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APPROPRIATE TECHNOLOGY FOR THE PRODUCTION OF SUGAR

BY-PRODUCTS OF THE SUGAR INDUSTRY IN CUBA: PRESENT AND FUTURE SITUATION,

Background Paper *

BY-PRODUCTS OF THE SUGAR INDUSTRY IN CUBA: PRESENT AND FUTURE SITUATION

by

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INTRODUCTION

During the last years it has become more evident that the future of the sugar industry will lie on the advantages which from the by-products use, the producing countries will be capable to develop.

In the next decade the sugar cane derivatives industry will play an outstanding role in the economy of the Republic of Cuba. It is our desire to give a broad view of the different alternatives, its potential, the situation of the industrialization nowaday and in the immediate future in this country

I. THE BY-PRODUCTS IN THE WORLD TODAY

There are a great variaty of by-products of the sugar cane which are under commercial exploitation in the world today, many of them are currently present in the international commercial exchange and some others are used only in the internal market of the producing countries not being well established yet in the world market.

It is very well known that many developed countries had devoted some efforts in the field of the by-products of the sugar cane industry with the consequence of the industrialization of those products in their own countries or in some of the developing countries which own sufficient amounts of raw materials.

The analysis of the situation shows that in the recent years there have been a sustained but still modest tendency toward the increase in the amount produced, the enlargement of the assortments, the introduction of new products, the modification of the technologies, the optimization of the equipment and the increase of the economical efficiency of the industry.

Nowaday there are conditions that clearly show the advantages that the development of the industry of the by-products of the sugar represents for the producing countries like the followings:

(1) This development will grant an strong and certain diversification of the economy, making it practically independent of the fluctuations of the world market price of a single product.

(2) The increasing shortage of non-renewable sources of organic raw materials opens an unlimited field to the fibers from the sugar cane.

(3) It represents a certain way of diminishing the imports and/or increasing the exporting funds.

(4) The shortage in animal feeds in many countries allows an important role for the molasses and the pith as a mean of satisfaction of the ever increasing demands of the animal production.

(5) The development of the chemical industry opens new possibilities to the by-products.

(6) The sustained uprising tendency of the prices of the products in the world market makes highly profitable the installation of new industrial capacities.

(7) Some products, due to the high profitability or its specific use won't be threatened by the possibility of substitution by synthetic compounds.

II. THE BAGASSE

The bagasse could be obtained as a surplus product after covering the energy requirements of the sugar mills. As an example, it is possible to calculate that in a sugar mill with a milling capacity between 1,500 and 2,000 ton/day is possible to obtain from 10-15% of its bagasse as a surplus if the operation is steady with an adequate utilization of the industrial capacity and without significant milling interruptions.

If a higher thermal efficiency is obtained the recovery of surplus bagasse could be as high as 25% of the total.

Whenever the calculation of bagasse-oil substitution arises, it is necessary to consider that 1 ton of Bunker-C oil represents 6 ton of bagasse (50% dry matter) as fuel. Although, this figure could be improved if an efficient energy generation system is employed.

In the world today the most common uses of the bagasse are for the production of pulps, papers, cardboards, particle and fiber boards, furfural and of course, as fuel in the sugar industry.

Adequate product for the manufacture of animal fodders, a suitable raw material for the production of furfural and can be employed also as fuel.

III. THE INDUSTRY OF PULP AND PAPER FROM BAGASSE

The production of pulps and papers using bagasse as raw material is very widely developed in the world, today more than 1 million tons of papers are produced from this raw material.

A. Writing and printing papers from bagasse

The writing and printing papers are used in books and magazines when quality and durability are required.

The bagasse is a fibrous raw material which could be efficiently used for the production of chemical pulps for writing and printing papers of adequate quality. The chemical pulps are obtained mainly by alkaline processes (soda and sulfate).

For the installation of a pulp and paper plant is necessary to insure:

- Sufficient capital due to the high investment cost.
- Adequate amount of bagasse to insure a full capacity operation 300 days per year.
- A high amount of water with the necessary quality.
- Efficient methods for the treatment of the effluents.

A plant for the production of 45,000 metric tons of writing and printing papers plus 15,000 metric tons of tissue papers will cost 75-80 million dollars.

The price of the writing and printing papers in the world market is around $600 dollars, per ton, and the cost of production will be in the range of $350/ton.

B. Newspring paper from bagasse

This product could be defined as the type of paper produced at a reasonable low cost with good printing characteristics suitable to be used in the modern high speed printing machines. The main use of this type of paper is in newspapers and pamphlets, taking advantage of its low cost.

The traditional raw material for the production of newsprint have been the mechanical pulp from coniferous.

It is possible to produce different types of paper from bagasse without difficulties and in an efficient way but it have not been possible yet to manufacture newsprint from bagasse with the required technical and economical conditions.

At present, various alternatives under study seem to offer in - teresting possibilities.

According to available information the investment cost for a paper mill with a capacity of 300 metric tons of newsprint per day will be 43 million dollars.

The price of newsprint is in the range of 400 dollars per ton and the production cost will be 260 dollars per ton.

In spite of the high investment cost the pulp and paper indus- try from bagasse can shows a favorable cash flow due mainly to the upward trend in the prices that will be stressed in the future as a consequence of the increasing demand and the limited availability of wood to face it.

C. The pulp and paper industry in Cuba today and its perspectives

At the time being, Cuba has in operation 3 factories for the pro- duction of paper using bagasse as raw material. This industry uses

more than 100,000 ton/year of bagasse for this purpose.

"Tecnica Cubana" Factory.

This factory is located in the province of Matanzas, the installation has a capacity of 20,000 ton/year of writing and printing paper and was erected in 1957; after 1959 was modified and technologically adjusted to reach the design capacity.

"Pulpa Cuba" Factory.

Located in the province of Sancti Spiritus has a capacity of 18,000 ton/year of a combination of writing and printing papers and papers for industrial uses. Was installed in 1959.

"Sergio Gonzalez" Factory.

The factory has a capacity of 15,000 ton/year and was built in 1958. The installation produces cardboard and papers for industrial uses.

A new installation with a capacity of 60,000 ton/year of printing and writing papers will be erected to start its operations between 1981-1985. This new investment will be complemented with an ample program for modernization and enlargement of the existing factories.

D. Development and introduction of new technologies

Toward this aim during the past years Cuba has being working; special attention devoted to the development of technologies for the production of newsprint paper and dissolving pulps (more than 92% of cellulose) for textile fibres, cellophane and other cellulosic derivatives of high profitability.

Concerning the newsprint paper the main efforts have been centred on obtaining mechanical pulps from bagasse to allow a newsprint paper production with the same quality and similar economical

efficiency as those obtained from wood.

The development of the new technologies will ensure an adequate diversification of the uses of the bagasse for the production of pulps and papers. The mechanical pulps from bagasse will solve an important gap in the formulation of mixtures which is an important technical and economical requirement in the production of many types of papers which production today is limited to use of unsuitable and expensive chemical processes.

These two task are very closely related with the Cuba-9 Project that the Cuban Government implements with the cooperation of United Nations Development Programme, the United Nations Industrial Development Organization and the financial contribution of Canada and Finland.

IV. PARTICLE AND FIBER BOARDS FROM BAGASSE

The fundamental use of this product is in the construction of furniture for houses, offices, panels for the building industry, doors and others uses such as interior covers in buses and trains.

The technology for the production of particle and fiber boards isknown and does not offer any difficulty. The fundamental equipments for these plants consists of machines for the milling and preparation of the bagasse, gluers, forming machines, press, as well as equipment for the finishing. The rest are mechanical and neumatical conveyers known world-wide.

These plants may be installed in places where there are no great resources of water, the consumption of bagasse is low (3,0 ton of wet bagasse per ton of board).

A plant with a capacity of 120 t/d of boards costs approximately 13,5 million dollars with a production cost of 180 dollars per m^3 of board.

A. The bagasse boards industry in Cuba today and in the future

For more than 20 years 2 factories have been in operation in Cuba for the production of particle boards from bagasse. One is located in the province of Cienfuegos with a capacity of 18,000 ton/year; the other one, in the province of Havana, with a capacity of 12,000 ton/year, was originally designed to produce particle boards from the residues of the industrial utilization of an special type of hard wood, later the installation was adapted to use bagasse having a successful performance for more than 10 years.

In the province of Las Tunas there is in operation a factory for the production of 7,800 ton/year of fiber board from bagasse.

At the time the bagasse utilization for the board industry represents 150,000 ton/year. As a consequence of a close examination of the efficiency of this type of industry the Cuban Government is carring out an investment program which includes the construction of 4 new factories for the production of particle boards from bagasse. According to this program -the first of these factories will start its operation in november 1978- the bagasse board production in Cuba will be at the end of 1980 more than 170,000 ton/year. The production will cover the demands of different products for the internal consumption. The total investment cost of the program is 48 million pesos.

V. THE PRODUCTION OF FURFURAL

The furfural is a product of wide use in the world with the characteristic of being produced only through hydrolysis of agricultural and forestal residues, and in particular, from bagasse.

Among the most common uses of furfural is possible to mention the followings:

In the lubricants industry.

The furfural is used as a selective solvent because of its capacity to dissolve those easy oxidable compounds and the ones which tend to form resine contributing in this way to improve the lubricant properties of the greases.

In the mechanical industry.

More than 60% of the world production of furfural is used for the production of furfurilic alcohol by means of hydrogenation process employing not too complicated technologies.

Most of the furfurilic alcohol is devoted to the production of resine with special properties for the costing in the smelting industry.

In the pharmaceutical and pesticide industry.

For years various products with pesticide properties manufactured from furfural have been in the market. The most widely used is the Piremina, a classic pesticide in the beet plantations.

In the pharmaceutical market as well is possible to find furfural derivatives like the Furantoin, Furazolidin etc.

A. The world market

According to the estimates the demand for furfural in 1980 will be 315,000 ton, and the installed capacity then will reach only 308,000 ton/year, this figure includes the plants already in operation plus the new capacities that will be incorporated between 1978 and 1980.

B. The Industry

Historically the furfural industry has been reaching an utilization of 75-78% of its installed capacity, if in 1980 the behavior is similar it is possible to estimate a production of 236,000 ton with a deficit of 80,000 ton.

Taking into consideration the availability of bagasse as well as the minimum feasible size the most convenient capacity seems to be - for Cuban conditions - 5,000 ton/year of furfural.

The investment cost of such factory is 8 millions pesos, the operation cost $267/ton and the cost of production $372/ton. In the table No. 1 the consumption index are shown.

According to the situation Cuba foresees the installation of industrial capacities to reach a level of 10-15,000 ton/year of furfural in the period 1980-1985.

VI. THE BLACKSTRAP MOLASSES

Could be defined as the liquid residues from the process of sugar crystallization being an important source of carbohydrates which may offer interesting solution to many problems through two alternatives:

(a) Directly as an energy source for animal feeding.

(b) As a highly valuable raw material for the fermentation industry.

A. Energy source for animal feeding

In Cuba today, and as a result of years of research and tests, more than 1 million ton of blackstrap molasses are used in the animal feeding becoming a basic component of the diet of different types of animals.

In the case of ruminants the diets content up to 85% of its dry matter in the form of molasses. The use is extended to the hog and poultry feeding through the development of new procedures that, by means of modification of the composition of the molasses, allow to overcome the limitations imposed by the characteristic type of animal.

B. The fermentation industry

It is possible to say, that may be no any other industry suits better to the conditions of the developing countries than the fermentation industry. With low energy and capital demands together with the possibility of highly valuable production its limitation lies in the availability of suitable sources of raw material.

The blackstrap molasses are, with no doubts, this suitable source that have been used for many years for the production of single cell proteins, alcohol, citric acid, aminoacids, etc.

VII. THE PRODUCTION OF SINGLE CELL PROTEIN FROM MOLASSES

One of the most distressing problems that mankind is facing today is the shortage of protein sources for the satisfaction of its most urgent needs.

In the future, this shortage will be most acute and the solution that until recently seemed to offer the production of SCP from hydrocarbons is more and more doubtful due to the steady increases in the oil price.

The sugar-producing countries have an ideal source of raw material for this purpose in the molasses.

A. The Cuban experience and future trends

Since 1965 there has been in operation in the province of Ciego de Avila a plant for the production of Torula fodder yeast with a capacity of 9,000 ton/year using blackstrap molasses as raw material. The factory represents the first feasible experience using cane molasses in this field.

As a consequency of this analysis of the behavior of the protein market and taking advantage of its own experience in this type of production, the Government of Cuba is carrying out an investment program for the installation of 10 new factories, each one with a capacity of 40 ton/day of dry Torula yeast using molasses as raw material.

The investment program will cost 100 million dollars and will allow for an increased production / capacity of SCP in Cuba of up to 150,000 in 1980. At that time the total amount of blackstrap molasses devoted to this industry will be 600,000 ton/year.

The first two factories of this program are already in operation

and with a nice performance; the construction of the other 8 installation proceeds according to the plans.

According to the Cuban experience the investment cost of a plant with a capacity of 12,000 ton/year is 9 million dollars with a production cost of $170/ton of dry yeast 50% raw protein content, considering the molasses a $5.00/ton.

The consumption indexes shown in Table No. 2 could be easily reached in the commercial operation. It is necessary to point out that the cost of production of the fooder yeast are very much influenced by the price of molasses which sometimes represents almost 60% of the cost.

VIII. ETHYL ALCOHOL FROM MOLASSES

This is one of the oldest form of the use of molasses. The technology is widely known using conventional equipment.

The most common use of this product is in the preparation of beverages not being replaced for this purpose by synthetic alcohol.

The increase of oil prices in the last years compels to consider the possibility of alcohol obtained through fermentation, from the molasses as a substitute of great possibilies for the traditional fuels obtained in the petrochemical industry.

This alternative creates very favorable perspective for the cane sugar producing countries as a mean to reduce the expenses from the import of crude oils or refined products.

The investment for the installation of an alcohol distillery with a capacity of 100,000 liters per day at 100º G.L. ranges between 4,0 - 5,0 million dollars, and the cost of production of one liter of alcohol, considering the molasses a 4,0 U.S. dollars per ton, would be 4 cents (dollars).

The production of alcohol through fermentation allows also to obtain yeast by a process of recovery before the distillation. At the same time, the use of the distillery waste for the production of single cell protein have been successfully tasted in Cuba.

A. The cuban experiences

The production of ethyl alcohol from molasses is an industry of long tradition in Cuba. The history of the development of this production has been always influenced by different factors, the I and II World Wars, the Korean war and also the Dry Law in the United States.

At the time, there are 18 distilleries in Cuba with a total production capacity of more than 200.0 millions liters per year, the capacity of the installations ranges from 20,000 liters/day to 150,000 liters/day. The yeast recovered from this production reach 9,000 ton/year because according to the experience this type of process is only economically feasible for factories with a capacity not less than 50,000 liters/day.

An industrial complex for the production of 100,000 liters/day of alcohol for beverage is under construction and includes an installation for the production of 6,000 ton/year of Torula yeast using the waste of the alcohol distillation as raw material.

According to the Cuban experience it is possible to combine the alcohol and SCP production with the recovery of the Sacharomyces yeast from the alcohol. The first industrial experience of this type will be in operation at the end of 1979.

IX. TECHNICAL DEXTRAN FROM MOLASSES

The dextran is a glucose polymer obtained through a microbiological process from the refined or the raw sugar. In Cuba sometimes the syrups of the sugar refineries have been successfully used for this purpose.

Since 1963 an industrial installation produce technical dextran in Cuba, the plant located in the province of Matanzas has a capacity of 300 ton/year of the product in the form of a highly hygroscopic white powder.

To give an idea of the characteristic of the process the consumption indexes are given in Table No. 3.

From these figures is possible to find out that the whole economy of the process lays in the actual cost of the source of sucrose employed. As it was mentioned the use of refinery syrups or cane juice have been successfully tested.

The application of the product range from the manufacture of oil wells drilling muds to the preparation of blood volume expanders, including the use as a highly efficient additive in the food and cosmetic industry.

X. CONCLUSIONS

The wrong bearing of the prices of the sugar in the world market in the last years and the present situation of depression in these ones make necessary to analyze deeply the future of the sugar cane industry.

Each time it is more evident that for the developing countries is quite difficult to carry out their development base on one product whose price has such an unforeseen bearing.

The Cuban experience shows, however, that the by-products of the sugar industry constitute valuable raw material sources capable of supporting the production of strategies and high valuable products that can act as a buffering factor in periods of price depression and also as new exportable resources to improve the balance of payments.

The future of the sugar cane industry lies on the industrialization of its by-products not more as a matter of technical or scientific interest but as the only possible way to guarantee its own existence.

Table 1. Consumption indexes furfural from bagasse

	Per ton of furfural
Bagasse	12,5 ton
Water	60 m^3
Electricity	1200 kwh
Fuel oil	5 ton

Table 2. Consumption indexes SCP from cane molasses

	Per ton of yeast	
Blackstrap molasses	3,8	ton
Water	75	m^3
Electricity	1200	kwh
Bunker C oil	0,430	ton

Table 3. Consumption indexes for the production of dextran

	Per ton of dextran	
Sugar	4,0	ton
Ethyl alcohol	1700	l
Steam	50	ton
Electricity	700	kwh

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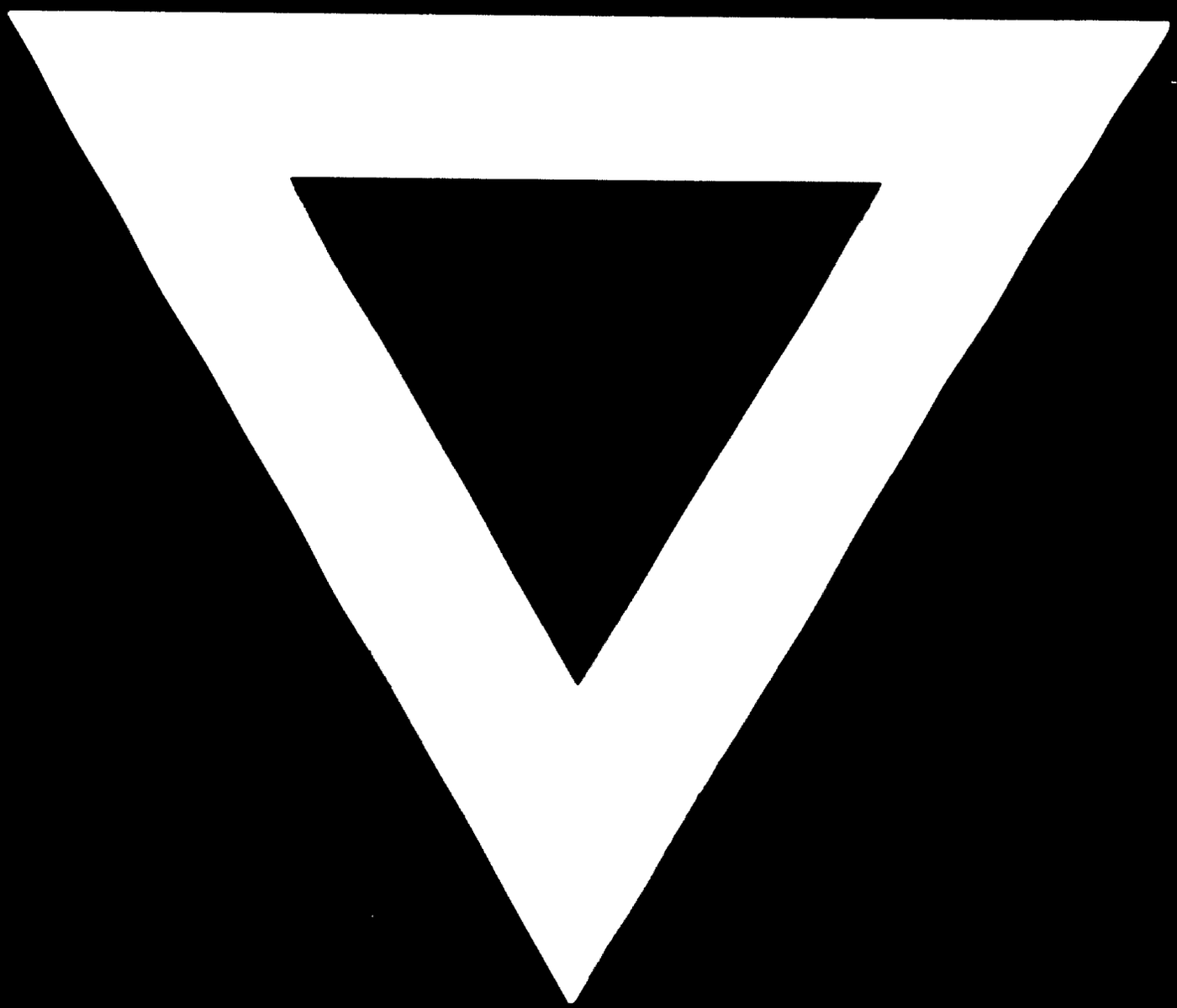

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