The Heritage Foundation Backgrounder

No. 86 The Heritage Foundation 214 Massachusetts Avenue N.E. Washington, D.C. 20002 (202) 546-4400

June 4, 1979

ALCOHOL FUELS: ENERGY FROM AGRICULTURE

INTRODUCTION

With each passing day, the news regarding our nation's energy position seems to grow worse. The overall picture, which was bleak enough, has deteriorated rapidly since late last year. First, militant strikers shut down the Iranian oil fields. Even when production was resumed, it was at a significantly reduced level, and indications are that much of the production which originally had been earmarked for the U.S. domestic market is being diverted to Europe and Japan.

On the heels of the Iranian shutdown, the OPEC oil ministers embarked on another round of price increases. At their March 28 meeting, they increased the price of oil by nine percent, and then allowed the addition of surcharges of up to $4 per barrel. Most member nations imposed some surcharge shortly afterwards, with more and more reaching the maximum. In the interim, the spot price for crude oil was reaching well over $20 per barrel with no end in sight. The high prices predominating on the spot market tempted producer nations to divert oil which otherwise would have been sold under contract, leading to further allocation problems. These allocation problems have manifested themselves in this country by spot shortages on both coasts, and higher prices at the gas pump.

While the energy crisis appears to have arrived with a vengeance, a significant portion of the American public still does not believe it exists. There is a deep-rooted suspicion of the oil industry among the public, and, to a large degree, they seem to feel that they are being manipulated. This suspicion is having its effect in Congress, where increasing opposition to the decontrol of domestic oil prices is forming.

The problem of energy production is of such pressing urgency that others pale by comparison. However, as noted, this message seems to have been lost on the general public. For the four weeks ending May 4, 1979 (the latest period for which statistics are available), the United States imported an average of 7.8 million barrels of oil each day. This represents a 39.1 percent increase over the same period in 1973. During the same period we consumed 7,086,000 million barrels of gasoline to fuel the nation's 117,147,000 passenger cars, 31,921,000 trucks and buses, and 5,138,000 motorcycles. We know that we must reduce our dependence on what President Carter has termed "a thin line of tankers stretching to the Middle East," but the question is: How.

What may be a partial answer has recently surfaced: the use of ethanol as an extender for domestic gasoline stocks. What is perhaps most attractive about the use of this additive is that it has the further benefit of serving as a potential solution to the food shortage as well.

ALCOHOL FUELS

There are two basic types of alcohols which are used as fuels. The first is ethanol, commonly termed "grain alcohol," and the other is methanol, referred to as "wood alcohol." While basically similar, these two alcohols each possess unique qualities which determine their desirability for certain types of fuel uses.

Ethanol appears to be the more suitable for use in automobiles, at least for the near term. This is because it can be readily mixed with conventional gasolines, and may be used in existing automobiles without requiring any engine modifications. Methanol, however, would require some engine modification to be used in an alcohol/gasoline blend, and tends to separate easily. It also tends to promote the formation of water in the fuel. Finally, there is a severe toxicity problem with methanol, and even small amounts of methanol vapors in a passenger compartment could cause serious harm to the compartment's occupants Methanol, however, may be ideal as a replacement fuel for petroleum-based products in the turbine engines used by many utilities as peaking units. In numerous tests, methanol has demonstrated its desirability as a turbine fuel, and can even be used in an 80/20 ratio with water.

What makes ethanol so desirable as a motor fuel, of course, is its adaptability to the existing automobile fleet. While much attention has been given to recent successes in marketing ethanol/gasoline blends under the name "gasohol," such blends have been used as various times and in various countries since the inception of the age of the automobile.

EXPERIENCE WITH ALCOHOL FUELS

Perhaps the best known experiment with alcohol/gasoline blends took place during the early 1930s when Henry Ford teamed up with the Dow Chemical Corporation in an attempt to market such fuels in the midwest. The alcohol/gasoline mixture was marketed under the name "Agrol," beginning in 1935. Eventually the project was abandoned, because it could not compete economically with the cheap petroleum available at the time. Other instances in which alcohol fuels were used on a fairly wide basis include a 1933 experiment by the Illinois Agricultural Association in which 500,000 gallons of a 90/10 blend were distributed, a period between 1923 and 1930 during which Germany used a blend of 75 percent gasoline and 25 percent alcohol, and the 2 million mile road test in Nebraska.

At present, Brazil has an aggressive program under way to expand the use of alcohol as an additive to petroleum. They are experimenting with blends of up to 30 percent alcohol content, and have one test fleet of 200 cars which have been specially adapted to run on pure alcohol. In 1977, alcohol distilled from manioc and sugar cane was supplying between 1 percent and 2 percent of Brazil's total motor fuel requirement. Its program's goal is to have alcohol fuels supply fully 20 percent of Brazil's automobile fuels by the middle 1980s.

At present, a number of pilot projects are under way to determine the extent to which alcohol fuels, and especially ethanol/gasoline blends are practical for the United States. As the world's most efficient agricultural nation, it would seem logical to harness our expertise in farming to utilize this fuel source. Public acceptance of alcohol/gasoline blends to date would seem to indicate that the general population agrees. There are some questions which must be addressed, however, if alcohol fuels are to be adopted on a widespread basis. Primary among them is the question of the economic viability of such fuels over the long term.

THE ECONOMICS OF ETHANOL

Perhaps the most frequent criticism heard when the use of ethanol fuel is discussed is the allegation that that it is uneconomic, and would therefore require massive subsidies in order to compete with more conventional motor fuels. The data generally cited to support this contention are usually based in the work of Dr. James Kendrick of the University of Nebraska. Dr. Kendrick's work has been cited in congressional testimony, and was most recently published in April 1978 by the Agricultural Experiment Station of the University of Nebraska-Lincoln. Certain assumptions, which were correct at the time Dr. Kendrick did his research, no longer hold true, however. Also, there appear to be certain omissions from Dr. Kendrick's considerations which may have resulted in overly pessimistic conclusions. Finally, Dr. Kendrick did not consider the question of fuel availability -- i.e., alcohol which can be produced from a domestic resource may remain more available over the long-term than petroleum which increasingly must come from abroad.

To begin with a more specific examination, one must look to the crude oil price used by Dr. Kendrick as a basis for all of his calculations. This price was approximately $11 per barrel, resulting in a price at the refinery of 26¢ per gallon of product. He then estimated the cost of refining and marketing at an additional 10¢ resulting in a total cost per gallon of 36¢, excluding taxes. Successive increases in the price of imported oil, however, have made these figures grossly understated. For example, April 3, 1979, before the effects of the March 28 OPEC ministers meeting were fully felt, the price of unleaded regular gasoline ranged from a low of 50.6-53.9¢ per gallon in California to a high of 62.2-64.0¢ per gallon in the midwest. The national average price for unleaded regular gasoline was 56¢ per gallon at that time. With successive surcharge additions, the price of gasoline at the wholesale level has continued to rise since April. This price rise has been worsened by the necessity for some oil companies to enter the spot market to purchase refined products to meet their commitments. Amoco, for example, reported in the May 23 issue of The Energy Daily, that it was paying up to 85¢ per gallon for refined products on the spot market. On the Rotterdam exchange, the spot price for a barrel of light crude oil reached $30 in some instances during the final week in May.

What all of this means, obviously, is that the price of oil on which Dr. Kendrick based his calculations, is no longer adequate. A second consideration is that he neglected to take into consideration the subsidy of imported oil which results from the entitlements program. Under the provisions Of this program, each barrel of imported oil is subsidized by the refiners of domestically price-controlled oil. The subsidy amounts to $3 per barrel, or 7¢ price reduction. A comparison of the prices which would prevail for a 90/10 gasohol blend, as opposed to the price of gasoline refined from imported oil without the benefit of subsidy, makes a powerful argument on behalf of alcohol blends. The following prices assume that corn is the feedstock for the alcohol, and that it is selling for $3.50 per bushel.

PRICE PER BBL OF IMPORTED OIL	PRICE PER GALLON EXCLUDING TAXES GASOLINE	GASOHOL
$18.50	71.6	71.5
$20.00	75.2	74.7
$22.00	79.9	79.0
$25.00	87.1	85.4

Amazingly, gasohol maintains and even improves its relative economic position relative to import prices for oil within the range anticipated for this year, as long as the subsidy for imported oil is taken into account. More importantly, this occurs even with a corn price considerably above the current market. In fact, it is entirely possible that if the world market price for oil were to rise to the $30 per barrel currently predominating on the spot market, that an even higher corn price could be justified. This also ignores externalities which result from diverting the expenditure of dollars from overseas, where they increase our balance of payments deficit to our farm economy and where they are subject to a multiplier effect of 7.

ENERGY BALANCE

One of the most hotly contested aspects of the debate over alcohol fuels is the question of relative energy balance. Put simply, opponents of their use contend that since more energy is consumed in producing the grain which would be necessary to produce a gallon of alcohol under conventional processes, the concept is ill-advised. Actually, unless the fuels being used to produce the alcohol are entirely petroleum based (this includes both the fuels used on the farm and those used in the fermentation and distillation process), the argument is specious. In fact, most conventional energy sources would present a negative energy balance under these circumstances.

Perhaps the best example of a negative energy balance is found in the generation of electricity. We produce about one-third the energy in the form of electricity that we consume in the form of oil or coal, or natural gas in a conventional base-load electric generating station. No one, however, would contend that we should stop producing this energy form. The fact is that what we are really doing is taking a less useful form of energy, say lumps of coal, with limited utility, and converting it, albeit at a penalty, to a more useful one.

In the case of alcohol production, what we are doing is converting some form of energy (including the energy content of the starches and sugars in the corn) to a liquid fuel which may be used in the transportation sector. The key is to insure that the energy inputs which are usable in the transportation sector are less than the energy outputs in form of alcohol. This can be accomplished in a number of ways.

One way to reduce the amount of petroleum-based fuels which may be used in the process of making alcohol is to recapture waste streams from the process, and convert them to methane gas to use as part of the facilities' overall energy mix. The bioconversion of wastes is a known technology, and can provide as much as 60 percent of the requirements of an alcohol plant given the present state of the art. With improvements, the percentage may be increased. This approach has the added benefit of reducing the overall requirement to purchase energy, making the plant more efficient, and therefore cheaper to operate. Another approach is to use co-generation. Alcohol plants require relatively low temperature-low pressure steam for their cookers, fermenters, and distillation columns. This is exactly the type of steam available through co-generation. Co-generation, of course, offers the advantage of taking what would normally be waste heat and putting it to productive uses, thereby increasing the overall efficiency of the utility plant providing the steam. A final approach which has been suggested is the use of coal as a fuel. Coal is present in abundance within the confines of the continental U.S. , and is not directly usable in automobiles, although there are processes by which it can be converted to gasoline. However, coal used in this fashion would not divert motor fuels, as there is more than enough coal to go around.

A second fallacy which consistently appears in arguments related to the relative Btu ration of inputs and outputs in the alcohol conversion process is the assignment of the total Btu expenditure of the process to the production of alcohol. In fact, alcohol is but one of several products which are going to result from a plant processing grains. The corn oil, and vital corn gluten would certainly be of considerable value, and should properly be assigned a portion of the overall Btu expenditure. When such an assignment is made, the energy balance can actually be made positive, assuming that at least 60 percent of the plant's fuel comes from co-generation, or methane recapture.

THE AVAILABILITY QUESTION

Perhaps the key question which has been ignored in the debate over the use of alcohol fuels is that of availability. It is this, more than any other single consideration which mitigates in their favor. They are produced from domestic resources, and are not subject to the vagaries of foreign governments. Moreover, the lead-time for construction of an alcohol plant is from 18 months to 2 years, by far the shortest time of any option available to us. To maintain perspective, however, it should be remembered that alcohol fuels are not a panacea. Rather, they are a major source which can help to reduce our dependence on imports by as much as 20 percent in the relatively near term. This, in and of itself, is a contribution significant enough to eliminate the necessity to overstate the benefits of alcohol fuels. This is especially true, since each barrel of alcohol used in our motor fuel stocks reduces the nation's import requirements by at least two barrels of oil. This is because, at best, we can distill 21 gallons of gasoline from a barrel of oil, and when unleaded gas is to be the product, the figure is closer to 19 gallons. As a result, it takes two barrels of oil to produce one barrel of gasoline. Regardless of how many barrels of oil it takes to produce a barrel of gasoline, though, the important point remains the availability of petroleum from which to distill our motor fuels. When the alternatives are either to use alcohol as a supplement or to do without, the choice becomes obvious.

CONCLUSION

In examining the extension of motor fuel stocks with alcohols distilled from grains, a couple of significant advantages become evident. First, and foremost, is the fact that alcohol fuels would be based in a domestic feedstock, and therefore not subject to the sudden interruption by foreign governments. Secondly, the adoption of an alcohol fuels program could provide the farm economy with a whole new market, helping to make the farmer self-sufficient, and, hopefully, eventually eliminating the need for farm subsidies.

While it is true that the increase in the price of grain which would result if alcohol fuels were widely used would also be reflected in higher food prices, the fact is that higher petroleum prices on the world market might have a similarly adverse effect.

Finally, while keeping perspective, and realizing that the use of alcohol fuels in and of themselves will not solve the energy crisis, we must acknowledge that they do present one of our most hoepful short-to-intermediate term solutions. An alcohol plant with an annual capacity of 50 million gallons can be built in 18 months to 2 years. Each such plant has the potential to reduce our import requirement by 240,000 barrels annually. Were we to go to a 10 percent alcohol blend throughout our pool of motor fuels, we could reduce our import requirements by 1.4 million barrels per day, far more than we were importing from Iran.

Milton R. Copulos
Policy Analyst

Alcohol Productivity of Field Crops *

Crop	Unit	Alcohol Yield (gallons)
Barley	bu.	2.05
Oats	bu.	1.05
Corn	bu.	2.70
Wheat	bu.	2.60
Potatoes	bu.	1.11
Sugar Beets	bu.	.72

*It should be noted that sources disagree frequently on the amount of alcohol per unit. For example, the yield of alcohol per bushel of corn ranges from 2.41 to 2.7. Although 2.7 may be on the high side, 2.7 for corn and 2.6 for wheat are used in this study since these figures frequently are cited in the literature and give a currently much discussed program, gasohol, the benefits of somewhat uncertain conversion ratios.

Sources: D. S. Clark, D. B. Fowler, R. B. Whyte and J. K. Wiens, Ethanol from Renewable Resources and Its Application in Automotive Fuels, p. 44 (potatoes, sugar beets).

USDA, Motor Fuels From Farm Products, p. 24 (barley and oats).

D. L. Miller, Fermentation Ethyl Alcohol, 1976 (wheat and corn).

GROSS ALCOHOL COST PER GALLON

50-million Gallon Capacity Plant
(amortized for 20 years at 10%)

	$2.00	$2.50	$3.00	$3.50	$4.00	$4.50
Fuel	.08	.08	.08	.08	.08	.08
Plant	.18	.18	.18	.18	.18	.18
Labor	.13	.13	.13	.13	.13	.13
Grain	.74	.93	1.11	1.30	1.48	1.66
Transporting	.05	.05	.05	.05	.05	.05
Marketing	.01	.01	.01	.01	.01	.01
Gross Cost	1.19	1.38	1.56	1.75	1.93	2.11

(1) These figures correspond to those used by Dr. James Kendrick of the University of Nebraska.

(2) The Table assumes that 60 percent of fuel requirements are provided by waste recovery.

(3) A byproduct credit of 40¢ to 60¢ per gallon must be applied to determine the net cost per gallon.

Energy Equivalents of Various Materials

Material	Btu per Gallon
Ethyl alcohol	84,861
Crude oil	132,029-153,290
Fuel oil	143,924-152,207
Gasoline	127,654
Methyl alcohol	63,542
Propane (liquid)	94,543

Source: Handbook of Chemistry and Physics, 42nd edition.

COMPARATIVE COSTS OF UNLEADED REGULAR GASOLINE REFINED FROM IMPORTED OIL WITHOUT BENEFIT OF THE ENTITLEMENTS SUBSIDY AND A 90% GASOLINE/10% ALCOHOL BLEND

OIL PRICE: $18.50 per BARREL

Price/ Bushel	Grain Cost/ Gallon	Gasoline Price/ Gallon	Cost 90/10 Alcohol/Gasoline Blend	Gasoline From Imported Oil Without Entitlements
2.60	1.00	64.4	68.0	71.6
3.00	1.15	64.4	69.5	71.6
3.50	1.35	64.4	71.5	71.6
4.00	1.54	64.4	73.4	71.6
4.50	1.73	64.4	75.3	71.6
5.00	1.92	64.4	77.2	71.6

OIL PRICE: $20.00 per BARREL

2.60	1.00	00.68	71.2	75.2
3.00	1.15	00.68	72.7	75.2
3.50	1.35	00.68	74.7	75.2
4.00	1.54	00.68	76.6	75.2
4.50	1.73	00.68	78.5	75.2
5.00	1.92	00.68	80.4	75.2

OIL PRICE: $22.00 per BARREL

2.60	1.00	72.8	75.5	79.9
3.00	1.15	72.8	77.0	79.9
3.50	1.35	72.8	79.0	79.9
4.00	1.54	72.8	80.9	79.9
4.50	1.73	72.8	82.8	79.9
5.00	1.92	72.8	84.7	79.9

OIL PRICE: $25.00 per BARREL

2.60	1.00	79.9	81.9	87.1
3.00	1.15	79.9	83.4	87.1
3.50	1.35	79.9	85.4	87.1
4.00	1.54	79.9	87.3	87.1
4.50	1.73	79.9	89.2	87.1
5.00	1.92	79.9	91.1	87.1