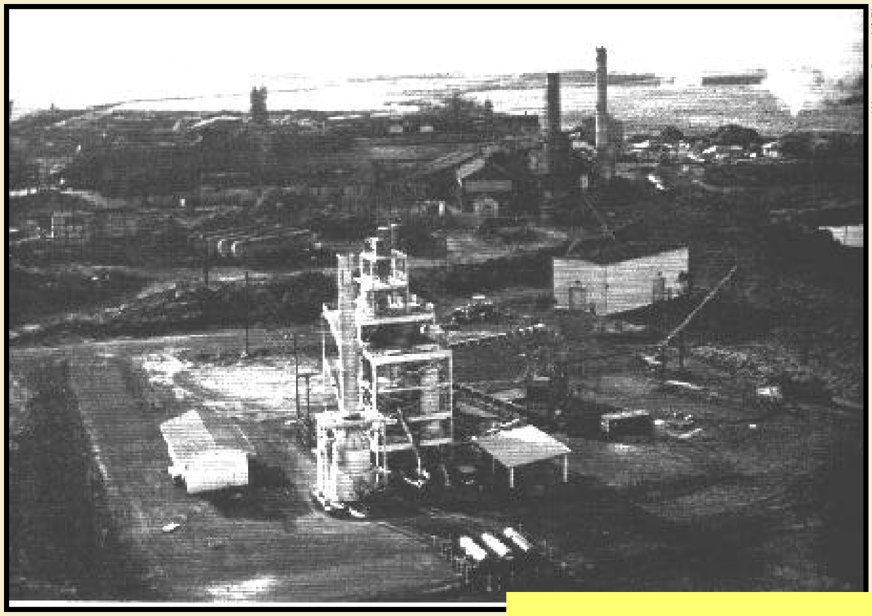
The Program

The U.S. Department of Energy (DOE), through its Biofuels Systems Division, sponsors the Biomass-to-Methanol Program managed by the National Renewable Energy Laboratory (NREL). The program concentrates on two areas: developing catalysts that can reduce the impurities formed during biomass gasification while simultaneously producing the desired hydrogen-carbon monoxide mix; and demonstrating a biomass-to-methanol pilot plant. The goal of the program is to reduce the cost of methanol from biomass to $0.13/liter ($0.50/gallon) from its present estimated cost of $0.22/liter ($0.84/gallon). At the reduced price it will be competitive with the wholesale price of gasoline from oil at $25/barrel.

NREL researchers are using novel catalysts to demonstrate that simultaneous gas conditioning and composition adjustment is possible at the laboratory scale. Additional work is needed, however, to determine if the catalysts can destroy impurities from various feedstocks and produce an acceptable product for methanol synthesis under realistic operating conditions.

Warren Gretz, NREL

The NREL methanol pilot plant demonstration is cost-shared by DOE and the Pacific International Center for High Technology Research in Hawaii. The plant will use a gasification system developed by the Institute of Gas Technology. Sugarcane residue (bagasse), abundant in Hawaii, will be the primary feedstock for the plant.



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Utilization

In accordance with the 1988 Alternative Motor Fuels Act (AMFA), DOE is conducting several methanol testing and evaluation projects. AMFA requires that an increasing percentage of U.S. government and private fleet vehicles operate on alternative fuels, including methanol, starting in 1991. Several government and private-sector fleets are participating in DOE-sponsored alternative fuel projects. Data on performance, emissions, and other variables are being collected on neat methanol, methanol blends, and MTBE used in light-duty passenger autos, heavy-duty trucks, and buses. The data is sent to the NREL Alternative Fuels Data Center and other organizations for evaluation and analysis.

Neat methanol can be used in existing vehicles; however, engine modifications are required to facilitate cold starts and to replace materials that can be corroded by methanol and M85. Methanol has a higher octane rating than gasoline, which helps reduce engine “knock.” It can also deliver greater fuel efficiency if the engine’s compression ratio is properly adjusted.

The availability of neat methanol and M85 is limited but steadily growing in regions such as the high-population areas of California, where the state government has sponsored a comprehensive methanol fuel and vehicle program. (Approximately 1000 methanol-fueled vehicles are on the road statewide.) Several major U.S. companies are participating in these and other methanol demonstration projects across the United States. And all three major autor manufacturers are producing vehicles that will run on either neat methanol or any methanol/gasoline blend.

Such demonstration projects help government and industry researchers to improve methanol utilization. Several improvements need to be made before neat methanol is considered a viable alternative to gasoline. Methanol’s energy density is about half that of gasoline, which reduces the range a vehicle can travel on an equivalent volume of fuel. When fueled with methanol, today’s vehicle engines can be difficult to start at low ambient temperatures because of methanol’s lower vapor pressure. Engineering solutions to these problems have been identified, however, and are under development. It is important to note that M85-fueled vehicles do not have the same degree of cold-start problems

Warren Gretz, NREL

Federal and nonfederal U.S. fleets were estimated to include 12,000 M85-fueled vehicles as of December 1994.

as vehicles operated with neat methanol. This is because of M85's 15%-gasoline component.

Environmental Effects

Methanol fuels produced from biomass feedstocks can reduce net greenhouse gases from automobile emissions. The biomass feedstock takes up carbon dioxide during growth— in amounts equal to those emitted during combustion—creating a "carbon cycle." Methanol's high heat of vaporization results in lower peak flame temperatures than gasoline and, therefore, lower nitrogen oxide emissions. Its greater tolerance to lean combustion (higher air-to-fuel) ratios results in generally lower overall emissions and higher energy efficiency.

In addition, production of methanol from biomass can turn municipal, industrial, agricultural, and forestry wastes into energy resources. Cultivation of dedicated energy crops for methanol production can provide year-round ground cover for erosion-prone croplands.

As NREL, state and federal agencies, and industry continue their demonstration and evaluation of methanol, answers will be found to break down barriers to its use as an alternative transportation fuel. As demand increases and feedstock and conversion research advances, methanol produced from biomass may fuel a steadily growing percentage of our vehicles into the next century.

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