Some economic Implications of Power Alcohol

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INTRODUCTION

Liquid fuel has become firmly established as the most acceptable and, in many cases, the most economically viable source of energy for road vehicles. With its convenient properties and almost universal availability, alcohol has been considered as a possible motor fuel throughout virtually the entire history of the internal combustion engine.

Ethanol-petrol mixtures in various proportions have been used from time to time in many countries, for example, Brazil, Eire, France, Germany, S. Africa and the U.K. but, because of the then low petrol prices, they were not considered seriously. In the face of rapidly rising hydrocarbon fossil fuel prices, many countries are considering substituting a part of their petrol with alcohol manufactured from suitable agricultural crops. The advantages of a motor fuel derived from such regenerable sources are listed as follows:

a) considerable savings of hard currency on oil imports
b) some control over the availability of a part of the motor fuel requirement
c) stimulation of domestic agricultural industry

In addition, there is growing interest in the use of alcohol as a substitute for naptha in the manufacture of petro-chemical derivatives. Ethanol can readily be converted into ethylene, the primary building block for a wide range of common products like polyethylene and polyvinyl chloride.

The concept of power alcohol is therefore of greatest interest to those countries which do not have their own adequate oil reserves but which do have an abundance of sunshine and water to grow the necessary feedstock crops.

The revival of interest can be traced directly to events in Brazil following the announcement of the “PROALCOOL” energy programme of November 1975. Many other countries are now studying the possibility of following the lead set by Brazil, and some have already embarked on the first stages of a national power alcohol programme, e.g. USA, Philippines and Sudan. Each country has adopted a somewhat different attitude towards its own programme and this paper attempts to describe the relationship between various technical and economic aspects.
THE TECHNOLOGY OF POWER ALCOHOL MANUFACTURE

Raw Material Feedstocks

Alcohol is manufactured by fermentation of a carbohydrate (sugar or starch) crop followed by distillation to separate and purify the alcohol (it must be anhydrous if it is to be blended with petrol). Many factors influence the choice of raw material, but the most important relate to the resources which are available in any country.

If a crop is to be grown specifically for conversion to alcohol then its yield is important: the table below shows the approximate yield of alcohol per hectare per annum for six crops:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Crop Yield</th>
<th>Alcohol Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t/ha/year</td>
<td>1/t</td>
</tr>
<tr>
<td>Sugar Cane</td>
<td>40-120</td>
<td>70</td>
</tr>
<tr>
<td>Cassava</td>
<td>10-40</td>
<td>180</td>
</tr>
<tr>
<td>Sweet Potato</td>
<td>10-40</td>
<td>125</td>
</tr>
<tr>
<td>Sugar Beet</td>
<td>10-40</td>
<td>120</td>
</tr>
<tr>
<td>Sweet Sorghum</td>
<td>20-60</td>
<td>55</td>
</tr>
<tr>
<td>Maize (corn)</td>
<td>1-4</td>
<td>400</td>
</tr>
</tbody>
</table>

The growing of a specific crop for power alcohol demands not only that the necessary resources (land, people and finance) are available but also that they can be organized efficiently.

In addition to the agricultural costs, the processing costs can also be important. With starchy crops like cassava or corn, the starch must first be extracted and converted to sugars (saccharification) ready for the fermentation. In the case of cassava, the roots must be processed within a day or so of gathering in order to prevent decay, although partial processing e.g. to-dried chips, is a possible alternative and is essential if year-round operation is desired.

Processing costs are minimized if liquid sugar materials are already available, either in the form of molasses, or as a sugar syrup from a sugar factory.

In the context of a world energy crisis, the energy balance is also important and power alcohol production should show a net energy gain. One of the most important factors in this balance is the amount of energy required to operate the alcohol production unit, and it is here that sugar cane shows a significant advantage. Sugar cane provides both the fermentable sugars and the bagasse fuel simultaneously. In fact, sugar cane provides more bagasse fuel than is actually required to process the cane juice, so that bagasse can be accumulated during crop to power the plant.
during the out-of-crop season on some alternative feedstock, e.g. stored thick syrup; molasses from neighboring factories, cassava or cassava starch. Syrup and molasses offer the advantage that they can be fermented directly but a saccharification facility greatly increases the flexibility of the plant to accept almost any fermentable feedstock. In this way, the installed plant capacity can be utilized throughout the whole year, instead of being limited to the availability of a particular crop.

Some crops have a negative overall energy gain but this does not rule them out of court; they may be in temporary surplus, or surplus to a stabilized market (e.g. corn in the USA), or they may offer the opportunity to turn an inconvenient solid fuel (wood or coal) into a convenient liquid fuel and this could be worth some energy loss.

The following examples may illustrate the range of possibilities:

**Brazil**

In setting its target volume of alcohol production, Brazil has predetermined the total quantity of fermentable feedstock required and the most readily available material initially was molasses, one of the by-products of the sugar industry. However, Brazil does not have enough molasses to make its target volume of alcohol, so it has turned to sugar cane juice, processed either in specially built so-called autonomous distilleries or in distilleries appended to sugar factories, and to the starchy root crop cassava. Mention should also be made of the potential for using Babacu nuts which is under active investigation and trial.

**Thailand**

Thailand has a strong agricultural economy and a wide variety of fermentable crops (cane sugar, tapioca, maize and rice). Under the conditions of a bumper crop and low world prices, surpluses would be channelled into power alcohol, thereby stabilizing the domestic agricultural market and facilitating long term plans. Technical problems will be serious and investment costs high, but the prize would be partial substitution of oil imports.

**Sudan**

With a fast growing sugar industry and a transportation infrastructure incapable of handling its by-product molasses, Sudan is facing the prospect of having to dump its molasses in the desert. Instead, it is now considering a power alcohol programme based on the utilization of what would otherwise be a waste product.

Many other developing countries have stated their interest in power alcohol based on agricultural product. Colombia, Cuba and the Philippines are examining the use of cane juice, Papua New Guinea, cassava, and Ivory Coast, molasses.
In the developed countries, the USA is likely to proceed with a corn-based alcohol programme, possibly looking to sugar cane in Louisiana and Puerto Rico, while in Europe the choice of a suitable fermentable crop is not so obvious.

**Processing**

Sugar cane must be shredded and milled to separate juice from bagasse. This is the conventional first stage of sugar manufacture and the technology is very well established. Molasses requires only dilution and clarification, and is therefore the simplest feedstock available.

Starch crops like cassava or corn must be milled, pulverized or shredded prior to the saccharification stage, and while this process is well established with corn (being the first stage of corn syrup manufacture), Brazil has had to develop processes suitable for cassava.

The conversion of sugars to alcohol is carried out by yeast fermentation under carefully controlled, but well understood conditions. The same process is used conventionally to produce potable spirit. Most fermentation processes installed today are batch systems, but it is worth adding that increasing attention is being given to the possible adaptation of continuous processes, with the objective of reducing capital cost.

After fermentation the alcohol is separated by distillation, and three stages are recognized: stripping, rectification and dehydration. The latter requires the addition (and, of course, recovery) of a third component, usually benzene or cyclohexane, to remove the last traces of water from the alcohol.

**Effluents**

The residue from distillation, called “vinasse” or “slops”, present a major pollution problem and several countries e.g. Australia and Thailand, have stated that they will not proceed with a power alcohol programme until they have been assured that adequate effluent treatment systems are available. The “slops” contain valuable minerals, notably potash with some phosphate, which should be returned to the field. The best solution, in many cases, involves primary treatment only, with the effluent water pumped back to an irrigation system. However, such a method can only be used where the distillery is located in an estate, the lands of which fall under the same authority as the distillery itself. Where irrigation is not possible, activated sludge treatment is generally found to be too expensive and evaporation methods are chosen either to produce an animal feed product or for incineration. Anaerobic digestion processes, which would yield methane fuel, are under active development in several countries.
THE DEVELOPMENT OF NATIONAL POWER ALCOHOL PROGRAMMES

Although many countries are now considering power alcohol as a substitute for oil, it is extremely hazardous to generalize about the economics of production. Each country has a variety of resources available at different costs and different market prices and evaluation of these is fundamental to the analysis of a national programme.

The prime resources to be evaluated include land, labor and capital and particular attention must be given to the identification of surplus agricultural produce, and to under-utilized manufacturing capacity. Specific factors include:

- Estate and infrastructure development costs.
- Agricultural, harvesting and transportation costs.
- Purchase price of bought-in fermentables.
- Storage Costs.
- Factory/Distillery capital and operating costs.
- Alcohol storage, distribution and blending costs.
- Petrol price, duties and taxes.

In virtually no country has power alcohol stood cleanly on its economic feet when judged at market prices: alcohol appears to be an expensive fuel with a total cost typically approaching US$2/gallon. However, current market prices are not necessarily relevant to the particular analysis: the use of surplus crops or by-products which would otherwise be wasted has already been referred to, and represents a means by which the feedstock costs can be reduced. Alternatively, the conversion of existing distilleries or existing sugar factories can save a large amount of capital expenditure, and low interest Government finance can also help to reduce the capital cost element.

Nevertheless, in most countries of the world, power alcohol today would cost more than petrol, and without Government stimulation and support it is doubtful whether a power alcohol industry could be considered viable. In the USA Gasohol Programme, for example, the combination of State tax and Federal excise tax rebates can amount to as much as US$1.20 per gallon of alcohol, compared with the current pump price of petrol around US$1.10 per gallon.

Apart from the domestic economic analysis, the national economic objectives must be identified. Power alcohol programmes can residue imports of oil and benefit the balance of payments as well as providing opportunities for economic development in both the agricultural and industrial sectors. Power alcohol can also contribute to strategic objectives, by reducing dependency on imported oil and by developing or stabilizing specific sectors of the economy.

For these reasons, it is perhaps, not surprising that different countries have
adopted different attitudes to power alcohol. With the proviso that the distinctions will probably tend to blur as the programme is implemented, the following three basic concepts have emerged.

The Target Volume

Brazil has set a series of targets for the volume of alcohol to be produced by successive dates. The capacity of authorized distilleries already exceeds 4½ billion liters p.a. and the alcohol content of petrol reached 12% in 1978. The target is now to produce up to 10.7 billion liters p.a. by 1985, by which time alcohol will provide nearly 5% of Brazil's total energy requirements.

This concept is likely to predominate in smaller countries where the target volume of alcohol production can be related with a specific agricultural development programme. In Zambia, for example, 5000 hectares of additional sugar cane would yield sufficient alcohol for a national 15% blend.

The Economic Regulator

This is the concept in Thailand where surplus crops would be converted to power alcohol to stabilize domestic prices for agricultural product and oil imports would be reduced accordingly. With its focus on corn, the USA might appear to be following this concept, which is clearly attractive to all countries with a dominant agricultural economy.

Waste Product Utilization

Sudan has already been mentioned as the example where surplus molasses is available too far from export markets to have a positive value. A power alcohol programme could convert this into a valuable substitute for oil imports. The possible utilization of waste agricultural products in this way is obviously attractive in many other countries.

INTERNATIONAL IMPLICATIONS

The choice of molasses and sugar cane as raw materials has had important implications for the world trading markets for molasses and raw sugar and for the economics of sugar production. Two particular aspects are referred to here.

Market Flexibility

The diversion of molasses to alcohol production in Brazil has strongly influenced the world price of molasses which is currently at an all-time high level. At the same time, there is a price at which it is more profitable, even for Brazil, to sell molasses on the export market and buy oil. This is a new situation which
will surely be exploited by all countries with a molasses export potential, especially those with the capacity to grow additional sugar cane.

The question of sugar exports is even more interesting. Under the terms of the International Sugar Agreement, exports of sugar are currently restricted to agreed quotas. However, should the world price of raw sugar rise above certain levels, these quotas are progressively increased and finally abandoned: historically, it has not been possible to raise production quickly enough to prevent dramatic surges in the world sugar price which in turn are followed by over production and low prices again.

Brazil, the world’s largest producer of cane sugar, now has the advantage of being able to increase rapidly its sugar exports when these are profitable: a 20% increase in sugar exports would require only 10% of the sugar cane needed for the PROALCOOL plan, and much of the necessary production capacity is already available. Should Brazil choose to exercise this option to switch cane production from alcohol to sugar exports, then the whole nature of the world sugar economy will be changed: the effects will depend on the magnitude of the switch but could include the stabilization of world sugar prices at higher levels than those to which we are accustomed. The implications for all sugar exporting countries are very significant.

Operating Flexibility

The addition of a power alcohol distillery to a sugar factory gives the producer some choice over the mix of his products. Normally, the molasses/sugar ratio is largely dependent on the cane quality and factory efficiency, the objective being the extraction of the maximum amount of sugar from the cane. But with a distillery attached, the ratio of molasses/sugar output can be varied to take account of market opportunities, and it is noteworthy that in Brazil, the sugar content of molasses going to the annexed distillery has increased significantly in recent years.

Since complete extraction of all available sugar from molasses is expensive, this increased operating flexibility can also lead to a reduction in cost and improvement in quality of the sugar produced. If the sugar quality reaches the level of the so-called very high polarization raws (\( > 99.5^{o} \text{Pol} \)), then the costs of subsequent refining can be substantially reduced and the raw sugar can attract a premium price.

CONCLUSIONS

The implications and consequences of national power alcohol programmes are of very considerable international importance. Brazil led the way in developing the first practical alternative to petrol, and other countries are now introducing to the world the means by which certain agricultural commodity markets can be stabilized, to the benefit of a great many people in both producing and consuming countries.
REPORT OF THE STANDING COMMITTEE ON GERMLASM AND BREEDING

By Don J. Heinz, Chairman

Major activities of the Standing Committee on Germplasm and Breeding since the Sixteenth Congress of the ISSCT in Brazil in 1977 have been the quarantine and distribution of the 1976 Indonesia and 1977 Papua, New Guinea germplasm collection by the U.S. Department of Agriculture (USDA) at Beltsville, Maryland, publication of the ISSCT Sugarcane Breeders Newsletter, and coordination of the two World Collections of Sugarcane Germplasm maintained by the USDA and the Coimbatore Sugarcane Breeding Institute.

GERMLASM COLLECTION

Sugarcane clones collected in Indonesia in 1976 were quarantined in Brisbane, Australia for one year prior to shipment to the USDA Beltsville, Maryland quarantine station. The Beltsville station was the primary quarantine for all those clones collected in Papua, New Guinea. The New Guinea (NG) clones arrived in Beltsville between late April and early June of 1977 and the Indonesian clones arrived between August and November 1977. Some replacements were sent later for those clones which did not survive the initial shipments. In all, cuttings of 241 NG clones and 472 Indonesian clones were received, of which 141 and 398 clones, respectively, were established at Beltsville.

As of June 1979, 110 NG clones and 150 Indonesian clones had been sent to Ft. Pierce, Florida for a one-year quarantine prior to placement in the World Collection at Miami, Florida. A total of 89 NG clones have been forwarded to India for eventual inclusion in the collection at Cannanore. In addition, 17 NG and 56 Indonesian clones were sent to Barbados and 111 were shipped to Hawaii during 1979.

FINANCES FOR INDONESIAN AND PAPUA, NEW GUINEA EXPEDITIONS AS OF NOVEMBER 1979

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total funds available</td>
<td>US $42,112.00</td>
</tr>
<tr>
<td>Expended on the Indonesian Expedition:</td>
<td>($25,970.00) *</td>
</tr>
<tr>
<td>Expended on the Papua, New Guinea Expedition:</td>
<td>($10,556.00)</td>
</tr>
<tr>
<td>Expended for processing and shipment to world collection:</td>
<td>($755.00)</td>
</tr>
<tr>
<td>Total Funds Expended</td>
<td>($37,281.00)</td>
</tr>
<tr>
<td>Funds returned to ISSCT General Fund:</td>
<td>$ 4,831.00</td>
</tr>
</tbody>
</table>

*Estimated figure reported at 1977
ISSCT Congress—$26,582.00

LIV
COMMITTEE REPORTS AND SECTION MEETINGS

WORLD GERmplASM COLLECTIONS

Collection at Miami, Florida

Dr. J. D. Miller, Location Leader, Sugarcane Field Station, Canal Point Florida, reports the USDA has transferred the World Collection of sugarcane and related grasses from Beltsville, Maryland and Canal Point, Florida to 10 acres on the USDA Subtropical Horticulture Research Unit at Miami, Florida. Presently (as of July 1979), the collection consisted of the following clones:

- 551 *Saccharum officinarum*
- 261 *Saccharum spontaneum*
- 64 *Saccharum robustum*
- 90 *Saccharum sinense*
- 18 *Saccharum edule*
- 130 clones of related grasses
- 156 foreign and historical manmade hybrids
- 19 clones, unclassified.

The collection is being supervised from and is under the direct control of the Canal Point Station to insure that it receives proper attention.

The number of shipments made from the World Collection and the Canal Point breeding collection were:

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Shipments</th>
<th>Number of Clones</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>36</td>
<td>304</td>
</tr>
<tr>
<td>1977</td>
<td>19</td>
<td>227</td>
</tr>
<tr>
<td>1978</td>
<td>27</td>
<td>419</td>
</tr>
</tbody>
</table>

Rust was discovered in the collection at Miami on May 4, 1979, smut is also present in Florida, but has not been found in the collection. As a precautionary measure all cuttings shipped from Canal Point or Miami are given a hot-water treatment of 52°C for 45 minutes and treated with a fungicide. This should provide protection from both rust and smut disease.

All requests for clones from the Miami World Collection should be addressed to:

Sugarcane Field Station
Star Route Box 8
Canal Point, Florida 33438

Collection at Cannanore, India
Dr. K. Mohan Naidu, Director, Sugarcane Breeding Institute, Coimbatore, reports the following clones in the World Collection at Cannanore (as of January 1, 1979):

<table>
<thead>
<tr>
<th>Number of Clones</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>628</td>
<td><em>Saccharum officinarum</em></td>
</tr>
<tr>
<td>26</td>
<td><em>S. barbieri</em></td>
</tr>
<tr>
<td>22</td>
<td><em>S. sinense</em></td>
</tr>
<tr>
<td>37</td>
<td><em>S. robustum</em></td>
</tr>
<tr>
<td>450</td>
<td><em>S. spontaneum</em></td>
</tr>
<tr>
<td></td>
<td>(Part maintained at Coimbatore)</td>
</tr>
<tr>
<td>23</td>
<td>Ripidium and allied genera</td>
</tr>
<tr>
<td>1008</td>
<td>Indian hybrids (Co, CoS, etc.)</td>
</tr>
<tr>
<td>591</td>
<td>Foreign hybrids</td>
</tr>
<tr>
<td>143</td>
<td>Indo-American (IA) hybrids</td>
</tr>
</tbody>
</table>

Cuttings of 191 clones were sent to eight foreign countries during the year — USA, Egypt, Barbados, Burma, Spain, FAO Rome, Madagascar, and Kenya, and to six stations within India.

All requests for clones from the Cannanore World Collection should be addressed to:

Dr. K. Mohan Naidu, Director
Sugarcane Breeding Institute
Coimbatore—641007
(Tamil Nadu)

ISSCT SUGARCANE BREEDERS' NEWSLETTER

Mr. J.A. Lalouette, former Head of the Biometry and Plant Breeding Division of the Sugar Industry Research Institute, Reduit, Mauritius, has been Editor of the Newsletter for the past three years ending in the Spring of 1980. Mr. Lalouette deserves the recognition and appreciation of his colleagues and the Society of his dedicated work in publishing outstanding issues of the Newsletter.

The Sugar Industry Research Institute has published and distributed the Newsletter without cost to the Society and deserves our thanks and appreciation.

Dr. R. Breaux, Research Agronomist, USDA, Sugarcane Field Station, Houma, Louisiana, has agreed to be Editor for the next three-year term, during which time the publication will be sponsored by the USDA Sugarcane Field Station, Houma.