

# A GENERAL SURVEY OF FUEL ALCOHOL PRODUCTION, WITH SPECIAL REFERENCE TO BRAZIL

by G. C. DYMOND.

Before the Pyramids this fascinating carbon compound was an article of commerce, and is probably the world's oldest and most widely known chemical.

The forms in which Alcohol beverages have existed, and still exist, in every country of the world are multitudinous and range from the paint and metal removers, such as Hooch and Skokiaan, to the Arrack of India made from the juice of a palm, and the Ubusula of Maputaland, where a recent expedition was sent to expel the elephants which were raiding the wild fruit of the busala tree, from which the drink is made.

In Tartary fermented Mare's Milk is called Araka; Sake, the well-known Japanese drink, is made from rice, and so on for almost any natural liquid containing sugars to the highly prized products of the grape, the scintillating wines of France and Italy.

Here we must leave the romantic maze of potable liquors, the part they have played in the creative arts, the theme of poets, the spirituous Gold of rich and poor, and descend to the prosaic economic lanes of pure Industrial Alcohol.

## History.

The name "Alcohol" is derived from two Arabic words "Al" and "Koh'l," which denoted the powder used by Oriental women to darken their eyebrows. The methods used in the preparation of these powders and the distillation of fermented liquids suggested the name Alcohol.

About 1500 A.D., this name was applied to any volatile liquid, but gradually the name was used only for "spirits of wine rectified to the highest degree."

The 16th century saw the development of the first fractionating column, while in 1832 the first continuous Still was patented. Towards the latter part of the 19th century, Industrial developments necessitated the passing of the first law making denatured Alcohol tax-free in England.

In 1897 the American Government were advised that "the use of Alcohol for industry is legitimate and necessary, as there is scarcely a manufacturer who does not use Alcohol in the production of his goods." In 1906 legislation was passed eliminating the revenue tax on Ethyl Alcohol, provided it was denatured according to Government regulations.

The Great War gave a further impetus to the widening uses of Industrial Alcohol so that, while the production in America alone amounted to a scant one million gallons in 1906, it rose to 10 million gallons in 1914, to 50 million gallons in 1918, while today the output is roughly 100 million gallons in America alone, and in the whole world 1,100,000,000 gallons.

So widespread is the use of ethyl Alcohol in Industry, the Arts and Sciences, that, excluding water, it is regarded as the most important accessory chemical in use today. A table showing the important uses of Industrial Alcohol, prepared by the U.S. Industrial Alcohol Company, is appended.

This Company ranks as the world's largest producer of Industrial Alcohol. In their four plants situated on the seaboard at Baltimore, Newark, New Orleans and Anaheim, they produce 80,000 gallons per day, and employ 40 chemists and 800 other employees.

## Fuel Alcohol.

Here again it is necessary to leave Industrial Alcohol and its multiple products, and concentrate on the main object of this paper—Fuel Alcohol, and its economic position in the world of today and tomorrow.

The ever mounting fuel bills for gasolene has for many years assumed astronomical proportions. In America alone 25 billion gallons were consumed last year, while we in the Union used a paltry 186 million. No one can predict with accuracy when the world's resources of this active power will begin to fail, with corresponding restrictions on its use, with mounting prices.

One point is significant—the increasing interest of Governments and the Oil people themselves in Fuel Alcohol; firstly, on account of its now accepted value in raising the octane ratio, and secondly, on the long view that its use will lengthen the life of the gasolene business itself.

The scientific literature is replete with reports of the characteristics of blended fuels, together with preliminary estimates of the influence of Farm Chimurgy upon employment, improvement in farm practices, freedom from the vagaries of international trade, and the provision for the future petroleum deficiency. In this connection the increasing activities of the Farm Chimurgic Council at Aitchison, Kansas, is of particular interest.

Argol fluid is a denatured anhydrous ethyl Alcohol made from American farm surpluses, such as corn, rye, wheat artichokes, etc. These blends of Alcohol and Gasolene, have now passed the 60,000 gallon a day mark in 2,000 Service Stations in nine American States, and sales are progressively mounting. The cost of 70-72 octane gasolene to the consumer at the Service Station is \$0.18 per gallon, or approximately 11d. per imperial gallon, while the cost of Ethyl Gasolene is 2 cents higher, or slightly over 1d. per gallon dearer.

The substitutes for petrol in the principal European countries in 1937, namely synthetic petrol, benzene, alcohol and shale oil, amounted to 18% of the total petrol consumption, or 46 thousand million gallons, of which 116 million gallons were alcohol.

For 1938 it is calculated that 25% of substituted products have been consumed.

In 1937 the extra cost to the consumer through using these substitutes amounted to £47,000,000 or 1/4d. per gallon.

The peak of Alcohol fuel production took place between 1930 and 1936. Since then, there has been a sharp drop, due it is said to its diversion to other uses, principally armament manufacture.

Lack of space forbids further analyses of Alcohol-petrol blends in England and other countries. We may, however, well ponder on the future, when we consider these interesting developments of Alcohol production in the heart of the oil business of America, and the fact that Ethyl blends are being sold at higher prices than straight gasolene on their value, and that a variety of farm surpluses are being used for this purpose.

#### Alcohol from Farm Products.

It is stated that there are 6,800,000 farms in the United States, and the recent development of Fuel Alcohol production has been advocated mainly as a surplus relief for farm products rather than as a conservation measure for the petroleum supply. This complicates the problem, for should high prices be paid for farm surpluses—situated mostly at uneconomic distances from the site of manufacture—the cost of Alcohol becomes impractical. The technical operations have long been established, but the economics of satisfactory price adjustment for surpluses, since Alcohol costs more than gasolene, have not as yet been worked out.

It is of interest to note what the potential sources of Alcohol are in the United States, and the following table shows the manufacturers' interest in Imperial Gallons of Alcohol producible from a short ton of material, and the farmers' interest in the gallons per acre.

Raw Material	Alcohol Yield.	
	Gals. per ton.	Gals. per acre.
Sugar Beet . . . . .	16.6	238.2
Sugar Cane (La) . . . . .	11.5	222.4
Jerusalem artichokes . . . . .	15.1	149.4
Potatoes, white . . . . .	17.3	147.7
Potatoes, sweet . . . . .	25.8	117.0
Apples . . . . .	10.9	116.2
Raisins . . . . .	61.4	84.7
Grapes . . . . .	11.4	75.0
Corn . . . . .	63.4	73.7
Rice (rough) . . . . .	60.0	54.4
Molasses (blackstrap) . . . . .	53.1	37.3
Grain sorghum . . . . .	60.0	29.5
Wheat . . . . .	64.1	27.4

On the basis of these yields it has been calculated that 15% of the United States production from all crops would yield 1,199,047,000 gallons of 99.5% alcohol.

It is obvious that the use of an entire crop is impracticable, while the utilisation of 15% of all crops, as instanced by the above total, would be impossible for some considerable time because of geographical distribution and the absence of, and uneconomic production from, numerous small Alcohol plants. Any Alcohol fuel programme must have a cheap and reliable source of raw material which will be adequate over a long period of years.

The search for replacement fuels is only at its beginnings, and ranges from the cracking of waste gases, polymerization, hydrogenation and synthesis. The fermentation process, however, based on the annually replaceable endless production of carbohydrates produced by the interaction of sunlight, air, soil and water constitutes the logical source of future supply. The process is simple, capital costs relatively small, while last but by no means least, it constitutes an outlet for the farm surpluses of the world and, therefore, a benefit to a considerable portion of a country's population.

#### Economics.

The history of our time has shown the rapid scientific development of production, which has far out-distanced methods of disposal. Sugar in particular showed a period of rapid expansion after the Great War, which was followed by over-production, collapse of the world markets and a general economic shrinkage. It is recognised today that persistent over-production eventually drives prices below the cost of production. Capital is dissipated, repairs and replacements fail, depriving collateral industries of business. Wages drop, unemployment increases, there is social unrest with a clamour for monetary devaluation.

From these observable causes and effects of over-production and business depression, has

originated the law of Davenant and King that "Whenever an excess of productions begins to hang over a market, prices soon fall to a level out of proportion to the amount of the surplus." The result has been the slow evolution of a new social economic system called proration.

To prorate means to allot or divide in proportion or to agree on the basis of a given rate proportionately.

Sugar, one of the principal manufactures of the world, has adopted this system in principle, varying its application to suit varied local conditions. Needless to say, prorationing is never invoked until markets threaten to become supersaturated; it then by agreement becomes a guarantee to every qualified producer a share of the existing business with no encroachment on the preserves of others and no creation of new Factories.

This is constructive social economics evolved to ensure fixed prices with reasonable returns, with the further object of keeping up efficiency and paying reasonable living wages. It is a compact between a Government and a self-governing industry in the public interest, assuring adequacy of supplies at fair prices. Our own Sugar Act is indeed an Act of prorationing, for without it, the Sugar Industry of Natal would have gone out of business with distressful results on employment and collateral interests.

All sugar countries, since the final failure of the Chadbourne plan due to the non-incorporation of all sugar countries into its policy of restriction and the general decrease of per capita consumption caused by the depression, are now working on systems of prorationing.

There is not time to go deeply into the various adaptations of prorationing in the various sugar countries, but there is a dividing line between two groups, those that have, and those that have not, petroleum resources, whereby it is possible by a directed economy to provide a non-food outlet for surplus sugar.

#### **European Countries—Beet Sugar Production.**

The beet sugar countries, Czecho-Slovakia, Italy, Germany, Poland and France have all been through the same effects and aftermaths of the World War.

Czecho-Slovakia, before its recent partition and final absorption by Germany, had a population of 15 millions and no less than 3,791,600 beet sugar farms. During the sugar production boom, it produced 1½ million tons of sugar, of which it consumed only one-third. The following depression brought the export price to 1 per cent per lb. which was below the cost of production. The analytical economists, as in every other country, clamoured for nature to take its course, while the social economists maintained that the Industry must be saved. The latter

won, and proceeded to raise the local consumption price two to three times higher than the export value, thereby saving the farmers, 198,216 of whom produced less than 10 tons of beets per year, and provided the manufacturers with fixed prices at which they could at least operate, and secure foreign credit on their export.

Every effort was made to foster Fuel Alcohol production, and in 1937 Power Alcohol consumption amounted to 13,915,000 gallons.

In Germany, where the first sugar beet factory was erected in 1802, sugar production amounted to 3 million tons in 1914. There followed war neglect, the boom, depression, tariff protection, local high price with a fixed directed economy, while the Fuel Alcohol production rose to 57,500,000 gallons in 1937.

Italy, with the highest sugar production cost of any European country, passed through the same type of conditions, and eventually encouraged beet production for Alcohol, thereby reducing foreign credits, providing power for internal defence, and more employment.

France, Poland and the other European countries have all conformed in varying ways to the same principles.

#### **Cane Sugar Countries.**

In every case the European countries mentioned are dependent on a foreign country for their petrol supplies. This is not the case with some of the cane producing countries. Louisiana, Mexico, Trinidad and the Argentine have their own petroleum resources, while on the other hand, Australia, Brazil and South Africa have none, and of these Brazil is the only cane sugar country in the world that has evolved a directed economy to provide a non-food outlet for surplus sugar.

In 1925, Australia had a surplus of 200,000 tons of sugar and, as usual, a section pressed for the withdrawal of all tariffs, the application of the natural economic law, with the consequent overthrowing of the Queensland Industry.

Again, Social Economics won, the industry was prorated, given a controlled market and a fixed price for sugar independent of geographical position, with an agreement to supply other Industries, such as the important fruit canning business, with sugar at prices at which they could compete in export. During the last two years, Australia has been toying with the Alcohol idea, so far without results.

The Argentine is a Federated Republic like the U.S.A., with a population of 12 millions and a high cost sugar industry situated in three Northern provinces. With the general advent of a supersaturated market for its sugar, the Argentine had no resource in a non-sugar outlet for its surplus, as it

has its own flourishing petrol industry. The result was the usual raising of prices to the consumer, the quota system, and the maintenance of the industry for the country's good.

### Brazil.

We now come to Brazil, which, unlike every other sugar country is developing its surplus sugar into a directed Alcohol production.

Brazil is a country of vast distances, and in size comparable with the U.S.A. Its population of about 42 millions is split up into 20 States, one Federal District and the Territory of Acre.

Its Sugar History goes back to 1521, when sugar production, began to flourish in the States of Sergipe, Ceara, Alagoas and Pernambuco, of which the latter was the most important. The industry developed on slave labour, most of the production being exported to Europe.

From the North-Eastern corner, the industry spread South to the States of Minas Geraes, San Paulo and Rio de Janeiro. In the South, however, coffee was, and is, still the principal crop, while Sugar reigns supreme in the North. In this country of extremes, every condition of sugar manufacture is to be found from great modern Factories, such as Santa Theresina in Pernambuco, to the lowly Engenhos.

There are three categories of Sugar Factories in Brazil: first the Usinas having Vacuum Pans and Centrifugals; secondly, the Usinas with Vacuum Pans and no Centrifugals, and thirdly the Engenhos with neither. In 1935 it was reckoned that 341 were in the first category, 408 in the second and 24,923 in the third. Needless to say, with the developments taking place in Brazil today, the Engenhos are rapidly disappearing, and the writer had difficulty last November in securing photographs of one in actual operation.

The economic history of sugar in Brazil has taken the same general pattern as the other sugar countries of the world. With only 10% surplus during the great depression, Government intervention was sought. This comparatively small surplus had its usual psychological effect. At first, like surplus coffee, valorization, or with-holding a certain amount from the market, was tried out with disastrous results. New stocks accumulated, and the bottom dropped out of the market.

The idea of getting rid of the surplus in other forms of surplus wealth was then exploited. A Commission, called the Defence of Sugar Production was appointed, and its first acts were to export 10% of everybody's sugar at whatever price it would fetch. The second was to forbid any further developments of sugar production, and thirdly, the imposition of a tax of 3 Milreis per saccos (132 lbs.) on all local consumption sugar. This latter act would appear to merely add a further burden on the overburdened Industry, but in reality it was neces-

sary to create a fund to meet all contingencies, and to assist in helping manufacturers to equip themselves in the development of Alcohol. Finally, the Commission was abolished, and replaced by the Institute of Sugar and Alcohol, which today governs the activities of these products in Brazil.

The constitution of the Institute is as follows:— There is one delegate from the Federal Ministry of the Treasury, one from the Ministry of Agriculture, one from the Ministry of Labour, one from the Bank of Brazil, and one representative from each State whose annual sugar production exceeds 200,000 bags.

The institute has the power of enforcing restriction of output, the maintenance of fixed prices, and the promotion of the manufacture and sale of Alcohol. In this connection, it has fixed the price for anhydrous Alcohol at 850 reis per litre f.o.b. Rio and prescribes the amount of admixture, but has not attempted to fix the price for gasoline.

The mixture sells on its merits at a price slightly lower than gasolene. In this way the Brazil Sugar Industry is capable of indefinite expansion, limited only by its ability to produce cheaply.

It was only to be expected, that such a wholesale programme led at first to a great deal of confusion. Inadequacy of supplies and the quality of the Alcohol being produced rendered the law unworkable, and even today only the State of Pernambuco is able to use the 20% admixture required by law.

The oil companies are obliged to purchase alcohol to the extent of 5% of their imports of petrol, thus compelling them to market a mixed fuel containing 10—15% of anhydrous Alcohol.

Other than this, there are a large number of brands on sale in Brazil with alcohol contents as high as 95%. It is noteworthy that a similar fuel is being used in Mauritius. The usual procedure is to start the engine on petrol and then switch over to the Alcohol mixture, the result being an appreciable saving per ton mile, with it is said, no deleterious effects on the engine.

The future of the Brazilian Sugar Industry is now technically and economically bound up with anhydrous Alcohol. To the ordinary one track sugar mind the effects on sugar technique are of particular interest, for throughout the centuries, cane sugar manufacture as a major industry, has remained single-minded.

The fourth largest country of the world, where sugar crops start in the North and end in the South, where distances between can only be covered by air or by sea, where many States are still 80% virgin forests, this vast undiscovered country of Brazil, where a new outlet for surplus sugar cane has evolved based on a directed social economic system, and where sugarcane has at last found a primary sister product—Fuel Alcohol.

**PRODUCTION OF SUGAR IN BRAZIL BY STATES.**

**(1938—1939).**

The total sugar production of Brazil for the 1938—1939 crop is estimated at 18,855,700 bags of 60 kilos. The authorised production of this merchandise is 17,743,434 bags. The biggest producing States are Pernambuco, with 5,200,000 bags; Minas Geraes, 2,730,000; Sao Paulo, 2,710,000; Rio de Janeiro, 2,420,000 and Alagoas, 1,600,000. The average consumption in Brazil is 15,919,179 bags per year. The following is the estimated production of sugar per State, of the 1938—1939 crop in bags of 60 kilos:—

State	Fixed limit.	Estimated crop 1938—1939.	Authorised Production.
Acre .. . . . . .	5,873	13,050	8,073
Amazonas .. . . . .	4,113	12,400	10,113
Pará .. . . . . .	20,799	23,300	22,499
Maranhao .. . . . .	26,199	56,800	49,599
Piauhv .. . . . . .	3,405	43,600	41,005
Ceará .. . . . . .	23,598	513,800	415,598
Rio Grande do Norte .. . . . .	119,489	220,000	177,089
Parahvba .. . . . .	266,395	506,000	536,395
Pernambuco .. . . . .	5,207,097	5,200,000	5,326,097
Alagôas .. . . . . .	1,909,001	1,600,000	1,989,001
Sergipe .. . . . . .	786,568	580,000	789,768
Bahia .. . . . . .	771,917	1,500,250	1,009,917
Espirito Santos .. . . . .	53,050	145,100	68,050
Rio de Janeiro .. . . . .	2,069,848	2,420,600	2,127,848
Sao Paulo .. . . . . .	2,189,955	2,710,000	2,389,955
Paraná .. . . . . .	4,381	18,000	14,981
Santa Catharina .. . . . .	326,136	300,000	363,636
Rio Grande do Sul .. . . . .	8,535	31,500	15,735
Minas Geraes .. . . . .	645,232	2,730,000	2,207,732
Matto Grosso .. . . . .	29,443	23,300	31,943
Goyaz .. . . . . .	72,400	208,000	148,400
Totals	14,543,434	18,855,700	17,743,434
		1,244,476 sht. tons.	

## ANHYDROUS ALCOHOL DISTILLERIES OPERATING IN BRAZIL—1938.

Distilleries	States	Daily Capacity in litres.
Usina Mandacarú S.A. . . . .	Parahyba . . . . .	10,000
Usina Central Barreiros . . . . .	Pernambuco . . . . .	20,000
Distillaria Produtores de Pernambuco	Pernambuco . . . . .	20,000
Usina Timbó Assú . . . . .	Pernambuco . . . . .	5,000
Usina Catende . . . . .	Pernambuco . . . . .	30,000
Usina Santa Therezina . . . . .	Pernambuco . . . . .	30,000
Usina Utinga . . . . .	Alagôas . . . . .	5,000
Usina Conceicao Macabú . . . . .	Rio de Janeiro . . . . .	5,000
Usina Sapucaia . . . . .	Rio de Janeiro . . . . .	5,000
Usina Cupim . . . . .	Rio de Janeiro . . . . .	20,000
Usina Outeiro . . . . .	Rio de Janeiro . . . . .	5,000
Usina Queimado . . . . .	Rio de Janeiro . . . . .	8,000
Usina Rio Branco . . . . .	Minas Geraes . . . . .	5,000
Usina Vassununga . . . . .	Sao Paulo . . . . .	3,000
Usina Itahiquara . . . . .	Sao Paulo . . . . .	3,000
Usina Santa Barbara . . . . .	Sao Paulo . . . . .	6,000
Usina Monte Alegre . . . . .	Sao Paulo . . . . .	6,000
Usina Esther . . . . .	Sao Paulo . . . . .	8,000
Usina Piracicaba . . . . .	Sao Paulo . . . . .	12,000
Usina Villa Raffard . . . . .	Sao Paulo . . . . .	17,500
Usina Porto Feliz . . . . .	Sao Paulo . . . . .	17,500
Usina Itaquerê . . . . .	Sao Paulo . . . . .	3,000
Usina Tamoyo . . . . .	Sao Paulo . . . . .	10,000
Usinas Nacionaes . . . . .	Federal District . . . . .	3,000
	Total	257,000
		56,540 Gallons

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## Appreciation.

The writer wishes to record his appreciation of the assistance rendered him by the Officials of the Institute of Sugar and Alcohol of Brazil in supplying him with the data contained in this and other reports.

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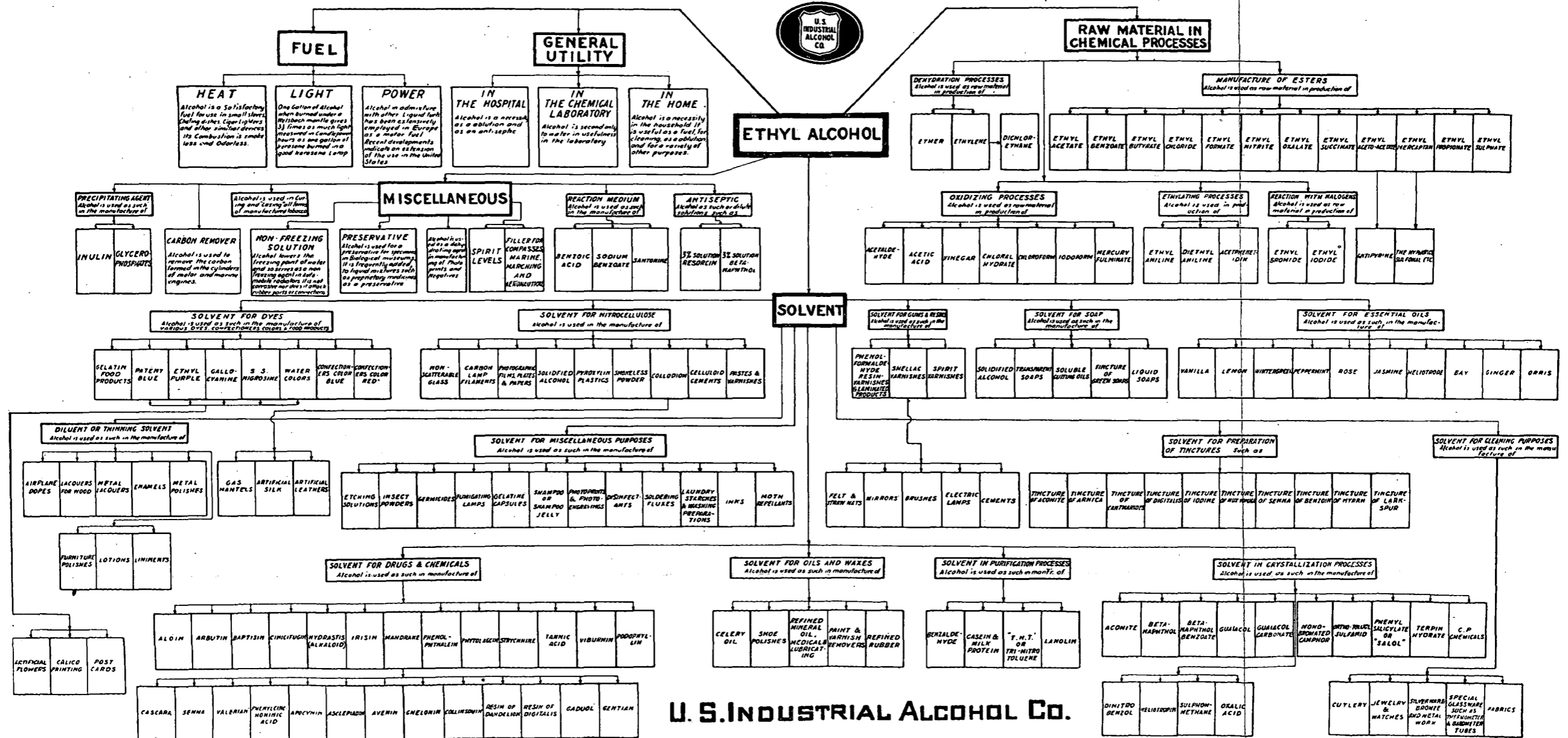
The PRESIDENT: Mr. Dymond has given us a very interesting paper. I am sure many of you have something to say about it. The paper is open for discussion.

Mr. DODDS: We are all very interested in this intriguing paper and the interesting illustrations.

It is very instructive to see how another country has developed with similar problems to those that we have here—problems of over-production and of disposal of waste products. I am sure it should give a lead to those who have this matter in hand in this country, and I would like to hear from any of the members of that Committee who are present.

Dr. HEDLEY: Mr. Chairman and gentlemen, there is no question about it but that this country is somewhat behind-hand, in utilising absolute alcohol as a fuel for internal combusting engines. It seems a pity, especially in view of the situation that is in Europe at present. At any time we might be called upon to provide fuel for transportation of military machines, and we would have to depend upon petrol getting to this country in tankers. Mr. Dymond has shown that in Brazil, there is a country which is turning a large percentage of its sugar—I think in one factory he said over 50% of the sugar—and the juices from the cane into alcohol. But it is a matter of economics, and it has yet to be decided whether it is economical to turn our juice, and perhaps

# IMPORTANT USES of INDUSTRIAL ALCOHOL



U.S. INDUSTRIAL ALCOHOL CO.

massecuite into alcohol. The matter is not going to drop. One firm in this country is going to investigate the question, and that firm will perhaps lead all the others if it is a success. It is very obvious that when you compare Brazil with South Africa the cost of cane in Brazil is very much less than the cost of cane in South Africa; and that what might be an economical proposition in Brazil might not be an economical proposition in South Africa. But because it looks a doubtful proposition, that is no reason why it should not be thoroughly investigated.

Mr. MOBERLY: There is one idea which gave me some thought in connection with this matter, that is the success attending the production of alcohol in Brazil. Whether the same economical conditions apply in this country is a matter for investigation. The point I had in mind was how the matter is to be dealt with eventually, who is to make the alcohol. It would appear there would be two possible lines, one to leave it entirely to private enterprise, the other hand it over to Government enterprise. Well, there are difficulties both ways. The general experience of a Government concern in industry is not very happy in any country. At the same time, one cannot give full marks always to uncontrolled private enterprise. The point I am getting to is this—we have in this country something which gives us an indication of what might be done. I refer to the Electricity Supply Commission, which is a body which I think any of its critics will say has done a very great deal, and works in a very splendid way. It is allied to the Government. The members of its Board are largely nominated by the Government, it receives its finances through Government Authorised loans, but there the Government control ends. There is no dictation from the Government as to whom it employs, what it buys or where it buys; the only stipulation is that it is limited to a certain return on its capital, and after that all profits go to the reduction of the cost of the output—in this case, electricity. And I think that this provides a possible solution to our difficulty here, the formation of some semi-Government institution—call it Fuel Supply Board or what you will—who would be charged with the manufacture from any suitable source of any fuel for internal combustion purposes not necessarily solely alcohol. It should work very much on the lines of the Electricity Supply Commission. It should not be a profit-making concern, beyond a reasonable return on loan money; but any profits resulting from its operation, should go to the cheapening of the product.

Mr. GODFREY: Regarding the suggestion of a Company like the Electricity Supply Commission, if that could be done, I suggest it would be an excellent thing.

Mr. MURPHY: We listened to Mr. Dymond's

paper with tremendous interest—at least I did—and for years now we have had in the back of our minds the possibility of making this alcohol and marketing it. In view of the fact that Mr. Dymond's paper covered such a wide sphere, and as a result of his tour overseas, I think it would be opportune, and we ought to ask Mr. Dymond if by chance he has thought out a scheme on which we might work to produce and market this fuel. It is perhaps a little bit out of the scope of his paper, but he may have some ideas on the point. I would like him to express his views if he has given any consideration to this point.

Mr. DYMOND: Mr. Chairman, and gentlemen, at this stage I am rather diffident in making statements on the possibilities of Alcohol production from surplus cane in Natal. Since I came back from Brazil, a number of reports have been submitted to the Sugar Association on the whole subject. Those reports are being considered by a special committee of the Sugar Association. You will, I am sure, understand that it is not politic for me to disclose the essential contents of those reports at the present time. I am however willing to answer questions on the technical aspects of a Sugar-Alcohol scheme. It has been said of this proposition, that: "The trouble is Dymond wants to make alcohol, and we want to make sugar." Well, that is a pithy statement, and covers a lot of the human factors effecting the general acceptance of the principle of Sugar-Alcohol manufacture. It is quite impossible, in my opinion, to run a large alcohol industry separate from sugar manufacture, the two are economically, and technically interwoven. If you want to make alcohol from surplus cane, alone, it is not an economic proposition without Government support in a large way. There is only one Factory, that I know of, which is doing it, and that is at Ponte Nova in Brazil. This can be done, firstly because the cost of the Raw material—cane—is low, and secondly because the Government fixes a reasonably high price for alcohol. I do not want to be drawn into a discussion on the costs and economics of this subject. One point I wish to make, is that if it is considered worth while doing it in this country, the only way is to run it in co-operation with the sugar manufacture, whereby benefits will accrue to both manufacturers as is obvious in Brazil. There the Distillery is considered the safety valve of the Sugar House. In Natal no doubt, the legal side of such a proposition, would be difficult on account of the intricacies of our Sugar Act, but I feel sure that the will to do, would soon iron out such superficial difficulties. Regarding technique, the best way would be to run a large pilot plant at one of our Mills, so as to establish the best methods suitable to our conditions.

Mr. BIJOUX: Could not a mill be set aside and used to crush the surplus cane for Alcohol production?

Mr. DYMOND: The utilisation of even a small Mill does not appear to me a very economical way of doing it. The usual procedure in Brazil—which I have to take as my standard—is that they have a quota of sugar, the same as we have here, and they have an unlimited market for alcohol, so they simply set the distillery to the course of sugar manufacture. First the Sugar House is started up, and then, when there is molasses the distillery is opened, using the Last Mill Juices as a diluent for the molasses. Towards the end of the season, if there is still surplus cane, it is crushed only for alcohol. Brazil is such a vast country, I wonder if you realise how vast it is, not only in its distances, but in the difficulties of inter-communication. The town of Manaos, on the upper reaches of the Amazon, has a representative in Parliament in the State of Rio de Janeiro. It takes him fifteen days to get down. The only ways of travel in Brazil are by air, river and sea. The railways are merely local affairs tapping the country near the chief ports. The consequence is that technicians in say the State of Pernambuco, know little of what is happening in the South, 3,000 miles away and vice versa. The consequence is that one finds all kinds of individual efforts in the development of Sugar Alcohol technique between State and State. You can pick the good from the bad if you go round. Don't let me impress upon you, that it is all good in Brazil. You will find the absolute primitive and the ultra modern, but usually the ultra modern has to do with distillery practice. If you ever want to write the history of sugar, go to Brazil. You will find the oldest machinery, and the oldest processes operating alongside the most modern Distillery plants.

Mr. GODFREY: It is because the different mills are such great distances apart from one another that each factory has its own distillery, instead of having one big distillery, if the mills were closer together, for the whole industry?

Mr. DYMOND: The sugar alcohol industry of Brazil has been going on since 1521, so you can imagine that is one of the reasons, apart from distances, why you get all kinds of conditions. After the Great War, with the boom of sugar, Brazil found itself with a ten per cent surplus, as I indicated yesterday. Eventually they overcame that by making a non-food outlet for their sugar, but they were not fully equipped to handle it efficiently. The Institute of Alcohol and Sugar today is a very strong financial body, one of its objects being to assist the sugar manufacturers in improving their alcohol plants. But, as you can imagine, there are many old plants that have been making aguardiente or rum, for a very long time and to suddenly turn them to high-grade alcohol plants will take a number of years. The consequence is that the Institute has built three very large distilleries—modern, up-to-date plants—in

which they take the surplus from the smaller men in the form of Sugar, rather than export it. This is far from the most economical way of handling surplus cane, but it is at present the only way they can enforce the law, and the project they have in mind, which is alcohol. The Sugar Quota is easily made from the rich juices, and they know where they stand in this respect for a number of years. But they don't know where they are with Alcohol as the field has no limit. Only in Pernambuco can they apply the legal 20% admixture with Petrol. In Rio de Janeiro it is between seven and nine per cent; in the State of Sao Paulo it is between three and four. In the inland states you find petrol pumps where you fill up with straight alcohol!

So centralisation to a certain extent has been forced upon the Institute to provide a portion of the Alcohol required by law, until such time as the private concerns can catch up.

Mr. BECHARD: To my mind, the strong plea that Mr. Moberly and Mr. Godfrey put forward a little while ago, about a utility company to embrace all by-products, is amply justified, for this reason—that, as Mr. Dymond has pointed out, the inter-relationship of alcohol and sugar at the present moment would be very great, because certain economies could undoubtedly be made in the steam used, the steam produced by the existing boilers, and deviated to the distillery. But if the bagasse were to be used for other purposes than its present use, as a fuel, then the inter-relationship that exists, or that appears to exist now between alcohol and sugar, would probably gradually disappear. That is the reason why it would be far better, when the subject is approached, to approach it from the broad point of view. Although it would appear that the distillery at present as an adjunct to every sugar mill is desirable, in case bagasse as fuel was displaced, and coal was used at the factories, then in such a case, it is very likely, that central distilleries would make a far better appeal.

Mr. FELTHAM: I have listened with a great deal of interest to Mr. Dymond's paper. It is a question of cost to the consumer. Now on page 46, he has a figure chart. He states: "In 1937 the extra cost to the consumer through using these substitutes amounted to £47,000,000 or 1/4d. per gallon." Now that is not quite clear to me. Exactly what is meant by that? A little above he states that the extra price to the consumer is approximately a penny a gallon. Can Mr. Dymond give us any idea as to what the extra price to the consumer would be in this way, by using alcohol, and further, I would like to know whether in Brazil the Government derive any revenue from the use of petrol?

Mr. DYMOND: In Brazil the cost price of gasoline c.i.f. at say Rio is 4.1d. per gallon. Various

State and other duties are applied so that the price of distribution at the pump is 1/3. The alcohol-gasoline mixture sells in Rio at 1/2 per gallon at the pumps of the Institute, and 1/3 at others, so it is obvious that if this country were to impose a duty, or enforce gasoline consumers to incorporate alcohol into their petrol, the Government would lose about 5½d. per gallon. The whole problem centres on Government interest, in a directed economy based on social economics. Other countries are making absolute alcohol for fuel and munition purposes. In Australia the petrol companies are obliged to buy alcohol to five per cent of their imports. In India the proposition is being considered by the Government. Now there must be something behind Alcohol production on a large scale when Governments are voluntarily

giving up large amounts of revenue from the Petrol tax. The amount of 1/4, that I mentioned in this paper, is a quotation from a paper dealing with substituted fuels, as made in Germany and other European countries, and not only alcohol. In America the general view appeared to be that while Alcohol is not a business proposition in competition with petrol, they were all interested. Taking the long view, if the Petrol Companies can assist the farmers on the basis of social economics, they are willing to help, partly because it will also lengthen the life of their not inexhaustible oil wells by 20%.

The PRESIDENT: I am sure we have all listened with pleasure to Mr. Dymond, and also to the discussion. I wish you to record a hearty vote of thanks to Mr. Dymond for this excellent paper.