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Fuel and Chemical Feedstock in Developing Countries

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FUEL AND CHEMICAL FEEDSTOCK FROM SUGAR CANE IN CENTRAL AMERICA*

by

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The important and ever increasing price of oil is causing a heavy strain on the economy of the developing countries, including the five Central American republics. As a result, they are seeking alternative sources of energy.

Ever since this crisis started, ethyl alcohol has been mentioned as a possible fuel and as a feedstock for the chemical industry. The Central American countries, having sugar cane among their principal agricultural crops, and conscious that sugar cane constitutes one of the best raw materials for the fermentation of alcohol, started looking towards ethanol as a partial solution to their energy problem and increasing balance of payments deficit.

In this respect, the Central American Research Institute for Industry (ICAITI) has undertaken studies to establish the possibility and convenience of producing alcohol as a fuel and whether it is technically feasible to manufacture chemical derivatives from sugar cane, and if these were possible, then to determine if there is sufficient acreage available to grow enough sugar cane for this purpose in the Central American countries.

Alcohol as a Fuel

The technology for preparing and using alcohol and gasoline mixtures in automobiles is not new. It has been used for many years and in various countries at one time or another, however, its use in these cases was determined by special circumstances. In Brazil, for example, the use of alcohol/gasoline mixtures has been used as a regulating mechanism for the sugar industry.

Lately, with the appearance of the energy crisis, there has been renewed interest in alcohol as a fuel, and in several countries of the world, studies and investigations and trials are being undertaken with mixtures of alcohol and gasoline. Brazil and Germany, it is reported, are designing motors that will operate on 100 per cent alcohol.

For this study, no laboratory research nor road tests were conducted to evaluate the performance of the mixture; optimum percentage of alcohol in the gasoline; need for modification of the automobile engines, etc. The generally and almost unanimous results of research carried out in different countries working independently, as well as Brazil's years of experience, could be taken, it was felt, as definite proof of the feasibility of using mixtures of alcohol and gasoline in conventional automobiles.

Some of the conclusions of the above research are the following:

- Mixtures of anhydrous alcohol and gasoline in proportions up to 25-75 per cent are technically feasible to be used as fuel in conventional automobiles without the need for adjustments to the engines.

- Gasoline and alcohol are miscible in all proportions; therefore, there is not difficulty in preparing the mixture. Furthermore, no special handling requirements are needed. The mixture can be handled in the same way gasoline is handled today.

- Ethyl alcohol has a higher octane number than that of gasoline; 106 compared with 96 for a premium gasoline in the Central American countries, and what is more, blended with gasoline it improves the octane number of the mixture. This property permits mixing alcohol with a cheap low grade gasoline, for example, obtaining a mixture with an octane number similar to the commercial gasoline.

- The use of an alcohol/gasoline mixture does not cause corrosion to engines.

The main concern of the study was to determine if the Central American countries could sustain an ever increasing sucrochemical industry parallel to or in combination with the existing sugar industry without altering or interfering with the acreage dedicated to other important agricultural crops.

The five Central American countries: Guatemala, El Salvador, Honduros, Nicaragua, and Costa Rica, consume approximately 359 million gallons of gasoline annually, increasing at the rate of between 6 and 7 per cent per year in spite of increasing prices of gasoline.

Although it has been mentioned that it is possible to mix up to 25 per cent alcohol with gasoline without the need of modifications in automobile engines, an 85/15 per cent gasoline/alcohol mixture was considered here.

Table I gives the figures for each of the individual countries. This table also illustrates that with the 85/15 per cent gasoline/alcohol mixture the total needs of alcohol for the five republics amounts to about 54 million gallons per year.

Table I

CENTRAL AMERICA. Consumption of Gasoline and Requirements of Alcohol

(Mixture of 85/15)

Countries	Gasoline 000 gallons	Alcohol 000 gallons
Guatemala	102 700.0	15 500.0
El Salvador	56 800.0	8 600.0
Honduras	40 100.0	6 300.0
Nicaragua	83 100.0	12 500.0
Costa Rica	76 200.0	11 400.0
Central America	358 900.0	54 300.0

The most economical raw material for the fermentation of alcohol in the Central American countries is blackstrap molasses. The requirements of this raw material for the fermentation of 54 million gallons of alcohol would amount to some 120 million gallons of molasses.

The production of molasses in Central America, however, is only 75 million gallons, or 65 per cent of the requirements, and half of this amount is consumed in the different countries for animal feed and industrial uses, especially for the production of rum and bakers yeast; the rest is exported. The exported molasses may be available for the production of alcohol. It represents about 31 per cent of what is needed.

Considering the production of the required alcohol from sugar cane juice, the needs of sugar cane would be around 3 million metric tons, which would mean an increase in the production of sugar cane by 20 to 25 per cent.

The average yield of sugar cane in Central America varies from one country to another, between 70 and 84 metric tons per hectare. The production of 3 million tons would require 39 545 hectares. Table II shows the situation for each of the five countries:

Table II

CENTRAL AMERICA. Sugar Cane Acreage for Introduction of 15 Per Cent Alcohol into Gasoline in 1980

Countries	Alcohol Required 000 000 gallons	Projected Acreage Hectares	% Increase
Guatemala	15.5	12 370	19.0
El Salvador	8.6	6 080	18.5
Honduras	6.3	4 400	39.0
Nicaragua	12.5	8 800	35.0
Costa Rica	11.4	7 895	35.0
Central America	54.3	39 545	22.5

This additional acreage of sugar cane does not represent a severe problem for any of the Central American countries, with the possible exception of El Salvador, although it is the country with the lowest needed percentage increase. Besides, in all of the five republics there exists the possibility of improving the yield of sugar cane considerably.

Another possible source of a raw material for alcohol fermentation in Central America is the cassava. The cassava is a tropical perennial with tuberose roots. The tuber is the commercial part of the plant ant it contains some 30 per cent of starch and about 3 per cent of sugar. The cassava presents several advantages among which the following could be stated: the tubers can be dried and in this form stored for long periods of time; the dried tubers may be transported long distances; the cassava does not require a fertile soil and, therefore, it could be grown in marginal areas not being used today for sugar cane or other food crops.

Among its disadvantages, it lacks a fibrous residue that could be used as fuel as in the case of sugar cane bagasse, and the tubers have to be macerated and cooked, and the starch hydrolized before it is suitable for fermentation. The

Central American countries should not disregard the cassava as a raw material for the fermentation of alcohol, it could become a complementary raw material to the sugar cane, it being processed in the months that sugar cane is not harvested.

There are several types of combinations of plants for the production of alcohol that are possible and the investments, as well as the operation costs, vary with each combination; among others, there are the following:

- Centralized distilleries gathering molasses and cane syrup from existing sugar factories and using petroleum as fuel

- Distilleries integrated with existing sugar factories processing sugar cane juice, syrup and molasses, and using bagasse as fuel

- Autonomous distilleries having their own cane milling, juice clarification and concentration facilities, and using bagasse as fuel

The cost of production of alcohol was estimated for the autonomous plant:

The capacity of the plant	31 700 gallons/day
Total investment	US$ 13 000 000
Price of molasses	US$ 0.26/gallon
Return on investment	20 per cent

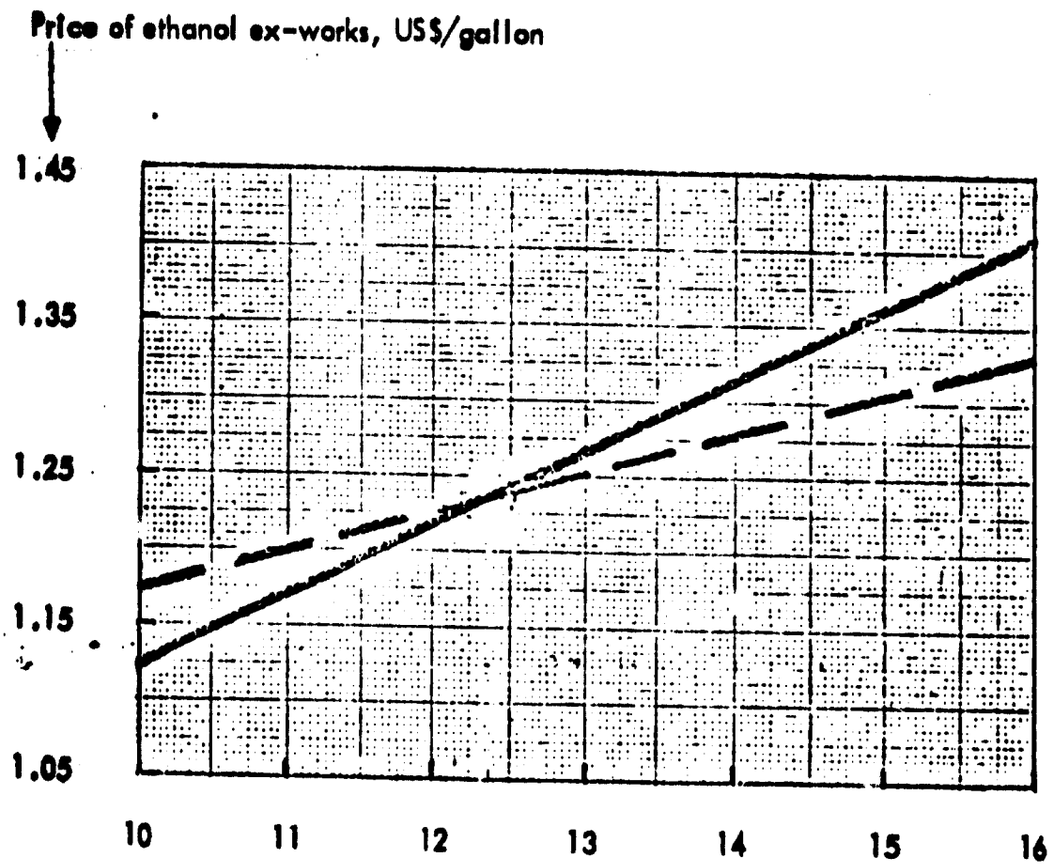
The following graph shows the selling price of ethanol for different prices of sugar cane. The dotted line refers to the situation in which the plant is using cane juice during the months of harvest and molasses in the off season. The continuous line represents using cane juice, as before, during the harvest months, and cane syrup, produced and stored during the season for use during the months cane is not in harvest.

Under these conditions, and for a price for cane of US$ 12.60/TM, the selling price of ethanol ex-works is US$ 1.25/gallon.

The selling price of US$ 1.25/gallon of ethanol compares with US$ 1.03/gallon for premium gasoline, as an average in the Central American countries.

Graph I

Price of Ethanol vs Price of Sugar Cane for Two Situations



Some authors claim technical advantages that alcohol contributes to the mixture that counteract the difference in price. One of these is that the ethanol is an octane improver. Therefore, it could be blended with a cheaper gasoline and still achieve the octane rating needed for conventional automobiles. One might be hearing more about this aspect in the course of this workshop.

Assuming that this is the case, then one can estimate the following value of a mixture of 85 per cent gasoline and 15 per cent alcohol in the Central American countries:

	Premium ¢/gallon	Regular ¢/gallon
Price of gasoline in refinery	63.57	57.33
Transportation and taxes	28.30	28.30
Retail station markup	11.13	11.07
Total	103.00	96.70

These are the selling prices for premium and regular gasoline in Guatemala, as of February 1st, 1979.

Using the regular gasoline for the blend, one can estimate the following approximate selling prices for the mixture:

	¢/gallon
Price regular gasoline at refinery (x 85%)	48.73
Alcohol (US$ 1.25 gallon x 0.15)	18.75
	67.48
Transportation and taxes	28.30
Retail station markup	11.13
Total	106.91

A difference of only US$ 0.04 between the estimated price of the blend and the price of premium gasoline, which might easily disappear with the next increase in the price of petroleum which is fixed for the following months.

So far, we have concentrated on alcohol as a fuel. Another possibility, and of much greater significance for the Central American countries refers to the use of alcohol as a chemical feedstock.

The study was undertaken in the year 1977, and at that time, of the several alternative types of combination of plants that were analized, it was estimated that the polyvinyl chloride monomer, in the most promising case, could be produced at a cost of US$ 720 per metric ton, compared with the price of the imported product into Nicaragua, which was, at the time, US$ 450/TM. With the subsequent increases of the price of petroleum, this difference is closing rapidly.

One of the most troublesome problems still to be adequately resolved before the sucrochemical industry could be established in the Central American countries, refers to the constant and significant fluctuation in the price of sugar on the international market and which has a direct effect on the price of sugar cane. In the first four years of the early seventies, for example, the price of sugar cane varied 257 per cent.

The following table shows the variation in price of sugar cane in one of the Central American countries, and its effect on the price of alcohol during the last seven years:

Year	Price of Sugar Cane US$/metric ton	Price of Alcohol US$/gallon
1972	7.70	1.02
1973	9.02	1.09
1974	12.38	1.27
1975	19.80	1.66
1976	13.20	1.31
1977	9.35	1.11
1978	9.90	1.13

These fluctuations can cause havoc to an industrial activity and to consumers and although the development of a parallel sucrochemical industry might tend to buffer these fluctuations to some extent in extreme cases, a high price for sugar, such as occurred in the year 1975, would probably reduce significantly the availability of sugar cane for the sucrochemical plants.

Some type of effective official mechanism would have to be devised to counteract these situations.

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