MODIFICATIONS TO CANE CARRIERS AND KNIVES TO IMPROVE EXTRACTION AT MONTELIMAR, NICARAGUA

Rodolfo Schaer
Central de Ingenios y Anexos Managua, Nicaragua

ABSTRACT

Modifications are described to cane carriers and knives to improve cane preparation. It is considered that the preparation is now good enough for operation of the diffuser without a pre-extraction mill and this will be tried next season.

Changes made to dewatering equipment are also reviewed. They have enabled the factory to operate with only one dewatering mill.

Data for power consumption, maintenance, labour cost and thermal efficiency of the factory are given. Results listed for the last 6 years with mills and the past 7 years with a diffuser show better extraction and recovery with the diffuser.

INTRODUCTION

An Egyptian type BMA diffuser was installed at Montelimar in 1965. To be on the safe side, the diffuser was preceded by a 3-roller crusher.

The present installation is shown schematically in Fig. 1 and consists of:

a) Two feeder tables, where the cane is also washed. One handles mechanically loaded cane and the other cane in bundles.

b) Two cane conveyors, 2 000 mm wide, the first with a set of 36 knives and the second with a set of 64 knives. Both sets are driven by electric motors and the second set is fitted with a commutator switch for reversing the direction of rotation.

c) One 3-roller crusher 890 × 2 000 mm driven by a 600 HP steam turbine.

d) One BMA cane diffuser with fixed screens over which a drag conveyor pulls the bagasse. The diffuser has 10 washing stages and a pre-dewatering device.

e) One dewatering mill 880 × 1 880 mm driven by a 600 HP steam turbine.

f) One continuous automatic bagasse weigher.

g) One automatic imbibition water scale.

h) One automatic mixed juice scale.

The juice from the crusher carries more impurities into the factory than the diffuser juice and an endeavour is being made to eliminate the crusher. In order to do this it is necessary to obtain adequate preparation with only 2 sets of knives and limited power consumption.

The efficiency of the diffuser pre-dewatering device has been improved to the extent that it has been possible to eliminate one of the 2 dewatering mills which was installed in 1965.
IMPROVEMENTS IN CANE PREPARATION AND EFFECT ON DIFFUSER PERFORMANCE

Analytical Procedure

The degree of cane preparation achieved after the 2 sets of knives was evaluated using the following method:

Samples of about 30 kg of prepared cane were taken from the cane conveyor after the second set of knives and were screened through square boxes 850 x 850 mm and 200 mm high fitted with screen bottoms. The 3 boxes used had screens of 80 x 80, 25 x 25 and 10 x 10 mm.

Pieces of cane that did not pass through the 80 x 80 mm screen were called “coarse”, those that stayed on the 25 x 25 mm screen were considered to be “medium”, those remaining on the 10 x 10 mm screen were “fine” and those that passed through this last screen were “very fine”.

Experimental

Different steel covers were used on the hood of the second set of knives. Some were elliptic and others circular in shape and they were tried in different positions with respect to the knives shaft (Fig. 2). Sight glasses were fitted to the side walls of the second knife set to observe results (Fig. 3).

The effect of the direction of rotation of the second knives set was also evaluated with power measurement of both the cane conveyor and of the knives being recorded. These tests were first started in 1967 when both sets of knives were on the same conveyor and were continued into 1973 when each set of knives was on a different conveyor.

Attempts were made to estimate results which would be obtained if the cane was sent directly to the diffuser.
RESULTS

Test A:
Both sets of knives on the same conveyor and rotating with the flow of cane.
Screen tests:
   Coarse  34%
   Medium  40%
   Fine    15%
   Very fine  11%
No percolation problems in the diffuser.
Pol in bagasse 1.55 — 1.60 at a draft of about 98.
The preparation was obviously too coarse for straight cane diffusion.

Test B:
First set of knives running with, and second set against, the flow of cane.
Screen test: Coarse 11\%
Medium 20\%
Fine 42\%
Very fine 27\%

Power consumption: Cane carrier — same as for Test A.
Knives — 56\% higher than for Test A (see Fig. 4).

Almost no percolation difficulties when operating with the diffuser preceded by a mill.
Pol in bagasse 1,50 — 1,56 at a draft of about 96.

Results with straight cane diffusion were fairly good but not good enough for industrial operation.

FIGURE 4. Power consumption of the cane conveyer and the 2nd set of cane knives. With knives running with and against the flow of cane.

Test C:
Each set of knives on a separate conveyor and both sets rotating with the flow of cane.

Screen test: Coarse 16\%
(Fig. 5) Medium 33\%
Fine 27\%
Very fine 24\%

Almost no percolation problems were experienced with the diffuser operating on bagasse from the first mill.
Pol in bagasse 1,40 to 1,56 at a draft of 98.
FIGURE 5. Screening Test "C". 2 cane conveyors on each one 1 set of knives, both running with the flow of cane.

FIGURE 5b. Cane preparation at Test "E"
Test D:
Each set of knives on a separate conveyor as for Test C but the first set running with and the second set against the flow of cane.
Screen test:
- Coarse 13%
- Medium 28%
- Fine 31%
- Very fine 28%
Power consumption: Cane carrier: same as for tests.
Knives: 52% higher than for Test C.
Percolation and pol in bagasse was the same as for Test B.

Test E:
Same conditions as for Test D except for an adjustable circular hood over the second set of knives instead of the elliptical steel hood used for Test D.
Screen test:
- Coarse 14% (Fig. 8)
- Medium 42% (Fig. 5B)
- Fine 30% (Fig. 5B)
- Very fine 14%
Power consumption: Cane carrier as for Test C.
Knives: 52% higher than for Test C.
This test produced the best results of all. Average power consumption was 8.56 ihp/tfh (Fig. 6) at the second knife set. Cane is shredded by the knives against the circular steel hood (Fig. 7). It can be seen, through the sight glass, that part of the cane is churned between the hood and pitch circumference of the knives while another part is carried over by the knives. Only a small fraction of the cane passes underneath the knives.
The best results were obtained with the following setting of the circular hood.
\[
\frac{\text{Radius of knives set}}{\text{Radius of hood}} = 0.78
\]
Clearance between front of hood and knives pitch circumference = 0.1 x pitch radius of knives.
A test of the installation with the front mill by-passed will be carried out early in 1974 and it is hoped that the results will be available for presentation at the XV ISSCT Congress.

FIGURE 6. Knife Test "E": 2nd Knife Set with Circular Hood, running against the flow of cane (see above).
When the diffuser was commissioned in 1966, it was fitted with 3 dewatering drums rotating on the bagasse bed at the discharge end of the diffuser. The first drum was 2 m in diameter and had a partially perforated surface. The 2 smaller drums were 1.2 m in diameter and were not perforated. The drums were driven by an 8 hp electric motor synchronised with the speed of the bagasse mat in the diffuser.
Some juice was squeezed into the large drum through the perforations and was withdrawn by a steam ejector. Part of the juice was also pressed off through the perforated walls of the diffuser.

During the first season, the holes in the large drum were sealed and the 3 drums were filled with water. This was a big improvement and enabled the second dewatering mill to be by-passed. Later the first drum was replaced by one 3 m in diameter and the 2 smaller drums were removed for simplicity and to save space.

Moisture determinations were carried out by drying to constant weight and the following results were obtained:

- Moisture content of diffuser bagasse with the 3 dewatering drums filled with water: 68-72%.
- Moisture content after the single 3 m diameter drum: 68-72%.
- Moisture content of final bagasse after the single 880 x 1 880 mm dewatering mill: 49-52.5% depending on roller conditions.

No trouble was experienced in burning this bagasse at the boilers and the mill's steam balance is so satisfactory that with 14% fibre in cane it is possible to supply power to the town and for irrigation and to provide process steam for both white and raw sugar production using only bagasse as fuel.

**Power and steam consumption of extraction plant**

- **Power:**
  - Cane feeding and washing tables: 110 hp
  - Cane conveyors: 44 hp
  - Cane knives (both sets): 310 hp
  - Crusher and dewatering mill: 705 hp
  - Diffuser: 295 hp

Total: 1 465 hp

- Steam for heating in the diffuser: 6 910 kg @ 0.8 kg/cm²

Since the factory capacity is 100 tons of gross cane per hour the steam and power consumption per ton of cane can be easily calculated.

**MAINTENANCE AND LABOUR COSTS**

These costs are broken down into materials and labour and are reported separately for each major unit of the extraction plant. Labour costs have been further broken down into season and off-season.

All costs are expressed per 100 tons of gross cane.

**Maintenance**

<table>
<thead>
<tr>
<th>Material</th>
<th>U.S.$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-roller crusher</td>
<td>2.73</td>
</tr>
<tr>
<td>Diffuser</td>
<td>0.78</td>
</tr>
<tr>
<td>Dewatering mill</td>
<td>1.73</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>5.24</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lubricants-crusher + dewatering mill</th>
<th>U.S.$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuser</td>
<td>0.73</td>
</tr>
<tr>
<td>Diffuser</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>0.77</strong></td>
</tr>
</tbody>
</table>
Labour

<table>
<thead>
<tr>
<th></th>
<th>Mills and diffuser</th>
<th>Amount attributable to diffuser.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off season-crusher + dewatering mill</td>
<td>U.S.$ 1.75</td>
<td></td>
</tr>
<tr>
<td>Diffuser</td>
<td>U.S.$ 0.43</td>
<td></td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>U.S.$ 2.18</strong></td>
<td></td>
</tr>
</tbody>
</table>

Season

<table>
<thead>
<tr>
<th></th>
<th>Mills</th>
<th>Diffuser</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 foreman</td>
<td>U.S.$ 1.02</td>
<td>U.S.$ 0.34</td>
<td></td>
</tr>
<tr>
<td>1 man at control panel</td>
<td>U.S.$ 0.82</td>
<td>U.S.$ 0.28</td>
<td></td>
</tr>
<tr>
<td>2 men at crusher</td>
<td>U.S.$ 1.06</td>
<td>U.S.$ 0.16</td>
<td></td>
</tr>
<tr>
<td>2 men at dewatering mill</td>
<td>U.S.$ 1.06</td>
<td>U.S.$ 0.16</td>
<td></td>
</tr>
<tr>
<td><strong>Totals:</strong></td>
<td><strong>U.S.$ 3.96</strong></td>
<td><strong>U.S.$ 0.94</strong></td>
<td></td>
</tr>
</tbody>
</table>

Total cost of mill + diffuser (labour and maintenance) per 100 tc was $12,15, of which the cost of the diffuser was only $2,19.

**EFFECT OF DIFFUSER ON FACTORY PERFORMANCE**

The figures listed in Table 1 show the effect of the diffuser on the factory sucrose balance. Total losses % cane have gone down from 3 128 during the last 6 years with mills to 2 313 during the past 7 years with a diffuser. During the same periods recovered sugar has increased from 8 862 to 9 627 for cane with almost exactly the same sucrose content.

The sucrose balance of Montelimar factory is also shown graphically in Table 2.

**TABLE 1.** Sucrose balance (expressed in sucrose % cane).

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Mills</td>
<td>0.969</td>
<td>0.484</td>
<td>0.496</td>
</tr>
<tr>
<td>Diffuser</td>
<td>1.863</td>
<td>1.922</td>
<td>1.747</td>
</tr>
<tr>
<td>Lost in bagasse</td>
<td>0.043</td>
<td>0.020</td>
<td>0.021</td>
</tr>
<tr>
<td>Diffuser</td>
<td>0.235</td>
<td>0.107</td>
<td>0.059</td>
</tr>
<tr>
<td>Undetermined</td>
<td>3.128</td>
<td>2.533</td>
<td>2.313</td>
</tr>
<tr>
<td>Recovered sugar</td>
<td>8.862</td>
<td>9.505</td>
<td>9.627</td>
</tr>
<tr>
<td>Sugar in cane</td>
<td>11,990</td>
<td>12,038</td>
<td>11,949</td>
</tr>
</tbody>
</table>

Lost time logged to the diffuser during the last season was 0.007 3 hours/100 t cane.

**CONCLUSIONS**

Tests carried out show that cane preparation is improved when the second set of knives rotates against the flow of cane.

Having the 2 knives on 2 different conveyors gives similar results if both sets run with the cane and the preparation is the same whether 1 or 2 conveyors are used if the second set runs against the flow of cane, using normal hoods on the knives.
TABLE 2. Sucrose balance of the Montelimar Sugar Mill, Nicaragua.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mills Sucrose % cane</td>
<td>11,990</td>
<td>12,038</td>
<td>11,940</td>
</tr>
<tr>
<td>Diffuser Extraction</td>
<td>91,92</td>
<td>95,98</td>
<td>95,93</td>
</tr>
<tr>
<td>Diffuser Sucrose in bag % cane</td>
<td>8,862</td>
<td>9,505</td>
<td>9,630</td>
</tr>
<tr>
<td>Sucrose losses % cane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with 14% Fiber and 12% sucrose in cane</td>
<td>0,484</td>
<td>0,486</td>
<td></td>
</tr>
<tr>
<td>in bagasse</td>
<td>0,969</td>
<td>1,922</td>
<td>1,747</td>
</tr>
<tr>
<td>in final molasses</td>
<td>1,863</td>
<td>0,020</td>
<td>0,021</td>
</tr>
<tr>
<td>in filter muds</td>
<td>0,043</td>
<td>0,107</td>
<td>0,059</td>
</tr>
<tr>
<td>undetermined</td>
<td>0,233</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sucrose in bag % sucrose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in cane</td>
<td>73,91</td>
<td>78,95</td>
<td>80,63</td>
</tr>
<tr>
<td>Sucrose losses % sucrose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in cane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in bagasse</td>
<td>8,08</td>
<td>4,09</td>
<td>4,05</td>
</tr>
<tr>
<td>in final molasses</td>
<td>15,54</td>
<td>15,97</td>
<td>14,63</td>
</tr>
<tr>
<td>in filter muds</td>
<td>0,36</td>
<td>0,17</td>
<td>0,18</td>
</tr>
<tr>
<td>undetermined</td>
<td>2,11</td>
<td>0,88</td>
<td>0,49</td>
</tr>
</tbody>
</table>

An eccentric circular hood over the knives with a narrow gap between the hood and pitch circumference of the knives has led to marked improvements in preparation when running against the flow of cane. Although screening tests have shown that there is still 14% coarse pieces, these were observed to be smaller and better prepared. The "very fine fraction" was also lower than for other tests and was always below 25%. No percolation problems were noted in the diffuser and it is proposed in 1974 to run the diffuser with this type of preparation and without pre-extraction mill.

Pre-dewatering with only one large drum in the diffuser has given excellent results.

Mechanical power consumption of the extraction plants is much lower than with mills only. Steam consumption is about 32% higher at the extraction plant but causes no problem as the factory has a bagasse surplus.

Maintenance cost of the diffuser is much lower than that of the mills. The higher cost for materials for the new crusher compared to the old dewatering mill can be attributed to reduced wear of the rollers, scrapers and trash turners due to the higher pH of diffuser bagasse.

Lost time due to breakdown has been shown to be very low for the diffuser.

On top of this sugar recovery has also been higher and the balance of 8 years of work with the new installation is really positive.

MODIFICACION EN LOS CONDUCTORES DE CAÑA Y EN LAS CUCHILLAS CAÑERAS PARA MEJORAR LA EXTRACCION EN MONTELIMAR, NICARAGUA

Rodolfo Schaer

RESUMEN

Se describen modificaciones hechas en los conductores de caña y en las cuchillas cañeras para mejorar la preparación de la caña. Creemos que la preparación de la caña ahora es lo suficientemente buena para trabajar.
el difusor existente sin el molino de preextracción. Se harán pruebas trabajándolo así en la próxima zafra.
Se informa sobre los cambios hechos en el equipo de presecamiento dentro del difusor. Ellos permiten que la fábrica trabaje con solo un molino desaguador.
Se dan datos sobre gastos de energía, de mantenimiento, de mano de obra y sobre la eficiencia térmica de la fábrica. En una tabla aparecen los resultados de 6 zafra en molinos antes de instalar el difusor y de las 7 zafra con el difusor, que desmuestran mejor extracción y—recuperación con el difusor.