SOME ASPECTS OF DEPITTHING AND STORAGE OF BAGASSE IN CUBA

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ABSTRACT

A brief description of some of the most important characteristics of sugarcane bagasse as raw material emphasizing the increasing technical and economical importance of this fibrous material as a primary source for the development of a by-products industry under Cuban conditions.

At the same time the peculiarities of bagasse in its industrial utilization are emphasized which unlike other raw materials, requires fiber preparation including parenchymatous tissue or pith removal.

The development and current design trend of today's specialized equipment for this operation is mentioned. At the same time some remarks about Cuban experience are given.

In a general way the importance of storage of bagasse during the non-crop season is explained with comments about available systems in Cuban mills and prospects for modernization in different industries in the near future.

INTRODUCTION

Bagasse is the fibrous ligno-cellulosic waste resulting after the extraction of sugar from sugarcane. This fibrous residue has been subject for more than a hundred years of countless efforts aimed at its research and utilization, and today we can say it represents a great source of raw material technically suitable for the productions of pulp and paper, board, furfural, activated carbon, animal feed and other applications.

As a result of these efforts, rapid progress was made in the use of this raw material, as can be shown by the fact that in 1952 some 10 factories of pulp and paper and board used bagasse. Today, more than 15 countries have particle board plants, representing 13% of the production of non-wood fiber boards. For the five years 1980-85 it is expected that 1.2 million MT of bagasse (50% moisture content).
will be used to produce around 380,000 MT of particle boards. This, plus the fact that actually more than 1,000,000 MT of paper are produced annually from bagasse, and out of 35 furfural plants in the world 10 use bagasse with a capacity of 142,000 MT, show the increasing importance of this raw material, available in great quantities.

The economical importance of bagasse industrialization lies, basically, in the fact that from waste material commercial quality products can be obtained.

The extension of this economic potential depends on available quantities, industrialization cost, price of imported goods bagasse industry can replace, etc.

The potentiality of bagasse in Cuba as a base of a developing important by-products industry and at the same time the fact that bagasse is a traditional sugar industry energy source establishes a situation when analyzing the future development of industries from this raw material. This issue has been subject of discussion for many years.

Contributions, technological and economical research of ICIDCA (Cuban Research Institute for Sugar Cane Derivatives) have backed the use of bagasse for by-products production and investment efforts that Cuba is currently undertaking in this field. Productions derived from bagasse in Cuba will represent annually some 500 million which, together, could represent the second or third economical resource of our economy; potential use of bagasse is so big that is expected to replace wood in countries like Cuba that have practically non-existing wood reserves (Lois).

Fairly well known is the fact that between bagasse and other ligno-cellulosic material there are differences that, if not taken into account, would create serious difficulties in the by-products industrialization. The decisive differences are those related with preparation of bagasse as raw material: Depithing and storage.

DISCUSSION

Some Discussion on Bagasse

In the preparation of bagasse, prior to its use in by-products industries, the process by which the cane is crushed in the sugar mill should be considered. During the crushing process, the aim is to open apart the greatest number of juice cells and increase the bulk density of the material, to obtain maximum utilization of the sugar crushing capacity. All this reflects in the final particle size of bagasse and has great importance in the technological criteria of industries where parameters like fiber, slenderness, particle size distribution etc. are decisive to get desired properties in the final product. This is particularly valid in pulp paper and board.

In Cuba there are more than 15 different patterns for the preparation and crushing of cane.
The most common ones are shown in Table 1 (Lois³).

**TABLE 1. — Typical sugar cane preparation and milling schemes**

| Levellers sets | 1 | 1 |
| Knife sets     | 1 | 1 |
| Crushers       | 1 | 2 |
| Three-roller mills | 5 | 5 |

In our country, bagasse coming out of the mill, once sugar has been extracted from cane, represents 0.25 MT of bagasse (48% M.C.) per MT of cane and referred to sugar. It is around 2.3 MT moist bagasse for each metric ton of sugar produced.

Formerly, when a sugar mill was constructed, its design included the possibility of burning all bagasse produced; forcing the mill to be inefficient in energy utilization. By good energetic operation or improvement, up to 20-30% surplus bagasse can be obtained.

Data taken from Cuban experience in the 1968 sugar crop show the values (Lois⁴) related in Table 2.

**TABLE 2. — Data concerning bagasse production in Cuba (crop season year, 1968)**

<table>
<thead>
<tr>
<th>Bagasse Production</th>
</tr>
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<tbody>
<tr>
<td>Milled cane (MT)</td>
</tr>
<tr>
<td>Produced sugar (MT)</td>
</tr>
<tr>
<td>Produced bagasse (MT)</td>
</tr>
<tr>
<td>Bagasse (%) of cane</td>
</tr>
<tr>
<td>Fiber (%) of bagasse</td>
</tr>
<tr>
<td>Bagasse moisture (%)</td>
</tr>
<tr>
<td>Bagasse (%) burned as fuel</td>
</tr>
</tbody>
</table>

A number of physical properties of bagasse are unique for this material. In essence, bagasse is a mixture of hard fibers with soft, smooth parenchymatous (pith) tissue, with high hygroscopicity; in this mixture soil, wax, and other foreign substances coexist in variable quantities as well as certain amounts of residual sugar.

Some of these properties vary somewhat due to the cane varieties cropped, length of crushing season, harvesting methods, mill setting, mill roll wear, etc. All
this makes that the particle size properties of bagasse are by no means homogenous.

In a study of bagasse properties made during the 1974 and 1975 sugar crop seasons in a sugar mill supplying a bagasse pulp and paper mill in Cuba, the following average values (Rodriguez) were obtained and are shown in Table 3.

**TABLE 3.** Average quality values of whole bagasse obtained in 1974 and 1975.

<table>
<thead>
<tr>
<th>Crop season</th>
<th>1974</th>
<th>1975</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber (%)</td>
<td>66.83</td>
<td>68.03</td>
</tr>
<tr>
<td>Pith (%)</td>
<td>21.05</td>
<td>19.61</td>
</tr>
<tr>
<td>Fines and solubles (%)</td>
<td>12.04</td>
<td>12.35</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>47.76</td>
<td>49.67</td>
</tr>
</tbody>
</table>

The two technological aspects most related to bagasse as raw material are the operations of depithing and storage.

The first of them is based on the negative effect that, as undesirable component, pith, need to be removed. The second arises from the seasonal nature of the sugar industry (Lois). Normally, the grinding season lasts between 3 to 6 months while the by-products industry produces the entire year.

**Bagasse Depithing**

The depithing method is highly related to the final use of bagasse and also with the way it will be stored during the non-crop season. As known, the different methods have been classified according to the water content in bagasse: dry, moist, wet, and combinations of these methods.

In bagasse particle board, in general, current practice is to have a first stage depithing prior to storage, although so far there has not been a uniform conclusion on the amount of pith removal necessary in this type of industry and as a rule the same concepts valid for pulp and paper have been applied. In this last one, mainly for the production of high quality papers, the approach of moist depithing, followed by bulk storage and final wet depithing is widely established.

Although in Cuba there is no actual experience of this type of depithing, due to the wide acceptance of the method, both in the Cuba-9 Project already in trial and a new writing and printing mill a moist depithing followed by wet depithing sequence is provided.

In wet fiberboard method, owing to the similarity with the pulp production methods, depithing requirements are practically the same.

When pith is separated, the question of the best way to dispose of it arises.
Production of molasses-urea-pith mixture for cattle feed has had increasing importance in recent years, and today more than 60 sugar mills in Cuba supply quantities of this nutritionally valuable product. In the 1978 sugar crop 250,000 MT of mixture were produced and production goal for 1979 is 1,000,000 MT.

Besides its utilization as animal feed, separated pith can be burned in the sugar mill furnaces, provided that these are modified accordingly to burn either oil, bagasse or pith.

Today, depithing no longer constitutes a complex problem, and there exist in many countries reliable and thoroughly tested equipment in both cellulose and board industries (Atchison², Lois³). These range from conventional screens to hammer mill depithers including hydrapulpers and washing equipment.

Greatest interest is focused in hammer mill depithers because of their great development.

According to their mechanical conformation they can be classified in a) vertical rotor depithers, and b) horizontal rotor depithers.

Latest development show an increasing trend to use more often the vertical solution with centrifugal self-separation (Lois³), through a perforated plate surrounding the rotor permitting bigger processing capacities. Fig. 1 shows a typical equipment of this kind.

**FIGURE 1.** Depither with vertical rotor
Some manufacturers have already available in the market machines with an inlet capacity of 400 bone dry metric tons of bagasse per day, and installed machine power of 300 kw, amply surpassing typical rates for horizontal rotor machines with self-separation which is on the order of 120 MT per day, requiring additional screening facilities to get separations in the 30-35% range.

Table 4 shows examples comparative capacities for the case of a bagasse plant requiring depithing of around 1,260 BDMT per day

TABLE 4. Comparative capacity indexes for depithers

<table>
<thead>
<tr>
<th>Capacity Index</th>
<th>Vertical rotor</th>
<th>Horizontal rotor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bagasse throughput (BDMT/day)</td>
<td>1,260</td>
<td>1,260</td>
</tr>
<tr>
<td>Quantity of equipment to be installed</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Total installed power, kw. (Without auxiliary equipment)</td>
<td>1,150</td>
<td>1,015</td>
</tr>
</tbody>
</table>

In Cuba most of the experience has been with horizontal rotor, forced feed, partial self-separation depithers combined with screens, with a total installed capacity in the country of 1,200 BDMT/day for moist depithing with a depithing rate of 30-35%. Fig. 2 shows a horizontal double rotor depither with pneumatic extraction.

FIGURE 2. Depither with horizontal rotors
Currently vertical rotor units are being installed for new board and paper investments with a total feeding capacity of around 5,600 BDMT/day of whole bagasse, and according to preliminary trials, separations of 35-40% of incoming material are expected. Fig. 3 shows a typical installation of a vertical rotor depither.

Bagasse Storage

Save a few exceptions in the world, most sugar factories operate only part of the year, frequently form 100 to 200 days. This forces bagasse consuming industries to store great quantities of bagasse during non-crop periods. Cuba belongs to the group that collects sugarcane some 150-180 days, that is from December to May, when rains usually interrupt harvesting. This makes it necessary to store bagasse for the period from June to November.

The storage method selection to be employed in by-products industries is an important and complex decision, due to its high incidence in investment and production costs, and also for the variety of available alternatives.

Undoubtedly in recent years great progress has been achieved in the design of new storage methods, (Lois and Atchison) although it is regretable that from a technological point of view there is not enough information to make a comparative evaluation on a concrete basis of all available alternatives.

Descriptions of existing systems can be found in the literature (Lois and Rodriguez) where generally opinions about advantages and disadvantages of each case are pointed out. We will refer briefly to the existing storage methods in Cuba and these to be implemented in the next years. Before, we must say that in general
Storage methods can be classified in two great groups: bale storage and bulk storage systems. Although for each case variations exist, we can consider the main alternatives as:

For Bale storage:
- a) Without previous drying of bagasse
- b) With previous drying of bagasse

For Bulk storage:
- a) With microbiological treatment
- b) Without microbiological treatment

It is generally agreed that the current trend in fiber board, pulp and paper industries favor bulk storage methods, although the use of microbiological treatment is widely discussed. Regarding baling methods, they are still commonly used for such industries as particle board and furfural where a dry raw material is required.

The actual situation of bagasse consuming plants in Cuba will change in the next years as new investments come on stream. Up to 1975, Cuba had basically bale storage systems for their bagasse based industries.

Until recently, existing board plants used mainly bales without previous drying.

Baling was made in national construction machines, with bales of around 115 kg and 800 x 600 x 400 mm size. The bale was made with 50% moisture content bagasse, this figure decreasing to an equilibrium value of 10-12%. This type of bale, with semi-automatic wiring, has great labor costs, and high storage losses.

Pulp and paper industry from bagasse has two plants operating with bales as the board mills operating with fresh bagasse during the grinding season, and storing the surplus bagasse for the non-crushing season.

One notable exception is the Guillermo Geilin (Tecnica Cubana) mill in Cardenas, province of Matanzas. This mill takes from storage all bagasse it processes. Storage is made in bulk with water irrigation of the pile. This factory has operated with this system with remarkable success for many years despite room for improvement in areas such as the lack of an adequate surface for the base of the pile, introducing foreign matter and increasing losses, inadequate channeling system to collect pile drainage and irrigation system.

As part of new investments for bagasse based industries, storage methods will be improved.

In three new particle board mills, baling method will be used, but using predrying up to 17-20% dryness. At the same time the bale size will be increased to 1,800 x 850 x 750 mm and around 410 kg. weight.

Bale wiring and stocking systems have been improved. Pre-drying of bagasse avoids fiber deterioration by fermentation and prevents fire risks due to self-ignition.
In the only existing bagasse semi-wet fiber board mill a wet bulk storage system will be employed.

New investments in the paper industry include changing from the previous bale storage methods to wet bulk methods. In some cases bagasse distribution in the pile will be made through an overhead conveyor along the pile. Tecnica Cubana mill bagasse yard will also be modified, mechanizing processes and improving irrigation. The new 200 MT per day bleached writing and printing paper near Sugar Mill "Uruguay" will also have a wet bulk storage system.

Although, as so far mentioned, the most widely employed method will be wet bulk, due to the ever increasing importance conceded now in Cuba to storage methods a bagasse pile of both research and industrial purposes has been constructed for the "Cuba-9" Project. This pile, which started successfully operations during the 1979 crop, has a microbiological system for preparation of liquor, that permits comparative evaluations in the same pile of several preserving agents, from water to microbiological liquors, and determine its effect in the properties of different grades of papers.

This shows the great concern in Cuba regarding research in this aspect of the preparation of bagasse. Table 5 shows how both the quantitative and qualitative composition of storage methods in Cuba will change in the next year.

### TABLE 5. Bagasse storage capacities in Cuba (Thousand BDMT/year)

<table>
<thead>
<tr>
<th></th>
<th>Bales</th>
<th>Bulk</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1976 figures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particle and fiber board:</td>
<td>65.0</td>
<td>-</td>
<td>65.0</td>
</tr>
<tr>
<td>Pulp and paper:</td>
<td>48.5</td>
<td>100.0</td>
<td>148.5</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>113.5</td>
<td>100.0</td>
<td>213.5</td>
</tr>
<tr>
<td><strong>1980 figures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particle and fiber board:</td>
<td>205.0</td>
<td>15.0</td>
<td>220.0</td>
</tr>
<tr>
<td>Pulp and paper:</td>
<td>-</td>
<td>209.0</td>
<td>209.0</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>205.0</td>
<td>224.0</td>
<td>429.0</td>
</tr>
</tbody>
</table>

**REFERENCES**

ALGUNOS ASPECTOS DEL DESMEDULADO Y ALMACENAMIENTO DE BAGAZO EN CUBA

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RESUMEN

Se hace una breve descripción de algunas características importantes del bagazo de la caña de azúcar como materia prima exponiendo la importancia técnico-económica que ha ido cobrando cada vez más este material fibroso como base para el desarrollo de una importante industria de derivados en las condiciones de Cuba.

Asimismo se resaltan las particularidades del bagazo en su aprovechamiento industrial a diferencia de otras materias primas lo que obliga a una preparación de fibras que implica una remoción de tejido parenquimatoso o medula. Se mencionan el desarrollo y tendencias actuales en equipos especializados para esta operación dando a su vez algunos criterios basados en la experiencia de Cuba.

De forma general se refleja la importancia del almacenamiento del
bagazo para el período de no-zafra y a la vez se exponen algunas consideraciones sobre los sistemas empleados actualmente en las fabricas cubanas y las perspectivas del futuro inmediato para los distintos tipos de industrias.