A REVIEW OF FUEL ALCOHOL PRODUCTION AND DUNDER DISPOSAL.

By G. C. DYMOND.

Gold and petrol are exhaustible products of the earth's crust. Alcohol, while the sun shines and plants grow, is inexhaustible. So is charcoal, and it is interesting to note that in Sweden, for the year ending 30th September, 1941, 69,000 vehicles operated on producer gas, covering in eight months 312,500,000 miles.

The cost of landed petrol is about 4d. per gallon—while it lasts; the cost of alcohol from molasses is 7d. or less, and that from sugarcane and molasses about 1/- upwards, according to quantity and the price paid for cane.

To-day geographical considerations—the possession or access to oil wells with the security of a navy—determine the economics of a fuel programme. In South Africa no national policy has been formulated. Producer gas is on trial; the cost of pit-head coal is 5/- per ton, from which the Fischer-Tropsch process could produce 40 gallons of petrol per ton of coal; and alcohol, it is said, is not an economic proposition. "Economics" is the most mysterious word of our age. Great Britain would purchase large quantities of alcohol from us at 2/10 per gallon, but our own Government will not consider further production, unless it can be manufactured on a white-labour policy at 6d. per gallon. Mr. Jas. Gray in his recent presidential address to the South African Association for the Advancement of Science, pointed out some of the strange manifestations of economics. He said: "Within recent months the Maize Board purchased South African maize at 22/9 per 480 lbs. and sold the surplus, amounting to approximately five and a half million bags, in London, where the ruling price was round about 12/-." This procedure is technically termed stabilizing, and numerous other instances could be quoted. The case of alcohol works in the reverse way. Although it is unlikely that the alcohol policy will change, a preview of alcohol potentialities is at least of general interest.

The whole subject can primarily be divided into:—
1. Economic considerations.
2. Systems and raw materials.

ECONOMIC CONSIDERATIONS.

While petrol is available and cheap, there appears little likelihood of any serious development of alcohol production. The reason is primarily very simple.

The government collects about £5,870,000 in petrol taxes, so that the substitution of, say, 20 per cent. of the petrol consumption by a tax-free fuel, would mean a loss in revenue of £1,173,000.

This substitution in terms of quantities would mean the production of 35,000,000 gallons of alcohol, which in turn would mean the following requirements in raw materials:—

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Quantities required</th>
<th>Gallons of alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molasses</td>
<td>20,000,000 gals.</td>
<td>7,600,000</td>
</tr>
<tr>
<td>Cane tops</td>
<td>881,000 tons</td>
<td>5,000,000</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>1,584,000 tons</td>
<td>22,310,000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>35,000,000</td>
</tr>
</tbody>
</table>

At 25 tons of cane per acre, the extra cane required would represent an acreage of 65,760, or 137 farms of 500 acres each. Added to this, there would be additional employment and the general benefits of a combined sugar and alcohol production, when sugar is restricted by a quota. The price to be paid for cane would determine the possible payment of a tax, but assuming a tax-free basis, the loss of £1,173,000 would necessitate additional taxation in other directions. The unpopularity of such a move is obvious. So while petrol lasts, or until such time as it can be demonstrated that the benefits to sugar, i.e., price reduction, would balance the loss in revenue, the possibilities of fuel alcohol developments from sugarcane surpluses would appear to be remote in South Africa.

SYSTEMS AND RAW MATERIALS.

Dealing with the sugar crop only, there are only two major raw materials—molasses and the cane itself.

Molasses may be either the normally exhausted type or "high-test" as produced in Cuba.

Surplus sugarcane can be utilised in a number of ways, for example—
1. Crushing the cane entirely for alcohol production, as at Ponta Nova, Brazil.
2. Using the last mill juice for molasses dilution, as at Santa Theresina, Pernambuco; additional imbition or maceration water can then be used with higher extractions.
3. Eliminating the filter press department by fermenting the subider bottoms, as at Usina, St. Cruz, Campos, Brazil.
4. Enriching molasses and thereby simplifying the sugar manufacturing process. This is general practice.

Utilising molasses only for alcohol infers centralisation and consequent limitation of any large fuel programme; whereas, using molasses with some of the initial products of the cane, means production at the sugar mills with attendant benefits and lowering of costs (except that of the raw material) and a production only limited by the capacity of the crushing plants.

Associated with this system would be the utilisation of cane tops. Mechanical harvesting without topping is comparatively simple, as demonstrated with windrow machines in Louisiana. The tops would then either have to be cut off for separate crushing, or be turned into cattle food. In Hawaii no increased difficulties were recorded in clarification with this procedure. This method would, however, be best suited when the ratio of quota sugar and alcohol production is high. Here it is of interest to record the claims made for Jeanite. By a special process of fermentation acetone and butyl alcohol are obtained from molasses. The butyl alcohol is then polymerised into a mixture of substances identical with petrol. The cost is said to be 20 cents per gallon.

METHODS OF USAGE.

There are two systems of utilising alcohol as a fuel. The most general one in vogue is to make absolute alcohol (99.7 per cent.) and mix it with petrol in proportions up to 25 per cent. (or 50 per cent. in the case of our local Union Spirit). The usual systems are the de Melle, Hag, Drawinal using ethylene-tri-chloride, and the Marillier process using glycerin. The latter process is used extensively in the island of Reunion and is the basis of the most recent British patent in the production of absolute alcohol.

The second method of alcohol usage as a fuel is the system in vogue in Mauritius and the Philippines. This I propose dealing with a little more fully, as there appears to be little in the literature on the subject.

All fuel alcohol, or distilled carburant, in Mauritius is a rectified spirit of from 92° to 94° Gay-Lussac. This spirit is mixed with 5 per cent. of petrol, 0.5 per cent. pyridine for denaturing purposes, and 0.5 per cent. of castor oil.

The consumption of petrol in Mauritius in 1940 was 3,132,220 gallons, and that of carburant in 1939, 141,510 gallons. Comparative costs in drums are: petrol 2/0.4 per gallon and carburant 1/7.0 per gallon. Carburant bears a duty of 6d. per gallon.

The development of this fuel is largely due to the peculiarities of Mauritian sugar estates, which are largely self-contained.
Thus many estates produce their own fuel requirements for cane haulage, which include Plymouth type locomotives, a few tractors, numerous lorries, buses and a few cars.

Experiments carried out at Sans Souci in 1933 gave the following comparative costs in fuel per ton-mile:—

<table>
<thead>
<tr>
<th>Type of Locomotive</th>
<th>Square Inch.</th>
<th>Fuel Used.</th>
<th>Cost in Rs. 1 per Ton Mile *</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-ton Plymouth petrol engine</td>
<td>60</td>
<td>Petrol</td>
<td>2.08d.</td>
</tr>
<tr>
<td>7-ton Plymouth petrol engine</td>
<td>90</td>
<td>Alcohol</td>
<td>2.06d.</td>
</tr>
</tbody>
</table>

The following conditions were necessary for the successful use of carburant:

1. The alcohol must be neutral in reaction and have a strength of at least 92° Gay-Lussac. All cases of corrosion were traced to these conditions not being observed.

2. Pyridine is costly and unnecessary, as petrol or paraffin can be substituted.

3. Only engines designed for such a fuel should be purchased. The results from converted petrol engines, though frequently good, often resulted in trouble, through some minor cause. Such engines should embody the following principles:
   
   (a) Starting and finishing on petrol, thereby avoiding any chances of corrosion.
   
   (b) Gravity feed.
   
   (c) Distributor control of ignition.
   
   (d) Direct metal (supply tank and carburettor) to be of anti-corrosive material.
   
   (e) Pre-heating device for low temperatures.
   
   (f) Correct compression ratio.

My own opinions on the relative merits of absolute alcohol used with 75 per cent. to 80 per cent. of petrol, as compared with undehydrated alcohol, are that:

1. The use of absolute alcohol needs no engine adjustments and in fact improves the performance. On the other hand, it requires legislation and the blessing of a government policy.

2. The second method neatly slips past the petrol combines and provides the government does not burden the product with excessive excise duties, it has been proved a successful substitute. Given a fair start at a low price and the right engines, there appears to be a good case for this fuel, when local demand warrants its production.

**DUNDER DISPOSAL.**

Associated with all alcohol production from sugarcane products is the disposal of the dunder or distillery slop. The difficulties associated with this disposal can be shown by the enormous number of methods, which have either been proposed, or are actually in use.

The first and simplest are, of course, natural methods of disposal, such as pumping into the sea and rivers, or into the bottomless hole which occurs at Reunion in Mauritius. Allied with these methods are those of pumping on to waste lands or large evaporating dams.

A method largely used in Mauritius is to lime the dunder and dispose of it continuously in the irrigation water. At Medine, Mauritius, the dunder is heavily limed in open concrete reservoirs. After settling the supernatant liquid is run into the irrigation ditches and the bottoms used for the type of compost known as scharagone. In industrial density populated areas natural methods of disposal are naturally prohibited.

In Brazil, since 1884, various commissions have attempted to solve the problem. The result was a flood of numerous and in many cases utterly impractical patents. The two most practical methods which I saw in operation, were those used at Santa Theresina and Usina Catende, both in Pernambuco.

At the former the Porion furnace, which burns the dunder to ash, was in successful operation. By this method all the organic matter is destroyed.

At Catende, the dunder was first evaporated to 60° brix, mixed with sun-dried screened bagasse, superphosphates added, and the whole dried in an ordinary sugar drier. This product contained 9 per cent. of water and was used as a fertilizer with excellent results.

The methods of evaporation are, however, fraught with difficulties. Mr. Alfred L. Webre, the well-known evaporator expert, says that the principal troubles must be due to the tubes and the formation of hydrogen sulphide and carbon dioxide in the vapours, the former attacking the copper parts and the latter forming a gas film, which affects the heat transmission.

At the U.S. Industrial Alcohol Company these problems have been largely overcome by using 20-gauge stainless steel tubes and pretreating the dunder. This is done by spraying the initial liquid, which has a temperature of about 205°F., into an atmosphere of steam at 100 lbs. pressure. This causes the heat reaction to take place outside, thereby forcing the liberation of both the carbon dioxide and the hydrogen sulphide before entering the evaporator, and causing a large percentage of the calcium sulphate to be precipitated. This principle of pretreatment can also be applied to distillery plants with beneficial results, in reduction of scale.

Lastly, the untreated method on a large scale of composting cane trash with the dunder.

In Hawaii, owing to their methods of grab-harvesting, it became imperative to perfect cane-cleaning devices at the mills. This has been accomplished, resulting in huge piles of accumulated trash, which would readily absorb large quantities of dunder.

**CONCLUSION.**

This review of a big subject is necessarily brief. The by-products of sugar have and are engaging the attention of many sugar countries. Sugar men are usually only sugar-minded, but should some day the principle of sugar-alcohol manufacture be accepted, it will, I believe, be the stepping-stone to other by-products of this important crop, the sugarcane.

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**References.**


Mr. DYMOND said that since writing this paper he had received the plans of the most recent British patented method of dunder disposal. Briefly, it consisted of a special type of evaporator for evaporating the dunder to a syrupy consistency. This was then dried on special roller dryers, using steam or flue gases. The final product was crushed and bagged.

In reply to a question by Dr. Rossouw, Mr. Dymond said that in the same way that Napoleon started the comparatively uneconomic beet industry through his continental system, so there were many other crops besides sugarcane which could and had been used for alcohol. There were, for example, sweet and round potatoes, cassava, Jerusalem artichokes, maize, wheat, etc., every case, however, there must be a surplus, that alcohol constituted the social economic method of disposal. In no case, however, could any of them compete economically with sugarcane under a sugar-alcohol system of manufacture.

There were forty countries which produced alcohol, either on a "free" basis or by state monopoly. In Natal, alcohol had raiilage protection, a 6d. protective duty as against petrol, and 3d. per gallon rebate when mixed with petrol for fuel purposes.

In reply to Dr. Fisher, Mr. Dymond stated that very little factory molasses was used for stock feeding. This was principally due to distribution and transport difficulties. Owing to its high sulphur content, this molasses should be fed in small quantities until stock became used to it. The refinery had tried to develop this business, but Mr. Dymond said he was unaware with what success.

In reply to other questions, Mr. Dymond stated that Mauritius had now standardized their alcohol fuel on a basis of 80 per cent. rectified spirits and 10 per cent. of petrol as denaturant. The alcohol had to be 94° G.L. at 15°C. with not more than 15 milligrams of acid calculated as acetic acid.

The British Improved Motor Spirit, Ltd., had recently patented a fuel which should be of interest in this country. It composed of 70 per cent. methanol spirit, 10 per cent. benzol, and the balance a petrol extract obtained by a narrow cut fraction from petroleum spirit.

Mr. PLATT said that only part of the refinery molasses was sold as stock feed. The rest went to the distillery.