Chapter 15

CRITICAL ECONOMICS OF COAL DERIVED ALCOHOL TRANSPORTANON FUELS1

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ABSTRACT

The need for and the results of a broader based economic evaluation of coal derived alcohol fuels are examined in this paper. This study indicates that coal derived alcohol fuels are at least marginally competitive with MTBE for use as a gasoline blending agent, and not economically competitive as neat fuels compared to gasoline even under a broader based evaluation process. However, alcohol derived from natural gas possessing the same characteristics as their coal counterparts exhibit superior economics.

INTRODUCTION

The objective of this paper is to focus on the need for a broader based economic evaluation of coal derived (CD) alcohol transportation fuels and to identify relevant social costs and benefits that need to be examined. The current practice of evaluating the feasibility of alcohol fuels solely on their financial attributes fails to account for all the cost and benefits associated with the production and consumption of these fuels and therefore may not reflect their true economic status.

The results and conclusions of this study are based on preliminary coal gasification and CD mixed alcohol production designs developed by the Chemical Engineering Department at West Virginia University, which consist of two base cases. The first case includes indirect liquefaction of coal using a high temperature oxygen blown Texaco gasifier in conjunction with the Sour Gas Shift conversion process to obtain the desired H_2:CO ratio syngas for the alcohol synthesis process. The second is a reference case based on steam reformation of natural gas with pressure swing absorption

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to adjust the H_2:CO ratio of the syngas. Both cases produce approximately l300 million gallons of mixed alcohol a year. The composition of the mixed alcohol product on a molar percentage bases is approximately 42% methanol, 43% ethanol, 10% propanol, 3% butanol and 1% pentanol.

PRODUCTION AND SOCIAL COSTS

The cost associated with the production of alcohol fuels can be divided into two broad categories, financial and social, which must be added together to obtain a true cost. Financial costs are explicit costs obtained through engineering analysis. Social costs include the difficult to measure items such as benefits and costs of air pollution control. Current studies focus primarily on production costs only. However, this type of analysis overlooks important social costs and benefits associated with production and use of these fuels. For example, the production of CD alcohol transportation fuels would inevitably result in increased mining activity at some environmental cost, while gasification may also impose some environmental cost attributed to increased CO_2 emissions. To determine the true cost of alcohol fuels these issues must be addressed.

If we assume that current mining legislation regarding acid -nine drainage and siltation is effective, potential environmental costs associated with increased mining activity should be internalized and reflected in the price of coal. The social costs associated with the gasification plant may be minimized through design alterations, which would internalize these costs. For example, CO_2 emissions may be minimized by supplementing the gasification process with hydrogen rich natural gas. In this case the cost of the natural gas could be offset by eliminating the Sour Gas Shift converter and the reduction in annual coal consumption that would accompany these changes. As a result, the production cost of alcohol fuels would represent the actual cost to society. This is significant, since it makes it possible to derive a net cost for alcohol fuels given the uncertainty surrounding the utility of these fuels.

SOCIAL BENEFITS OF MIXED ALCOHOL AND MTBE

Alcohol fuels may be used in one of two capacities, either as a neat fuel or as a blending agent with gasoline. Many blends are possible and each blend has different performance characteristics and different costs and benefits. To reduce the economic analysis of alcohol blends to manageable proportions, the commonly used commercial blend of 10 percent alcohol was selected to represent the use of coal derived alcohols in this capacity.

A comparison was made between 10 percent CD alcohol and gasoline and a similar blend using MTBE to determine if there were differences in benefits in the form of reduced hydrocarbon and/or carbon monoxide emissions. No significant differences were noted and no adjustments to equate the social costs and benefits of using MTBE versus CD alcohol were necessary in this case.

However, this is not true when CD alcohol is used as a neat fuel. Studies suggest that significant reductions in hydrocarbon, NO_x, and carbon monoxide emissions may be obtained if neat alcohol were to replace gasoline as a transportation fuel [1][4][6]. Rather than attempt to quantify individual social benefits and costs from using neat alcohol, total net benefits may be derived indirectly by subtracting the production cost of the neat alcohol from the cost of gasoline, assuming that all relevant costs are internalized, and making adjustments to account for different performance characteristics. Adjusting the plant gate cost of $0.65/gal according to PEP standards for the chemical industry yields an equivalent wholesale price for the CD alcohol fuel of approximately $0.82/gal. However, since the alcohol fuel has a lower heat content, a cost adjustment must be made. Compensating for differences in heat content, the cost of the CD alcohol fuel would be approximately equivalent to gasoline at a wholesale price of $1.28/gal. Given the current wholesale price of gasoline of $0.76/gal [9], additional social benefits attributed to the use of neat mixed alcohol fuels would have to exceed $0.52/gal to make their use economically feasible, provided no additional costs or negative benefits are incurred when the alcohol is used as a neat fuel.

COMPETITIVENESS OF ALCOHOL FUELS

On a price basis alone, the mixed alcohol produced by this proposed facility appears to be competitive with the popular blending agent, MTBE. The plant gate cost for the mixed alcohol would be approximately $0.65/gal. MTBE, on the other hand, currently sells for roughly $0.98/gal [2] on the spot market. This spread would provide producers of the mixed alcohol a considerable margin for markup and transportation cost without jeopardizing the competitiveness of the product. However, price is only one determinant influencing the demand for blending agents. Other factors, such as the practical aspects of manufacturing and distributing the CD mixed alcohols and engine performance characteristics, must be considered. Performance factors of major importance include the effects of the blending agent on reid vapor pressure, octane rating, and oxygen content of the fuel. Blending incentives related to these factors must be determined before the final competitiveness of the mixed alcohol to MTBE can be calculated. Preliminary research suggests that the economic differences between CD mixed alcohol factors and, MTBE factors are small.

On the negative side, in order for the CD mixed alcohol plant to obtain costs that are competitive with MTBE, economies of scale in the CD alcohol plant size must be exploited. It appears that one plant producing 1336 million gallons per year may saturate local eastern United States markets, which would cause additional costs due to additional marketing risks and distribution problems. (See Table 1).

TABLE 1
Local Market Potential for Mixed Alcohol as a Fuel Oxygenant (10% Blend)

										Total Market	
	WV	PA	MD	NJ	DC	DE	OH	KY	Local	US	a
MM gal/yr	82	449	198	327	17	33	461	180	1747	11092	1336

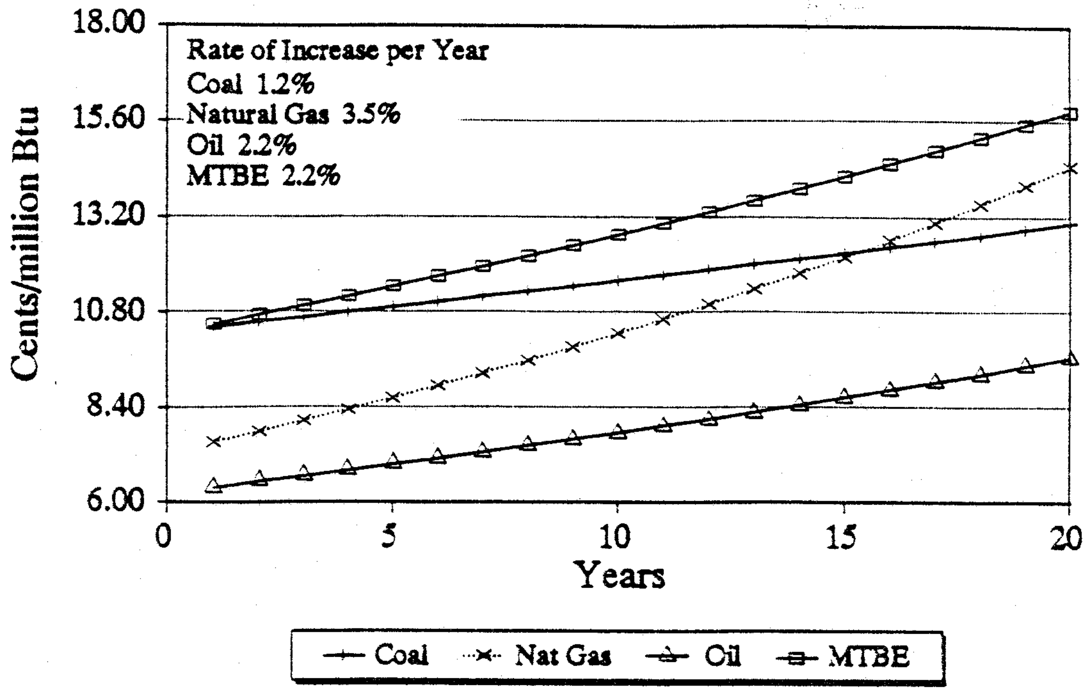
a-Proposed Alcohol Production from Base Case
Source: State Energy Data Report Consumption Est. 1960-1990 EIA May 1992.

While the mixed alcohol product appears to be at least marginally competitive as a fuel additive, this is not necessarily the case for its usefulness as neat fuel. Although a plant gate cost of $0.65/gal. is less than the current refinery price of gasoline at $0.76/gal excluding taxes, the mixed alcohol is still more expensive due to its lower heat content. This is because the mixed alcohol product is comprised of mainly methanol and ethanol, which have lower heat content, with only small amounts of higher alcohols, which have higher heat content. Given the composition of the mixed alcohol, its price in relative terms based on its heat content would be about $1.03/gal., which is substantially more than gasoline considering that this is a plant gate or break even cost. The high concentration of methanol (see [8]&[11]) in this mixture may also present a series of engine performance problems and institute additional social costs that would otherwise be avoided if the CD mixed alcohol were to be used as an additive.

EFFECTS OF CHANGING FEEDSTOCK PRICES AND TECHNOLOGY OVER TIME

Since natural gas can be used to obtain mixed alcohols with characteristics similar to those of CD mixed alcohols, the cost of producing alcohol from natural gas must be compared to the cost of producing alcohol from coal. Also, the price of oil must be considered in the cost of manufacturing MTBE, although MTBE prices may or may not accurately reflect the true incremental costs of producing MTBE at the refinery because of the nature of joint product pricing problems.

Figure 1.
Cost of Transporation Fuel
Oil $22 per Barrel



The relative economics of neat alcohol fuels with respect to gasoline depends upon both the initial costs and the rate of change of these costs over time. Figure I shows the results of an analysis of the relative costs of transportation fuel assuming coal costs about $30 per ton, natural gas costs $3.00 per mcf, oil costs $22 per barrel, and MTBE costs $41.16 per barrel. Also shown are the assumptions concerning the real annual increases in costs and prices over a twenty year period.

As can be seen in Figure 1, oil is currently the cheapest source of transportation fuel, followed by natural gas and then coal. However, different relative cost increases will change the ranking over time. According to DOE estimates, coal should increase 1.7 percent per year, oil and MTBE 2.7 percent per year, and natural gas 3.5 percent per year. If coal gasification costs decrease by 0.5 percent per year, overall coal costs would increase by 1.2 percent per year. Under this scenario, oil would be the fuel of choice over the next 20 years and gas would be a cheaper source of transportation fuel than coal for the next15 years or more.

CONCLUSIONS

This study indicates that coal derived alcohol fuels are at least marginally competitive with MTBE for use as a gasoline blending agent, and not economically competitive as neat fuels compared to gasoline even under a broader based evaluation process. In order for CD alcohol fuels to be competitive, additional cost reducing measures need to be realized. However, reducing costs of CD alcohol may be in vain because similar alcohols can be derived from natural gas at a fraction at a lower cost given the probable price relationships of coal an natural gas for the next 15 years. This situation is expected to continue, since natural gas prices are only project to increase at about 3.5% per year according to DOE estimates.

As a blending agent, CD mixed alcohols appear to be marginally competitive with MTBE under current conditions. However, it is still cheaper to produce mixed alcohols from natural gas than coal. In fact, the natural gas derivative of this product may even have a cost advantage over MTBE, although this remains to be seen, since the price of MTBE may be artificially high like many other joint products of the petroleum refinement process. If mixed alcohols from natural gas were to be produced in competition with MTBE, MTBE prices would be expected to drop significantly, which would inevitably effect the competitiveness of CD alcohols as blending agents.

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