OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

08729

Distr.
LIMITED

ID/WG.293/1
21 February 1979

ENGLISH

United Nations Industrial Development Organization

Workshop on Fermentation Alcohol for Use as
Fuel and Chemical Feedstock in Developing Countries

Vienna, Austria, 26 - 30 March 1979

POWER ALCOHOL IN THE SUDAN
A CASE STUDY*

by

O.M.R. Brown **

* The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

** Tate and Lyle Technical Services Ltd., Bromley, BR2 9NA, UK

id.79-1125

with
08729

Distr.
LIMITED

ID/WG.293/1
ABSTRACT
5 February 1979
ENGLISH

United Nations Industrial Development Organization

Workshop on Fermentation Alcohol for Use as
Fuel and Chemical Feedstock in Developing Countries

Vienna, Austria, 26 - 30 March 1979

ABSTRACT

POWER ALCOHOL IN THE SUDAN
A CASE STUDY*

by

O.M.R. Brown**

In January 1977 Tate & Lyle Technical Services was commissioned by the Sudan Government on the basis of credits from European Development Fund to report on molasses utilisation in the Sudan.

The Sudanese sugar industry is in a period of rapid growth and will approach a production of 1 million tons of sugar over the next ten years. Molasses production associated with this will reach about 300,000 tons. The study considered the actual current and projected future usage of this molasses.

Although realisations from export of the molasses appear superficially to be the most attractive outlet the major distances and transport difficulties between Port Sudan and the sugar operations mean that only a portion of this quantity can be economically transported and sold. However, the use of molasses to make alcohol as a component of gasoline produces a small but positive return on the value of molasses at the sugar factory. A two stage distillery programme has, therefore, been recommended which will eventually produce approaching 40,000 tons of alcohol. During this programme the alcohol will be used as a 10 - 20% blend on all the ordinary gasoline used in the Sudan apart from that directly distributed from the refinery to local areas.

---

* The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

** Tate and Lyle Technical Services Ltd., Bromley, BR2 9NA, U.K.

The Sudanese oil industry depends at the moment exclusively on import of crude oil. Expectations of local availability of oil will require time and money to be confirmed and exploited. As is common with less developed countries the refinery tends to be short on middle/lighter fractions with an excess of heavy fractions. The Petroleum General Administration is studying the implications of introducing alcohol as a further light fraction and tests to date are favourable.

As a result of the experience gained in working with the Sudanese Government and other bodies on this project the implications for other countries have been considered and some of the conditions which are likely to lead to an economic power alcohol programme are considered.

The Democratic Republic of the Sudan is the largest country in Africa. It covers about 250 million hectares of varied land from woodland savannah to desert with a rainfall variation from nil to 1,500 mm. The population is estimated at 16 - 18 million people, largely engaged in agriculture. Approaching 1 million of this number live in the capital area of the three towns, Khartoum, Khartoum North and Omdurman. The capital is at the point where the Blue and White Niles meet. These two rivers provide irrigation for a major part of the agriculture. Khartoum is about 1,000 km from Port Sudan on the Red Sea which is the major shipping port and the site of the single oil refinery.

One must stress the geographical aspects of the country because they are the key to the power alcohol scene and indeed to many aspects of the economy. The agricultural potential of the Sudan is enormous in that it is estimated that only about 10% of the potentially cultivatable 80 million hectares is currently exploited. The logistic aspects of the country are also enormously important. Until recently the rail route from Khartoum to Port Sudan was the major link between the Sudan and the outside world. The railway has not always operated at full efficiency and increasingly road transport is being used, although it will not be until 1980 that an all weather road will be in existence between these two points.

The Sugar Industry

The Sudan is in the middle of a major expansion of the Sugar Industry. The first two major factories date from the early 1960s when Guneid and Khashm-el-Girba were completed. These two factories were each designed to handle 4,000 tons of cane per day and while there have been difficulties particularly at Guneid, production here initiated the developments.

The next two factories were built at West Sennar and Assalya each with a c pacity of 6,500 ton of cane per d y. The programme of the Sugar and Distillery Corporation is completed with Melut (under construction) of 4,000 tons per day and potentially Mongalla which may be authorised at 2,000 tons per day. In addition, not under the control of the Sugar Corporation, is the Kenana factory which is enormous and with a design crush of 17,000 tons per day. As a result of these developments sugar production is estimated to approach 1 million tons per year during the 1980s with an associated availability of molasses of 300,000 tons.

Molasses Exports

In very general terms the past history of molasses in less developed countries has been one of export or dump. In the case of the Sudan to date alas the latter has predominated. Despite a market being available and indeed the conversion of an ex oil tank installation at Port Sudan to molasses, the exports have been conspicuous by their absence. The reason for this is simply the logistic problems. Not only is there congestion on the railways from Port Sudan due to the volume of import goods but a combination of higher valued alternative export materials and a desparate urgency to keep oil products moving has meant that even from the nearest sugar production point at Girba molasses has only moved in small quantities. As a result the majority of the molasses produced has had to be disposed of at some cost rather than realising some return. Improvements in the railway system and other developments will mean that this situation will improve at least as far as certain factories are concerned. However even the massive investments in transport infrastructure will still leave molasses as the relatively poor relation in terms of getting priority on the railway system. As a result we must continue to value molasses at zero or even a negative price at certain factories.

Industrialisation

A nil value raw material is a challenge and all forms of exploitation have had to be considered. In the study referred to we have examined the possibilities not only of bio-chemical transformation to products such as alcohol, citric acid etc. but also the prospects for animal feeding (the most important usage of molasses in developed countries). Recommendations have been made to exploit this last usage. Nowhere in the world has great success been attained in the sale of feed stuffs to nomadic herd owners whose attitude towards feeding animals depends on the availability of free grazing however poor. There are major schemes in existence to introduce these nomads to a cash economy whereby calves etc. will be bought and fattened for slaughter. In addition there are ranching operations being considered or instituted. However, it is difficult to find justification for such schemes on the basis of a nil value raw material. Rather the scheme has to be justified on the basis of availability of beasts and markets and the molasses is a bonus. We have been able to forecast a major build up in the use of molasses for this purpose but it will require promotion and assistance. Therefore, with a requirement for a major usage of molasses the prime target has to be alcohol.

The Alcohol Market

Despite having studied a large number of potential production points in the world it has not yet been possible for us to justify production of alcohol for export. The export alcohol market has consistently been volatile and apparently under valued compared to the raw material. From existing alcohol plants it has at times been marginally more advantageous in foreign currency terms to export alcohol rather than molasses but in general the molasses market has been a superior outlet particularly having regard to the capital cost of new plants.

As would be expected in a less developed country there is in Sudan only a small internal alcohol market. This is partly supplied from an existing small distillery operating on molasses and dates and partly from imports. However no substantial market can be envisaged in the short term in either the industrial or potable areas. The longer term development of a chemical industry, re-starting the elegant technology largely discarded in the developed countries in the last forty years remains a possibility.

It was therefore necessary to consider the creation of a market and this inevitably led to an examination of the power alcohol possibilities.

Oil in the Sudan

To date all mineral oil products required in the Sudan have been based on imports either of crude or of refined products. The refinery at Port Sudan is partly government owned and has a rated capacity of 26,000 barrels per day. The refinery is understood to be of a relatively simple conventional type with a distillation unit and a platforming unit. Again as is normal with less developed countries the problem in operation lies in a relative shortage of light/medium cuts and a surplus of heavy ends. The refinery is therefore balanced by the import of substantial quantities of diesel fuel, some imports of gasoline and exports of heavy oils.

The ideal supplementary indigenous material would therefore be additional gas oil or substitute. However with substantially less world experience in the value and use of alcohol as a diesel supplement we have looked more at the extension of the gasoline supplies. Experience in a number of countries including predominantly Brazil recently has shown that few, if any, problems are likely to arise with the addition of 10 - 20% alcohol in gasoline.

However, as is only prudent certain trials are required to assess the effect of this both having regard to the car population and to the temperature variation and to the characteris ics of the existing gasoline stream.

In view of the fact that many developments in the Sudan are also inhibited or discouraged by the logistic problems referred to above we have also examined the distribution areas for gasoline. This is favourable for a power alcohol programme. Approaching 90% of the gasoline requirements is distributed through terminals in the Khartoum area. The remaining 10% is primarily distributed in the provinces nearer to the Port Sudan refinery and is taken directly from the refinery. As can be seen the distance from at least four of the sugar factories is substantially less from Khartoum than is Port Sudan. To date moreover all such gasoline heading for the Khartoum area is transported by rail as the nominal multi product pipeline has so far operated more or less exclusively (and to its current capacity) on diesel fuel. Economic considerations suggested therefore the establishment of a two stage programme of distillery capacity. This would enable all ordinary gasoline distributed from Khartoum to be extended with 10 - 20% alcohol.

A considerable amount of work has been initiated to confirm the feasibility of such an operation. Laboratory tests have indicated a preferred blend of base stock for alcohol addition. Bench tests have confirmed laboratory assessment and field trials on a small cross section partly representative of the overall car population are under way.

The Power Alcohol Programme

As briefly indicated above a considerable amount of work on economic assessments of capital costs, running costs, transport costs etc. was required to determine the preferred scale and timing.

Effectively molasses is available or will be from each of the sugar factories in varying amounts on variable time scales. It is common experience that the movement of molasses to a distillery is an expensive operation and, of course, negates the value of a distillery of effectively nil value raw material. Against this however it should also be noted that distilleries are not cheap in capital cost and therefore the scale factor is important in determining the cost of the end product. Couple these equations with a partial availability of otherwise wasted steam from a sugar factory and with the preferred transport of the finished product and the equation becomes one of some complexity. I will not go into the details which occupy a considerable number of pages of the study and represent a substantial part of the work but suffice it to say the study suggested a distillery with a capacity of 16,000 tons of alcohol to be located at West Sennar along side the sugar factory as the first step. Potentially this can be followed by a larger distillery at Kenana.

While this total quantity can be absorbed into the gasoline market it is also believed that, during the period of construction, the optimisation both theoretically and as a result of field trials of the use of alcohol may indeed show some alternative application (such as addition of a small quantity to the diesel supply) will be worthwhile.

Economics

There are those who would say that anything is both possible and impossible in the Sudan. It is certainly true that the opportunities for development are enormous but that most of them are more difficult than one expects. The prime reason for such difficulties comes back again to the logistics. Where projects have been less successful than anticipated, it can probably be attributed to underestimating the difficulties associated with the infrastructure.

This has not infrequently resulted in shortages of vital materials when most required. One such shortage has indeed in the past been fuel so at least this project may be looked at as contributing to the infrastructure as well as its direct economic effect.

I mention this because it has resulted in capital costs which must be regarded as high in world terms. Transport of equipment from Port Sudan to site is a major expense as indeed is the cost of local civil works and erection.

However, the initial outline costing of the distillery showed that it was possible to produce alcohol delivered to the Khartoum terminal at a price on a volume basis equivalent to that of gasoline. Obviously this is a fairly crude comparison. However, it is probably a conservative one as the minor and overcomeable disadvantages of alcohol are out weighed by superior performance. Only parts of the superior performance are quantifiable. For example, the high octane rating effect of alcohol will enable either the lead content of the gasoline to be reduced or a lower quality base stock to be blended or an increase in the quality of ordinary gasoline to be instituted. The probable preference is to reduce the lead content which carries with it the least quantifiable improvement in environment.

Again this is a simple approach. The specification requirements for gasoline include fitting the specification evaporation characteristics. The introduction of a single chemical into the blend of hydrocarbons at the light end makes the fitting of the evaporation characteristics to the previously established specification quite difficult. The specification is, of course, derived from the requirements and experience of such problems as vapour lock.

Summary

The above represents a brief summary of some of the work done to establish the feasibility of a power alcohol programme in the Sudan. I have not discussed the full financial analysis which shows that the projects give a small but positive value to a raw material which would otherwise be worth nothing and effectively cost money to dispose of. Nor have I mentioned the overall effects on the Sudan economy of this relatively small development. I say relatively small because the costs one is thinking about run in the tens of millions of dollars whereas large agricultural schemes have run into hundreds of millions. What I have aimed to show is that in the specific case of the Sudan it has been possible to work out the viability of a power alcohol project in advance of its implementation and that this has and is being worked out with sufficient confidence.

The key questions are what conditions are required to enable this experience to be applied to other countries or areas. The prime (and unique perhaps) characteristic of the Sudan is that the raw material for the power alcohol programme can, if need be, be costed at nil. This is due to the logistic problems related to marketing area remote from an export or import point. In this particular case it has also related to the non availability of indigenous oil products. This last is not an absolute requirement and recent reports of potential oil availability in the Sudan would not effect our conclusions.

However, the requirements which we would normally seek to make a power alcohol project viable include:

1. Market for at least 60,000 tons of gasoline concentrated for distribution into a limited area or number of areas.
2. That the area of gasoline used should be within say 500 km of the potential raw material.

3. That the current value for the raw material should be low.

4. In the case of local refining of oil products there should preferably be an imbalance with gasoline in relatively short supply. If all oil products are imported in the refined state then stretching the gasoline supply is almost certainly advantageous.

The absolute key question which we have not discussed here and about which there are probably as many opinions as there are people is what is the forward price of oil products. It should be noted that in this study we did use a price for gasoline slightly inflated compared with the actual price at the time of the study. However, even within the period of discussion the price of gasoline has overtaken the figure we used and it has been partly demonstrated that inflation on oil products is faster than inflation in general. Given a finite availability of oil and oil products and given that over the next 20 years or so this finite availability will be increasingly reflected in prices then there will be an increasing number of places where power alcohol becomes an economic product. However, it should be stressed that a proper comparison should be made between the costs of power alcohol and a firmly established value for gasoline. May I therefore make a plea that power alcohol should be studied sensibly as one potential part solution to the energy problem and should not become a political catch phrase.without the economic facts of life being appreciated.

Acknowledgements

The study referred to was financed by the European Economic Community through credits from the European Development Fund. It was sponsored in the Sudan by the Ministry of National Planning who delegated responsibility to the Sugar and Distillery Corporation. Laboratory trials were conducted by the Port Sudan Oil Refinery. Bench tests were by the University of Khartoum. Refinery studies and field trials were conducted by the Petroleum General Administration with assistance from a Technical Committee including representatives of the Gasoline Distribution Companies and others.

Acknowledgement is due to all these and to many other people who assisted the work. I personally would like to put on record the gratitude all members of the study team feel regarding co-operation which was so generously extended to us.

SUDAN SUGAR INDUSTRY

PROJECTED PRODUCTION OF SUGAR & MOLASSES

PERIOD 1977 - 1987 (ALL FIGURES '000 MET.TONS) - ESTIMATE OF 1977

Note: Subsequently Revised

Factory		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Guneid	S	55	60	60	60	60	60	70	80	80	80	80
	M	18	20	20	20	20	21	24	28	28	28	28
Kh. um el Girba	S	65	75	75	75	80	95	95	95	95	95	95
	M	23	26	26	26	28	33	33	33	33	33	33
West Sennar	S	35	80	85	90	110	120	135	150	150	150	150
	M	12	28	30	31	38	42	47	52	52	52	52
Hager-el-Asalya	S	-	15	50	80	90	110	120	135	150	150	150
	M	-	5	17	28	31	38	42	47	52	52	52
Kenana	S	-	-	50	00	150	200	240	275	300	300	300
	M	-	-	17	35	52	70	84	96	105	105	105
Melut	S	-	-	30	35	40	45	50	55	60	60	60
	M	-	-	10	12	14	16	17	19	21	21	21
Mongalla	S	-	-	-	-	25	29	33	35	35	35	35
	M	-	-	-	-	9	10	12	12	12	12	12
TOTAL		154	230	350	440	555	659	743	825	870	870	870
TOTAL MOLASSES		53	77	120	152	192	231	260	289	305	305	305

GASOLINE AND OTHER FUEL CONSUMPTION IN THE SUDAN
PAST AND FUTURE

	Gasoline total 000 tons	Gas Oil	Diesel (for vehicles)
1963	81		154
4	78		165
5	78		170
6	82		194
7	82		193
8	92		217
9	95		248
1970	95		271
1	97		298
2	101	301	301
3	105	323	323
4	106	329	329
5	116	349	349
6	131	391	
7	134	485	
8	158	565	
9	168.5	621	
1980	181	683	
1	193.5	751	
2	206	826	
3	222	909	
4	238	1000	
5	255	1100	

Sources: Transport statistical bulletin for 1963-75 figures (Shell)

Shell Company of Sudan 1975 -

B-83

80.02.05