TOWARDS A MORE PRODUCTIVE USE OF B-SUGAR

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Abstract

The present trends in the processing of the B-sugar in the VHP boiling system are critically reviewed, and proposals are put forward with a view to improving the use of this high quality product in the raw mills with and without back-end refineries.

Introduction

Contrary to many other sugar producing countries, in South Africa the B-sugar is not used as commercial sugar. In the VHP system which is in general use locally, part of the B-sugar is used as footing for the A-massecuite while the remainder is dissolved and returned to the syrup. This system is conducive to producing an excellent commercial sugar albeit at the expense of energy, equipment and sucrose recycling. A basic shortcoming of the VHP system, as practised presently, is the poor usage it makes of the highly purified B-crystal found in the B-sugar. It is felt that much fuller advantage could be derived from this high quality product without necessarily jeopardising the quality of the VHP sugar. The key to the solution resides in separating the pure crystal from its surrounding film of low purity molasses, a process which is already used on the portion of the B-sugar which forms the footing for the A-massecuite. Our conviction is that opportunities do exist under local conditions for making better use of the B-sugar, especially in the back-end refineries, which would have an important positive effect on many facets of process operations.

The characteristics of the B-sugar

Generally speaking, under conditions prevailing locally, B-sugar, and the way it is used suffers from a number of bad characteristics. The B-sugar itself is of a small size, has a high proportion of broken crystals and a molasses film of low purity. The way this sugar is used results in a high level of crystal dissolution and recycling in process. On the other hand the B-sugar possesses one important asset in the high quality of its crystal.

Small Size

Nowadays, the B-sugar is totally cured in continuous centrifugals, a practice which over the years has progressively led to a reduction in crystal size. The smaller crystal size makes it easier to obtain good B-massecuite exhaustion, a performance parameter which receives high priority by the factory management, supposedly because of its positive effect on steam and equipment use. However, the fact that the reduction in size of the B-sugar achieves the exact opposite effect, through the resultant increase in the amount of B-sugar to be remelted, seems to have been overlooked.

Crystal Breakage

Because most mills use conventional continuous centrifugals for the B-curing, the level of crystal breakage is high (Rein and Archibald[2]). This leads to much crystal dissolution when the B-magma has to be washed clear of crystal fragments prior to being used as footing for the A-massecuite.

This dissolution is, in effect, equivalent to a drop in B-exhaustion (however it is not measured as such because it takes place after the molasses separation). Simultaneously, the washing of the damaged crystal in the A-footing leads to an overall reduction in crystal size, which for the same reasons given above, further aggravates the problem of B-crystal dissolution.

Crystal Dissolution

As explained above the adopted practice of boiling a small size B-massecuite, followed by its curing in conventional continuous centrifugals, is synonymous with high levels of crystal dissolution and defeats to a large extent the positive effects of high exhaustion at the crystallisation stage. In other words the achievement of high B-massecuite exhaustion is of little practical value when a large amount of B-crystal "exhausted" from the massecuite is dissolved back to process in the ensuing operations. However, it must be noted that a practical minimum B-exhaustion is warranted to ensure that the B-molasses purity is at a low enough level to accommodate the desired C-massecuite purity.

Table 1

Affinated B-Sugar From CG Smith Mills (Season 1989/90)

	Pongola			Gledhow			Noodsberg		
	Colour *	Ash %	Reducing Sugar %	Colour *	Ash %	Reducing Sugar %	Colour *	Ash %	Reducing Sugar %
Month	(* colour results in ICUMSA units)								
June	1287	0,15	0,13	822	0,08	0,12	928	0,08	0,12
July	1369	0,15	0,06	752	0,07	0,09	1066	0,08	0,11
August	1151	0,15	0,07	850	0,07	700	0,05	0,06	
Sept	778	0,08	0,06	1273	0,08	0,08	795	0,06	0,07
Oct	932	0,06	-	905	0,09	0,06	780	0,09	-
Average Affiniated B-Sugar	1103	0,12	0,08	920	0,08	0,08	854	0,07	0,09
Average VHP Sugar (season 89/90)	1508	-	-	940	-	-	961	-	-

Sucrose Recycling

Compared with a system in which the B-sugar is used as a commercial product, it is obvious that the VHP boiling scheme results in high levels of sucrose dissolution and recycling, made even more pronounced because of the production of small sized crystal in B-massecuites at the pan boiling stage and the damage to the crystals caused by the conventional continuous centrifugals.

B-Sugar Quality

It was mentioned above that the B-sugar possessed a very high quality crystal. This is borne out by measurements carried out on affinated B-sugars from three mills in the CG Smith Sugar (CGSS) group during the 1989/90 season and shown in Table 1 (all the analytical work was carried out by the Sugar Milling Research Institute (SMRI).

These results show that at all three mills the B-crystal was of a lower colour than the VHP sugar and was well within the VHP specifications for conductivity ash of <0,20% (there is no specification for reducing sugars). The excellent quality of the B-crystal is a clear indication that serious consideration ought to be given to a more productive use of this high quality product in the local industry.

Proposed process modifications

It is obvious that the most productive treatment of the B-sugar would be to use it as a commercial product. This approach is, however, not feasible in our raw mills because the B-sugar (owing to the molasses film of low quality surrounding the crystal) would reduce the quality of the total sugar below VHP specifications.

Since the B-sugar cannot be used as such, the alternative approach is to find ways of separating the B-crystal from its molasses film so that it can be used to its full potential. Two practical ways of "affinating" the B-crystal are available under the local conditions as follows:

(a) In mills without a back-end refinery, by magma-ing in syrup/clear juice/water for use as a footing for the A-sugar, as is currently done locally. The use of clear juice or water is, of course, not recommended, but is, unfortunately, essential with the badly damaged crystals produced by the conventional centrifugals.

(b) In mills with a back-end refinery, by a "proper" affination using the refinery returns of low colour as the affinating medium.

Magma System

Ideally, in the magma system, all the B-crystals ought to be used as nuclei for the A-sugar, with no dissolution of B-sugar. However this situation is never achieved in our mills for 2 main reasons:

- the size ratio of the A- and B-crystals produced in the mills does not make it possible
- the perceived negative effect of the additional B-crystal on the quality of the VHP-sugar

As mentioned above, the present practice is to produce a "small" B-crystal, estimated at a SGS of 0,25 mm on average. The target size of the A-sugar is around 0,65 mm in order to meet the VHP specification.

Table 2

Comparative VHP-sugar colours with different B-crystal sizes

B-crystal size (mm)	A-Massecuite to A-footing ratio (A-sugar: 0,65mm)	Colour (ICUMSA units)	
		VHP sugar	Affiniated Sugar
0,25	15:1	1 000	600
0,35	6:1	1 050	650

Applying the above crystal dimensions and using the "cube root" assumption for crystal growth

$$\text{i.e. } \frac{\text{crystal size 1}}{\text{crystal size 2}} = \frac{\sqrt[3]{\text{Massecuite Volume 1}}}{\text{Massecuite Volume 2}}$$

it can be calculated that the volume ratio of A-massecuite to B-footing is about 15:1. This is a fair reflection of the ratio actually obtained under average South African conditions. At such a ratio about 60 per cent of the B-sugar is redissolved (see Appendix 1). Using the same approach it can be shown that with a B-crystal of 0,35 mm, the ratio of A-massecuite to A-footing to obtain an identical size of A-sugar would reduce to 6:1 which would result in all the B-sugar production being used as nucleus for the A-sugar (see Appendix 2). This would lead to equipment and steam savings and reduce the sucrose losses which normally accompany recycling.

Based on the B-crystal affination results obtained this season (see Table 1) it can be calculated that the inclusion of additional B-crystal in the A-sugar, which would occur through the above process change, will have a negligible effect on the A-sugar quality as shown in Table 2.

The proper sizing of the B-crystal and the use of centrifugals without crystal breakage, would result in about 10% additional A-pan capacity and a reduction in process steam requirements of 1% steam on cane. It is worth noting that, in comparison, an improvement of 5 points in B-exhaustion is worth less than 0,1 % steam on cane.

B-Sugar affination using refinery return syrup

In mills with back-end refineries, of which there are six in South Africa, the availability of refinery returns of low colour offers an excellent opportunity of making direct use of the B-sugar as refinery feed. Because of its relatively low colour the return syrup from the refinery to the raw house is considered to be a very suitable affinating medium for the B-sugar.

With this in mind CGSS contracted the SMRI to carry out in 1989 a laboratory scale investigation into the feasibility of using affinated B-sugar as refinery raw material (Getaz[1]). The data which are given below have been taken from the SMRI report. Basically the tests consisted of determining the optimum conditions for mingling B-sugar in refinery returns and centrifuging the magma and evaluating the suitability of the affinated B-sugar (VHP-B) as raw material for a refinery.

The SMRI investigations have shown that provided certain conditions are observed, B-sugars of up to 99,4% purity could be produced depending on the level of washing at centrifugation. A typical set of results obtained on B-sugar from the Noodsberg (NB) mill is shown in Table 3.

Table 3

Affinated B-sugar ex Noodsberg (SMRI investigations 1989)

Centrifugal wash water % B-magma	Affinated B-sugar		% Crystal dissolution
	Purity	Colour	
3,0	99,0	1 850	8,0
7,0	99,2	1 550	17,8
12,0	99,4	1 250	28,9

Based on the above results it can be confidently expected that, under the NB conditions, VHP-B sugar meeting VHP colour specfications of 1350 ICUMSA units could be produced industrially. It must also be noted that the investi-

gations were carried out mainly with "normal" size B-sugar and it would be logical to expect a better affination performance with a bigger B-crystal. Table 4 below gives additional quality parameters of the NB B-sugar affinated to a purity of 99,3.

Table 4

Comparison between VHP sugar and affinated B-sugar (99.3. Purity)

	Affinated B-sugar	standards
Purity	99,3	>99,45
ICUMSA colour	1430	<1350
Cond ash %	0,16	>0,20
Turbidity	520	300 *
Filtrability	41	50 *
Gums (ppm)	1200	1000 *

The quality of the affinated B-sugar is only slightly inferior to the VHP specifications and, in view of the relatively small percentage that it will represent of the total raw sugar feed, it can be anticipated that no processing problems would be experienced when this sugar is used in the refinery.

The advantages of the direct use of VHP-B sugar as refinery feed material, as determined by computer modelling of the factory balance, are evident from Table 5.
The saving of 1,6% steam on cane is worth about 4000 tons of coal per season for a 300 TCH mill (assuming that the mill is burning additional fuel as all mills cum refinery do).

Table 5

Effect of the direct use of VHP-B sugar in back end refineries

	Conventional VHP scheme	VHP-B sugar direct to refinery	% reduction
Volume A-mcte	1,07	0,91	15
B-mcte	0,33	0,26	21
C-mcte	0,25	0,25	0
Total massecuite	1,65	1,42	14
Steam consumption (panfloor: % cane)	13,9	12,3	12

The reduction in massecuite boiling and sucrose recirculation will almost certainly improve the sucrose recovery, although at this stage the financial benefits are difficult to assess.

On the other hand, everything else remaining the same, the use of VHP-B could be expected to have a slight negative effect on the quality of the refined sugar, which in most cases would be of no practical importance. However, many simple solutions are available to remedy the situation if required, e.g. additional washing at the A and/or refinery centrifugals, treatment of the B-melt, additional use of chemical in the refinery etc.

Conclusions

- Because of the high quality of its crystal the B-sugar ought to be used more productively in our mills
- The production of a "small" B-massecuite to improve the exhaustion is self-defeating in the sense that it simultaneously increases the amount of B-sugar which is redissolved
- The use of conventional continuous centrifugals on B-massecuites, because of the crystal breakage, increases the level of B-crystal dissolution and consequently has the net effect of reducing the B-exhaustion
- In mills with back-end refineries, the refinery return syrup, of low colour, is an excellent affinating medium for improving the quality of the B-sugar and making it suitable as refinery feed
- A better use of the B-sugar in our mills has the potential of saving equipment and steam and improving sucrose recovery.

Recommendations

In order to be able to make fuller use of the B-sugar and derive the benefits associated with it, it is recommended that the following steps be considered:

- use of B-centrifugals fitted with devices which eliminate the breakage of crystals, e.g. big casings
- optimisation of the B-massecuite size so that all the B-sugar can be used as footing for the A-massecuite
- use of affinated B-sugar as refinery feed material in raw mills with back-end refineries.

Acknowledgements

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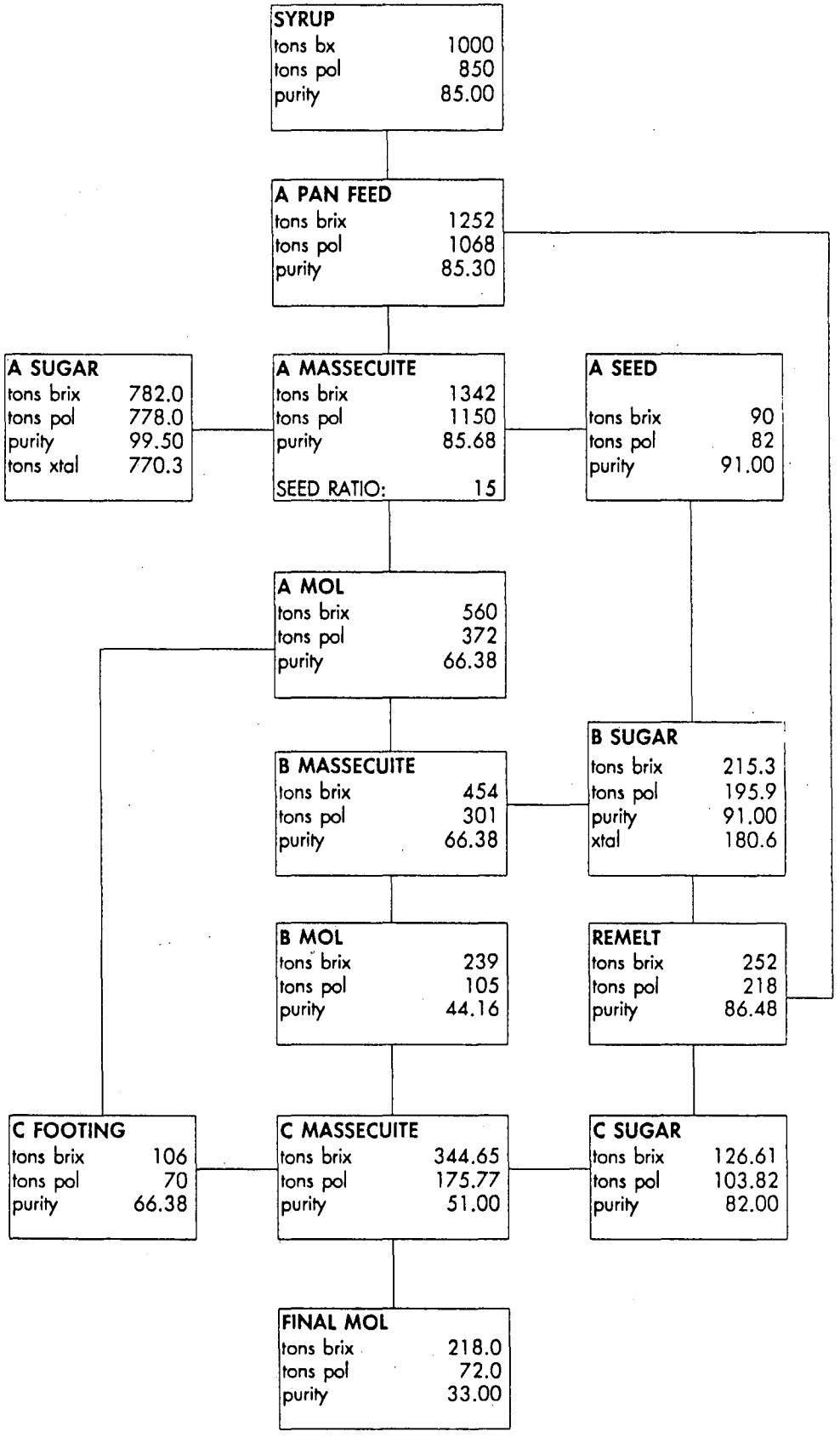
REFERENCES

1. Getaz, MA (1989). B-sugar Affination Tests. Confidential Report from Sugar Milling Research Institute, Durban.
2. Rein, PW and Archibald, RD (1989). Crystal Breakage in Continuous B-centrifugals. *Proc S Afr Sug Technol Ass* 63: 94-99.

APPENDIX 1

CONVENTIONAL PARTIAL REMELT SYSTEM



APPENDIX 2

ALL B SUGAR UTILISED AS SEED