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METHANOL FROM COAL

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ABSTRACT

Methanol or methyl fuel can be produced from coal using today's existing technology at prices equal to or less than other synthetic fuels on a cost per million Btu basis.

It has desirable properties from environmental, safety, toxicity, transportation, storage, ease of burning, and retrofitting of present boilers.

Its use as a boiler fuel has been tested in a public utility boiler with good results. Its use as a turbine fuel has been tested successfully. Automobiles are operating successfully.

It can be made in great quantities from domestic coal or lignite sources, providing vast reserves, and be a factor in this country's striving for self-sufficiency in energy.

Crushed coal may be slurried in methyl fuel rather than water and piped to the using installation from the mine-plant.

1. INTRODUCTION

The intensity of the energy and international balance of payments crisis and the need for more pollution-free forms of energy have forced attention to methods of producing synthetic fuels from coal. A number of the earlier papers have discussed technology in various stages of development rather than using presently available technology. The production of methyl fuel or fuel grade methanol, a mixture principally of methanol together with coproduced controllable percentages of higher alcohols, by gasification of coal to synthesis gas followed by catalytic conversion to methyl fuel, is one of the most promising routes available for the immediate production of a clean synthetic liquid fuel from coal.

Please note that I have a small burner operating on methyl fuel. Note the cleanliness and simplicity of burning.

Listing a set of criteria to which a synthetic fuel should conform to improve upon today's energy and environmental problems, one would include the following:

It should be environmentally clean burning in SO₂, NO_x, CO, hydrocarbons and particulate emissions and produce no ash for disposal.

It should be easy to transport, store in quantity and burn.

It should not pose new safety hazards or undue toxicities.

It should be burnable with only minor boiler retrofit expense.

It should be flexible so as to be burned in boilers, turbines, automobiles or diesels.

It should be available from domestic sources from essentially inexhaustible supplies of feedstock.

It should be available in quantity at costs equal to or less than other synthetic liquids or gases on a dollars per million Btu basis.

Finally, its technology must be available today, not awaiting further pilot plants, demonstration plants and other endless hurdles which seem to plague other synthetic fuels and on which inflation keeps taking its toll.

If one applies these realistic criteria to a fuel, then one may conclude that methanol, methyl fuel, is an answer.

A test undertaken by Vulcan Cincinnati, Inc., employees which involved turbine suppliers, boiler designers and burner manufacturers, did not reveal any substantive doubts regarding the use of methyl fuel as a fuel for stationary power facilities and gas turbines.

Major utilities we had spoken with had expressed great interest in obtaining fuel at the projected costs, but had deferred firm commitments because methanol had not been used in this way before. Therefore, a small-scale demonstration test of methanol combustion was conducted at the facilities of Coen Company, Burlingame, California, on a boiler test stand used for fuel and burner evaluations. The results of these tests are given in Table 1.

A larger scale demonstration was then carried out in cooperation with a number of utilities and other companies, including Southern California Edison, Consolidate Edison (New York), New Orleans Public Service, and twenty-four other organizations.

A boiler operated by New Orleans Public Service, Inc., was selected for the demonstration. This unit is a Babcock & Wilcox boiler with a rated capacity of 425,000 lb/hr steam and a net summer capability of 45 Mw. It is a balanced draft boiler with flue gas bypass for control of superheat and is equipped with six burners.

Table 1. Methanol Compared to Natural Gas and No. 6 Oil

	Methanol	Natural Gas	No. 6 Oil
Lb Fuel/MM Btu	102	42	54
Lb Stoic Air/MM Btu	686	723	756
Lb Flue Gas/MM. Btu	788	765	760
NO _x Emission/Equivalent Flue Gas	25-50	30-200	350

Methyl fuel firing of the boiler required only that a centrifugal pump be installed in parallel with the existing pumps, with a recirculating line from discharge to suction for start-up. No other changes were made except to change nozzle tips to B&W's 85 degree Y-type.

Fuel oil runs of the test series were conducted using the mechanical atomizing oil burners normally used. At any load, a dirty stack occurred when the excess air was below 25 percent. Gas tests were made with existing burner rings. Oil and gas runs were made with loads and excess air levels corresponding to the methanol runs.

Methanol was tested at two excess air levels and at load levels of 100, 75, and 50 percent. Two blends containing higher alcohols were used successfully.

With the Y-type tips the appearance of the methanol flame was similar to a natural gas flame, except that the blue was not as bright. The rosette at the burner tip was clearly visible. Bright sparklers noted at the flame intersections disappeared quickly and did not float in the furnace. The furnace was clear at all times.

Soot deposits from oil firing were burned off by the methanol.

One methanol run was made to establish the excess air level at which CO would be excessive. At 11.1 percent excess air, the CO concentration was 750 parts/million. All other methanol runs were with CO concentrations less than 100 parts/million. Generally, the CO concentration for the methanol tests was less than that observed for the oil and gas tests.

No particulates were observed coming from the stack at any time. Figure 1 shows NO_x found in the flue gas was less than detected from natural gas and much less than from oil combustion. The figure presents emission data on NO_x (lb/million Btu heat release) versus unit load Mw. Spot analyses for aldehydes, organic acids, and hydrocarbon indicated that there were negligible quantities of these materials. Since there is no sulfur in methanol there were no SO₂ emissions.

The Manufacturing Chemist's Bulletin for methanol was studied by operating personnel. The methanol was handled just as other fuels.

The results of these tests showed that methanol may be used as a base fuel or supplemental fuel, depending on the overall economic and emission requirements of the system.

For boilers equipped with gas and oil burners, the oil burner modifications are relatively simple. In general, any type of liquid fuel burner may be adapted to use methanol.

If methanol is used as supplemental fuel, a dual supply system to the burners would be advantageous if rapid changeover is required, and essential if oil and methanol are to be fired simultaneously. Simultaneous use with oil in designated burners would average down the level of pollutants from oil firing.

Use of methanol as a turbine fuel also has considerable merit. Vulcan Cincinnati, Inc., has collaborated with the General Electric Company (Gas Turbine Division in the successful demonstration of methanol combustion in a turbine combustor.

The principal results were:

1. All the physical combustion characteristics such as ignition, high and low flow blowout, temperature distribution, were within standard operating limits.
2. Measured NO_x emissions were quite low, being approximately 40 percent of the levels achieved on No. 2 distillate.
3. Preliminary estimates showed a possible 6 percent increase in output relative to a No. 2 distillate fueled machine. Subsequent work published by Mr. P. M. Jarvis of General Electric Turbine Division and by Mr. R. O. Klapatch of United Technologies leads to similar conclusions.

Methanol qualifies as a fuel for both intermediate and peaking load in turbines.

An important virtue of methyl fuel is the fact that it can be piped, shipped, transferred, and stored within the specifications now provided for a number of other liquid fuels. The storage tanks, piping systems, loading and off-loading equipment and tankers regularly used for petroleum can also be used for methanol.

It is significant that accidental spills of methanol in harbors or offshore would be of no serious consequences, and would present no fire or environmental hazards because of the rapid diffusion and complete miscibility and biodegradability of methanol in sea water.

I will spill some methyl fuel into water so you may observe the solubility after the panel discussion.

This makes it by far the most desirable source of energy to transport to meet both the energy and pollution problems affecting many areas of the world.

In regard to toxicity Andrew Moriarity, M.D., in his paper given on "Toxicological Aspects of Alcohol Fuel Utilization," presents the conclusion, and I quote, that "all available information to date indicates that the biomedical and environmental issues associated with the use of alcohol fuels are not critical...in fact the relative impact is clearly less than gasoline."

His paper was one given at the Second Annual International Symposium on Alcohol Fuel Technology held in Wolfsburg, Germany, in November 1977, sponsored in part by Volkswagen and the German Federal Ministry for Research & Technology. A compendium of all papers presented at that symposium is here in my possession and available for your review. Europe and Japan appear to be ahead of this country in giving proper attention to methanol as a fuel perhaps since it was used successfully in Europe during World War II.

As to the manufacture of methanol, commercial grade product is and has been manufactured here in California at Hercules, north of San Francisco, for many years, using Vulcan Cincinnati, Inc., technology.*

Methyl fuel produced from coal, or preferably the low grade lignite available in almost limitless quantities at relatively modest cost since its current uses are so limited, provides an ideal source of hydrocarbons for conversion to methanol.

* More recent private communication with the plant personnel in the Hercules California plant indicates that due to the high cost of purchased gas used as the raw material, the methanol, ammonia and urea plants have all been shut down and the overall plant closed. This makes even more tangible the need of coal energy and raw material sources for California.

With the Vulcan Cincinnati, Inc., process for methanol the only commercially proven American owned technology known to us, only the clean fuel would enter California from other States, to be used in boilers, turbines, automobiles and diesels. Impurities, ash, pollutants such as sulfur would remain at the mine-mouth plant for land reclamation and for sale of valuable by-products.

A new catalyst under development by Vulcan and presented in a paper at the Wolfsburg, Germany, seminar is designed to produce directly the blend of higher alcohols and methanol. We would see this as a significant breakthrough in methyl fuel technology.

To serve as the focus for a preliminary economic evaluation, Vulcan technology, from which seven methanol plants, including the largest plant, have been built, has developed a preliminary process design based on 5,000 ton modules to produce 25,000 short tons per day of methyl fuel from a plant at a lignite mine-mouth site making use of technology which has been reduced to commercial practice.

The total plant cost has been estimated to be about \$600 million in 1976 dollars. The methyl fuel selling price has been determined for each of three cases of lignite costing \$6, \$7 and \$8 per ton, and, on condition that all the utilities are supplied by the methyl fuel plant at no cost. Purchased oxygen is estimated at \$10 per ton.

It is anticipated that methanol product could be sold at about \$3 per million Btu's, depending on required return on investment and financing. Fuel grade methanol can be competitive at today's prices with alternative fuels as a source of energy even without credit for sales or utilization of any of the many by-products that exist.

I have several copies of an Executive Abstract on fuel grade methanol from lignite which you might want to review. A brief review of the executive summary of the recent Department of Energy "Conceptual Design of a Coal to Methanol Commercial Plant," leads to similar conclusion by our company of anticipated cost of methanol produced.

The block flow diagram, Figure 2, depicts the major process steps of methyl fuel production.

1. Lignite Preparation

Lignite is conveyed, stored, crushed and then ground to a fine particle size suitable for feed to the gasifier.

2. Lignite Gasification

The pulverized lignite is reacted with steam and oxygen at optimized temperature and pressure in the gasifier to produce a

crude synthesis gas. After heat recovery, the crude gas is quench-cooled and scrubbed free of ash and carbon particles.

3. Shift Conversion

The gasifier effluent gas is shifted to an appropriate H₂ to CO ratio in a shift converter. The gas from the converter flows in succession through heat exchangers.

4. Acid Gas Removal

Both hydrogen sulfide and carbon dioxide in the shift converter effluent are removed in this section.

5. Methyl Fuel Synthesis

Methyl fuel is produced by the catalytic reaction of carbon monoxide and hydrogen at optimized temperature and pressure in the reactor using specialized catalysts. The reactor effluent is cooled and methyl fuel product is condensed and separated.

6. Air Separation (by others)

The air separation process is the typical low pressure cycle process which is commercially available today.

7. Sulfur Recovery

Elementary sulfur is recovered from the acid-gas stream containing mainly carbon dioxide and hydrogen sulfide in this section.

Throughout the design concept of the plant, recognition of water shortages would be maintained. Cooling water usage would be minimized through closed cooling loops and through air-cooled heat exchanger. Low quality water would be utilized in the gasifier.

Mention has been made in earlier papers on the slurring of crushed coal in water and then pumping the mixture by pipeline to California.

A better solution may be to slurry coal in methanol produced at the mine-mouth, rather than in water.

The procedure would eliminate the need of pumping vast amounts of scarce water from the arid mine areas, would eliminate costly coal-water separation and drying at the point of usage, would produce an easier to burn fuel and would reduce SO₂, NO_x, and ash effluents from the boiler.

I would be pleased to discuss the subject further with you.

Thank you for your attention and interest.

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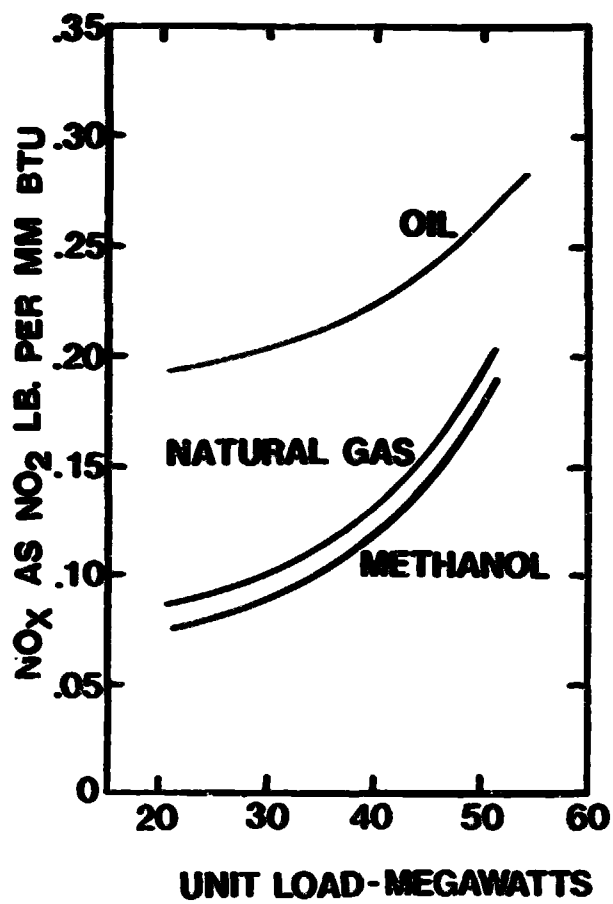
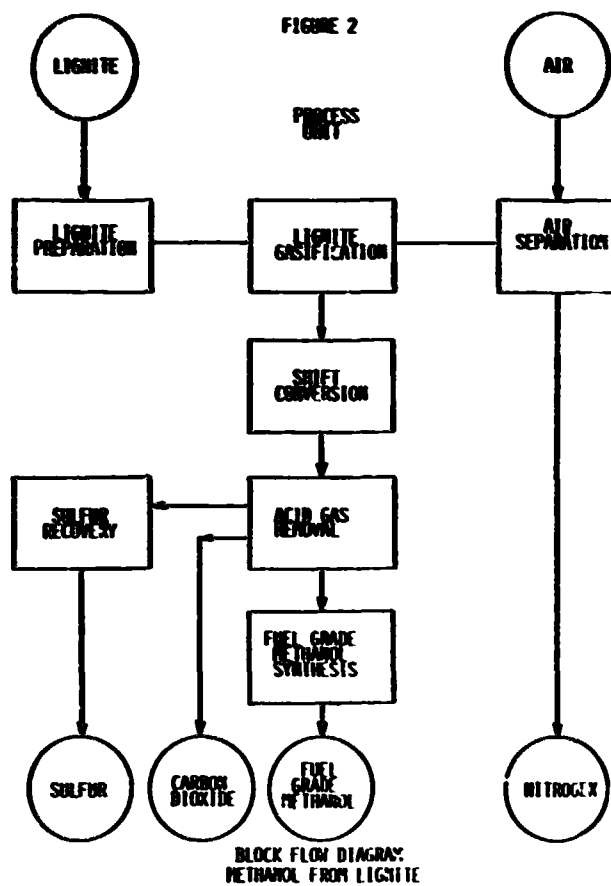


Figure 1



BLOCK FLOW DIAGRAM:
METHANOL FROM LIGNITE

Figure 2