IMPROVING THE QUALITY OF SUGAR CURED BY TWO CONTINUOUS A-CENTRIFUGALS

By

L. WONG SAK HOI, S. JOORIA and S. TSE CHI SHUM
Mauritius Sugar Industry Research Institute

Abstract

With the coming into operation of two continuous A-centrifugals FCB FC 1000 at Union St Aubin factory, sugar quality often did not conform to specifications. The situation improved after corrective measures were taken to regulate and increase massecuite throughput to the centrifugals, optimise wash water used, and ensure evaporative cooling of the cured sugar in the dryer. The centrifugals successfully produce raw sugar meeting specifications without having to resort to modifying the centrifugals or to automate the dryer.

Introduction

Two continuous centrifugals each of 12 t/h were installed at Union St Aubin in 1997 to replace two old batch machines. The quality of the product sugar was often outside specifications, which stipulate a polarisation above 98.0°. Between 98.0° and 98.5° polarisation, the dilution indicator (DI) must be within 25-40 and, above or at 98.5° polarisation, the DI must be between 25-45. A penalty system is applied if the sugar quality falls outside these limits.

Characteristics of the continuous centrifugals and of the dryer

The two 1000 mm diameter continuous centrifugals FCB FC1000, rotate at 1260 r/min and operate in parallel. They are fed by a common pipe of 356 mm diameter from the crystalliser and then split-fed through two pipes of 203 mm diameter each. The vertical conical basket has a slope of 25°. The centrifugals have centre feed arrangements with wash water applied in the massecuite feed pipe around the feed cone and radially along the basket wall.

The rotary cascade dryer is 9000 mm long and 2360 mm in diameter with an installed power of 18.5 kW. The drum is inclined at a predetermined angle and rotates at a speed of 3 r/min. The induced cooling air at 32°C is fed counter-current to the incoming sugar. In case the temperature of the feed sugar is too low, a forced draught air supply at 70°C can be used to boost up its temperature before drying. Initial efforts were concentrated on improving the dryer operation by varying the air to sugar ratio and increasing the temperature of the hot air, but no significant improvement was noted in the sugar quality.

Steps taken to improve the sugar quality

Drying of sugar directly from the centrifugals

The processing practice at the factory is such that, due to increased crushing capacity and limited storage facilities for dry sugar, the sugar issuing from the continuous A-centrifugals sometimes transited in a 100 tonnes buffer bin before being sent to the dryer. While this practice had no detrimental effects on the quality of sugar cured by batch centrifugals, it affected the continuously cured sugar, which was at a higher moisture and lower temperature (about 1.3% moisture and 36°C compared with the batch sugar of about 0.5% moisture and 47°C for massecuites at about 54–59°C). It was, therefore, recommended in the first instance to increase the dry sugar storage capacity and to by-pass the buffer bin by sending the sugar from the centrifugals directly to the dryer so as to increase evaporative cooling. Subsequently, a new 375 tonne bin was installed in 1999 and all the wet sugar from the centrifugals was conveyed directly to the dryer. The temperature of the dryer feed sugar increased from 34–38°C to 37–42°C. After these modifications, the quality of the product sugar improved but was not consistent because of variations in the quality of the dryer feed sugar.

Discontinuation of radial water supply to the centrifugals

The radial wash water along the centrifugal basket was discontinued as it resulted in high moisture in the product and large quantity of sugar lumps without any significant increase in sugar pol. The required sugar polarisation could be achieved by merely optimising the amount of wash water in the massecuite feed pipe and around the centrifugal feed cone. The dryer feed sugar had a lower moisture (typically 0.5% compared to the previous 1.3%), and was easily handled by the dryer.

Regulation of massecuite feed to the centrifugals

The feed rate of massecuite to the two continuous A-centrifugals was irregular, and was controlled manually by opening the gate valve on the feed pipe. A flow control system was designed (Figure 1) and implemented on both centrifugals.

The current drawn by the 45 kW centrifugal motor was measured using a current transducer and the output signal fed to a converter which outputs a 4 to 20 milliampere signal to the analogue input of a

programmable logic controller. The latter then issues an electrical signal to modulate a pneumatic butterfly valve controlling the massecuite feed rate to the centrifugal.

Modification to the massecuite feed pipes

With the continuous centrifugals operating one at a time, the individual curing capacities were found to be 12.0 and 12.3 t/h. However, when they were running simultaneously, the motor current of centrifugal A1 could hardly be varied, and the curing capacities of centrifugals A1 and A2 were determined to be respectively 7.9 and 9.1 t/h. This was attributed to the massecuite flow being hindered by the change from the large common feed pipe (356 mm dia.) to the smaller split-feed pipes (203 mm dia.), which were subsequently replaced by 356 mm pipes. The total massecuite curing capacity of the two machines was then increased to 24 t/h.

Assessment of sugar quality after operational modifications

Experimental methods

The two continuous centrifugals were operated simultaneously at maximum capacity. The flow rate of the two wash water applications at 90°C was optimised (typically 3.5% on massecuite) to obtain a wet sugar of about 98° pol and 0.5% moisture. Wet sugars from the two continuous centrifugals were sampled separately. Simultaneously, sugar samples were also collected before and after the dryer with a time lag of 15 minutes. All the sugars were sampled every three minutes over a period of thirty minutes, and were analysed for pol and moisture.

A-runnings and A-masses were similarly sampled. Nutsch molasses, extracted from A-masses, together with the A-runnings were analysed for purity.

Grain size analysis was carried out on the sugar crystals separated from massasses by the Nutsch extractor and on all sugars to determine: % fines below 600 μ and crystal mean aperture. Crystal breakage in the centrifugals and in the dryer was calculated using the method described in previous work (Wong Sak Hoi et al., 1997).

Results and discussion

Averages of six test results on the quality of wet sugar from the centrifugals and of product sugar before and after the dryer are shown (Table 1). The results were compared with previous data obtained with a STG/FCB continuous A-centrifugal (Wong Sak Hoi et al., 1997).

The data confirm that wet sugar issuing from the FCB FC1000 had a lower moisture content than from the STG/FCB centrifugal (0.4–0.5% as compared to 1–1.4%), and yielded product sugar of 98.56° pol and 0.35% moisture with a DI of 31, which meets specifications. Lumps produced were insignificant and A-runnings purity rise (2–3 units) was comparable to that produced by the STG/FCB.
Table 1—Quality of sugar issuing from two continuous A-centrifugals and of product sugar before and after drying.

<table>
<thead>
<tr>
<th>Sugar quality</th>
<th>Moisture%</th>
<th>Pol</th>
<th>Fines % &lt; 600 μ</th>
<th>MA mm</th>
<th>CV %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output centrifugal A1</td>
<td>0.45</td>
<td>98.53</td>
<td>15.5</td>
<td>0.869</td>
<td>30.8</td>
</tr>
<tr>
<td>Output centrifugal A2</td>
<td>0.53</td>
<td>98.39</td>
<td>10.7</td>
<td>0.903</td>
<td>29.5</td>
</tr>
<tr>
<td>Before dryer</td>
<td>0.50</td>
<td>98.28</td>
<td>14.9</td>
<td>0.909</td>
<td>32.6</td>
</tr>
<tr>
<td>After dryer</td>
<td>0.35</td>
<td>98.56</td>
<td>17.1</td>
<td>0.881</td>
<td>32.7</td>
</tr>
</tbody>
</table>

Grain size analysis yielded average results of crystal breakage of 8.9, 6.2 and 7.0% in centrifugal A1, A2 and in the dryer. These results are comparable to values found for the STG/FCB centrifugal installed at Beau Champ sugar factory in Mauritius (7.9% and 7.0% respectively in the centrifugal and in the dryer).

Work carried out by Broadfoot and Miller (1998) on a STG continuous centrifugal in Australia showed that there was a reduction in mean aperture of 0.05 mm and an increase of 3-6 units in grist. For comparison, using data from Table 1 and corresponding massecuite data of 0.953 mm mean aperture and 8.6% fines, it can be deduced that the centrifugals A1 and A2 at Union St Aubin produced reductions in mean aperture of respectively 0.08 mm and 0.05 mm, and increases in fines of 7 and 2 units.

Examination of data for the past four years (Table 2) shows that the percentage of consignments penalised for dilution indicator and low pol has decreased from 1998 to 2000.

It should be noted that at factory start-up, especially on Mondays, the massecuites temperature may be low (about 34°C), and the sugar unacceptable. The problem can be avoided by keeping as little A-massecuite as possible in the crystallisers before the week-end shutdown, and by applying hot air in the dryer to increase the temperature of the feed sugar.

Conclusions

Following simple modifications in the operation of two FCB FC 1000 continuous A-centrifugals and in the layout of the sugar bins, product sugar meeting Mauritian specifications was obtained. Crystal breakage was comparable to that obtained with other types of continuous A-centrifugals. No modifications to the centrifugals were required to reduce sugar lumps, and automation of the dryer was not necessary.

Table 2—Percentage of sugar consignments outside specification (1997–2000).

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<tr>
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<tbody>
<tr>
<td>&lt; 98.5° pol, &gt; 40 DI</td>
<td>10</td>
<td>13</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>&gt; 98.5° pol, &gt; 45 DI</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>&lt; 25 DI</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>&lt; 98.0° pol</td>
<td>7</td>
<td>6</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

Figures in brackets are numbers of consignments.

REFERENCES


AMÉLIORATION DE LA QUALITÉ DU SUCRE TURBINÉ PAR DEUX ESSOREUSES CONTINUES POUR LA MASSECUITE A

L. WONG SAK HOI, S. JOORIA et S. TSE CHI SHUM
Mauritius Sugar Industry Research Institute

Résumé

Avec la mise en opération de deux essoreuses continues FCB FC 1000 à la sucrerie d’Union St Aubin, la qualité du sucre n’était souvent pas conforme aux spécifications. La situation fut améliorée suite à l’application des mesures correctives: le débit de massecuite aux centrifugues fut réglé et augmenté, l’eau de clairçage fut optimisée, le refroidissement par évaporation du sucre traité dans le sècheur fut assuré. Les centrifugues parvinrent à produire du sucre brut aux normes requises sans avoir recours à la modification des centrifugues ou à l’automatisation du sècheur.

Mots clés: Alimentation de la massecuite, indice de dilution, brisure des cristaux.
MEJORA EN LA CALIDAD DEL AZÚCAR CURADA POR DOS CENTRÍFUGAS CONTINUAS-A

L. WONG SAK HOI, S. JOORIA y S. TSE CHI SHUM
Mauritius Sugar Industry Research Institute

Resumen
Con la puesta en operación de dos centrífugas continuas-A FCB FC 1000 en la fábrica de Union St Aubin, la calidad del azúcar con frecuencia no lograba adecuarse a las especificaciones. La situación mejoró después de que se tomaron medidas correctivas para: regular e incrementar el rendimiento de masacocida hacia las centrífugas, optimizar el agua de lavado que se empleaba y asegurar el enfriamiento con evaporación del azúcar curada en el secador. Las centrífugas exitosamente producen azúcar mascabado [raw sugar] que cumple con las especificaciones sin haber tenido que recurrir a modificar las centrífugas o a automatizar el secador.

Palabras claves: alimentación de la masacocida, indicador de dilución, rotura del cristal.