CANE SLICING, A NEW APPROACH TO EXTRACTION AND JUICE PURIFICATION

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ABSTRACT

A new process for extraction and juice purification was described, using results from a 150 TCD plant experiment. The cane was sliced first. Slices were then extracted in a continuous countercurrent diffuser and dewatered in a doublescrew press. Muds from the clarification process were recycled through the diffuser eliminating the mud filtration equipment.

The process offered a reduction in power consumption by 30-40 percent. Investment and maintenance costs can also be reduced. Extraction yields were high and the quality of diffuser juice was close to that of a normal first expressed juice.

INTRODUCTION

Many distinguished authors have been concerned with the relation between cane preparation and extraction yield (Payne1,2,3, Bruniche Olsen4,5, Townsley and Cheatham6, Diaz-Compain7, Tantawi8, Foster and Shann9). In the pursuit of maximum extraction figures as high as 99.6% have been claimed (Diaz-Compain7) as a result of extremely fine preparation. The effects of temperature, pH and retention time on extraction of impurities have been treated by several authors, and suitable ranges for these parameters have been established Weng and Bruniche-Olsen10, Bjerager and Bruniche-Olsen11, Loft12, Fitzgerald and Lamusse13, and Sayed et al.14).

However, the possibilities of realizing a purity gain by conversion to diffusion, similar to that experienced in the beet industry do not seem to be exhausted. It has been suggested that higher extraction in a diffusion process as compared to conventional milling could be counteracted by a decrease in boiling house recovery.

Using the experience gained in the beet industry, the obvious way of preparing cane for real diffusion is slicing the cane sticks perpendicular to their axis to obtain slices a few millimetres thick, wherein the natural structure of the cane

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tissue is largely preserved. Cane preparation of this nature has been known in Egypt for several decades (Tantawi\textsuperscript{8}), but was discarded due to mechanical problems and unsatisfactory performance in connection with batch diffusion. Today, however, slicing of cane and extraction of the slices in a continuous diffuser do not present any mechanical obstacles whether operating on chopped cane or whole sticks.

Recycling of clarifier muds to the extraction section is known in conventional milling as the Petree process which was used to a considerable extent in the 1920-30 period, but was discarded due to its detrimental effect on feeding at the final mill (Jenkins\textsuperscript{15}). Liming and recycling of muds have also been tried in conventional diffusion with no aggravating effects on juice quality (Payne\textsuperscript{3}, Weng and Bruniache-Olsen\textsuperscript{10}).

**EXPERIMENTAL PROCEDURE**

The experimental plant was designed to process 6-7 tons cane/hr. A flow sheet is shown in Fig. 1. The plant consists of the following units:

- b) DDS Cane Diffuser
- c) Screw Press
- d) Heater
- e) Liming System
- f) Clarifier

The sugarcane was loaded mechanically into the cane carrier, which took the roughly parallel cane sticks directly to the cane slicing machine. The sticks were cut in slices of 2-3 mm thickness at an angle of 60-90° to their axis. Fig. 2 shows typical sliced cane preparation. As will appear, the slices have been broken into smaller pieces or segments as a result of the mechanical stress in the slicing machine. Fig. 3 shows the preparation before breaking takes place.

![Flow Sheet for Pilot Plant](image-url)

**FIGURE 1.** Flow Sheet for Pilot Plant
The cane slices were taken by belt-conveyor to the silo of the diffuser, the filling of which was controlled by starting and stopping the cane carrier. The diffuser is a modified type of the well-known DDS Cane Diffuser. The bagasse discharged from the diffuser contained 80-85% moisture and was dewatered either by a 3-roller mill or by a double-screw press. The dewatered bagasse was used as fuel. Presswater from mill or press underwent no screening or other treatment before it was added to the diffuser at a place where the brix of presswater and that of diffuser juice coincided. Hot freshwater was added to the bagasse end of the diffuser and was conveniently supplied by condensate from the last effects.

The diffuser juice was heated to boiling before liming and settling took place in a clarifier. The muds from the clarifier were added to the diffuser at a point 2.75 m from the juice outlet. The moving bagasse bed in the diffuser acted as a filter and the mud solids were carried away with the final bagasse. This procedure which eliminates the traditionary rotary filters was made possible by the slice preparation and the use of a screw press for dewatering.

During the experimental periods the mechanical ability of the machinery has been surveyed very closely and necessary modifications have been made. Various operating conditions have been tested in order to examine capacity, power consumption, juice quality and influence of draft, temperatures and cane preparation.

RESULTS AND DISCUSSION

Mechanical operation of the diffuser was satisfactory with no tendencies of chanelling or flooding of juice. The cane slicing method seems to combine fineness of preparation with good permeability due to the uniformity of preparation. The permeability was preserved even though clarification or screening of presswater return was completely omitted.

Evaluation of juice quality has been done by comparison with the milling/bagasse diffusion factory to which the pilot plant was attached. Widely varying quality of cane has been these comparisons difficult, but by comparing juices originating from the same lots of cane it can now safely stated that the purity of juice from slicing/diffusion was significantly higher than purity of mixed juice from milling/diffusion and slightly lower than purity of the first expressed juice.

One possible explanation of this is the conservation of natural structure in the cane slices. It is to be expected that the breaking of slices into smaller segments mainly occurs along the soft-walled parenchyma storage cells, thus leaving the vascular bundles supposed to contain low purity juice, intact.

Pol extraction averaged 95% at a draft of 100%, but seemed to be rather insensitive to the draft, as visualized in Table 1. This opens up the possibility of reducing steam consumption at the evaporators by 5-10% by sacrificing only 1% in extraction. The feasibility of operating in such a manner is a function of the overall steam balance of the factory and should be assessed in each individual
case. Anyhow, the ability of the diffuser to work satisfactorily under varying conditions brought about by unskilled manpower seems to be a major advantage in practical application of cane slicing.

**FIGURE 2.** Cane slices to diffuser

**FIGURE 3.** Selected cane slices
I. Example of daily average results.

<table>
<thead>
<tr>
<th>Tons cane/h</th>
<th>6.6</th>
<th>8.2</th>
<th>7.1</th>
<th>9.2</th>
<th>6.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pol % cane</td>
<td>11.85</td>
<td>11.57</td>
<td>11.10</td>
<td>11.92</td>
<td>12.65</td>
</tr>
<tr>
<td>Pol % juice</td>
<td>11.67</td>
<td>13.42</td>
<td>12.73</td>
<td>11.11</td>
<td>12.31</td>
</tr>
<tr>
<td>Pol % bagasse</td>
<td>2.73</td>
<td>2.84</td>
<td>2.57</td>
<td>2.37</td>
<td>2.32</td>
</tr>
<tr>
<td>Moisture % bagasse</td>
<td>44.6</td>
<td>42.5</td>
<td>48.0</td>
<td>45.6</td>
<td>41.8</td>
</tr>
<tr>
<td>Bagasse % cane</td>
<td>26.1</td>
<td>25.1</td>
<td>27.8</td>
<td>26.4</td>
<td>24.5</td>
</tr>
<tr>
<td>Draft %</td>
<td>95</td>
<td>81</td>
<td>82</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Extraction %</td>
<td>94</td>
<td>94</td>
<td>94</td>
<td>95</td>
<td>96</td>
</tr>
</tbody>
</table>

Cane varieties NC076 and Co 421

Recycling of clarifier muds had a marked effect on juice purity and pH along the diffuser, as seen from Fig. 4. These effects diminished towards the juice outlet to a point, where there was no significant difference between diffuser juice with or without mud recycling. Analysis of diffuser juice colloids indicated no increase in extraction of starch, pectins, or gums, which could otherwise hamper operations in the boiling house.

**FIGURE 4.** Analyses of diffuser juice at various points along the DDS-diffuser
The main objective of mud recycling, namely to complete elimination of filtering equipment, has thus been achieved with no adverse effects. On the contrary, an increase of 20% in screw press capacity was noted.

Bearing in mind the experience from the Petree process, this is probably to be explained in terms of the pH rise in presswater rendering the bagasse more slippery and thereby less suitable for milling but well suited for the screw press. This is in accordance with other findings (Farmer).18

The small double-screw press installed in the pilot plant produced 300 kg/h bagasse with an average moisture of 45%. Power consumption was around 25 kW/tfh. However, both capacity and power consumption varied with the quality of cane. Specific power consumption is expected to drop with presses of larger capacities. Compared to trial runs with milling/diffusion bagasse, power consumption was considerably lower when passing bagasse of sliced cane.

Apart from this, sliced cane eliminated any tendencies to choke and feeding difficulties in the press, thus giving a smooth operation with no need of supervision.

CONCLUSION

The special uniform, short fibered cane preparation was well-suited for extraction in a DDS Cane Diffuser. It gave a higher purity than by milling/diffusion. At the same time, good extraction was maintained.

The draft can vary between 85-110% with only a small effect on the extraction which varies between 94-96%.

The presswater can be recirculated without treatment.

The bagasse was better suited for screw presses than mill-bagasse.

Recycling of clarifier muds had no influence on the juice quality, but it eliminated rotary filters and increased the press capacity by approximately 20%.

The plant is less sensitive than a mill-train to variations in the processing rate which can vary between 5-9 TCH.

The whole plant had a very simple construction compared to conventional mill processing and had the following advantages:

1) Reduced power consumption by approximately 30-40%.
2) Reduced investment
3) Reduced maintenance
4) Easier operation & consequently savings in labor
REFERENCES


REBAÑADO DE LA CAÑA, UN NUEVO METODO DE EXTRACCION Y PURIFICACION DEL JUGO

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RESUMEN

Se describen experimentos llevados a cabo en una planta piloto de 150 TCD con un nuevo proceso para la extracción y purificación del jugo. La caña se prepara rebanando y la extracción se hace en continuo a contracorriente desaguando el bagazo en una prensa de doble helice. La cachaza del proceso de clarificación es recirculada al difusor eliminando así el equipo de filtración.

El proceso permite una reducción en el consumo de fuerza de 30 a 40 por ciento. También son menores la inversión requerida y el mantenimiento. El nivel de extracción es elevado y la calidad del jugo extraído es muy similar a la del jugo de primera extracción de un molino convencional.