EVALUATION OF SCREEN MODIFICATIONS ON A CONTINUOUS CENTRIFUGAL

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Abstract

Modifications to both the sugar screen and the backing screen on a B.M.A. K850 centrifugal resulted in a significant capacity increase. This capacity increase is rated conservatively at 25% but figures of well over 50% increase have been attained. The increased throughputs were obtained with no increase in the water quantity above that required by a standard machine for an equal sugar quality, i.e. the water to massecuite ratio is lower, giving a higher molasses brix from the modified screens. Furthermore, an equal or lower molasses purity seems possible at the enhanced throughput. The effects of screen washing and process water temperature were also examined.

Introduction

The continuous centrifugal in general use in most Huletts factories is the B.M.A. K850.

When used on fore-curing duties, this machine is usually fitted with a 35° basket, an approximately four mesh, woven, stainless steel backing screen, and a perforated sugar screen with approximately 7% open area and apertures of 2,57 mm by 0,06 mm.

The nine fore-curing K850's at Empangeni have previously been modified as described in detail by McEvoy and Archibald[1]; — all baskets had been drilled and grooved to improve molasses drainage and were driven at a speed of 2 350 rpm. Of these nine machines, two were selected as test machines, one of them being fitted with a modified backing screen and a modified sugar screen.

Both machines are fitted with a water supply to the lube rods as well as to the usual annular water ring allowing water to be applied to both or either one as required. Both machines are fitted with 150 mm iris valves.

It has been felt for some time that a screen with a greater open area should have certain advantages over the standard sugar screen, particularly in the throughput area. However, the very nature of the electro-deposition technique used to produce such screens dictates a certain relationship between the open area and the screen material thickness. This means that the greater the open area for a given aperture width, the thinner the screen. This thinner screen brings with it attendant problems such as increased risk of mechanical damage whilst being fitted or damage from foreign objects while running, etc.

The Veco screen manufacturer's representative, on a visit to South Africa was consulted on the matter of producing a screen with a greater open area. This was agreed to after a discussion of the various problems of manufacturing such a screen as well as the likely problems of trying to operate with it. An order was placed for five sets of test screens at R180 per set plus a R350 charge for 50% of the matrix costs.

Modifications

It was felt that this modified sugar screen would require greater support than that afforded by the standard backing screen and to this end, a woven, ten mesh, stainless steel screen was acquired and fitted over the standard backing screen.

This operation was carried out by Alfa-Laval, who also rebalanced the basket, at a total cost of approximately R400.

The new modified sugar screen had an open area of approximately 14% with apertures of 1,02 mm by 0,66 mm. The backing screen modifications can be seen in Figure 1, while Figure 2 illustrates the modified and the standard screen aperture configurations.

Testing method

Once all the above modifications had been carried out, a testing method was laid out as follows:

The molasses outlets on two adjacent machines were modified to allow the molasses from each machine to run into two

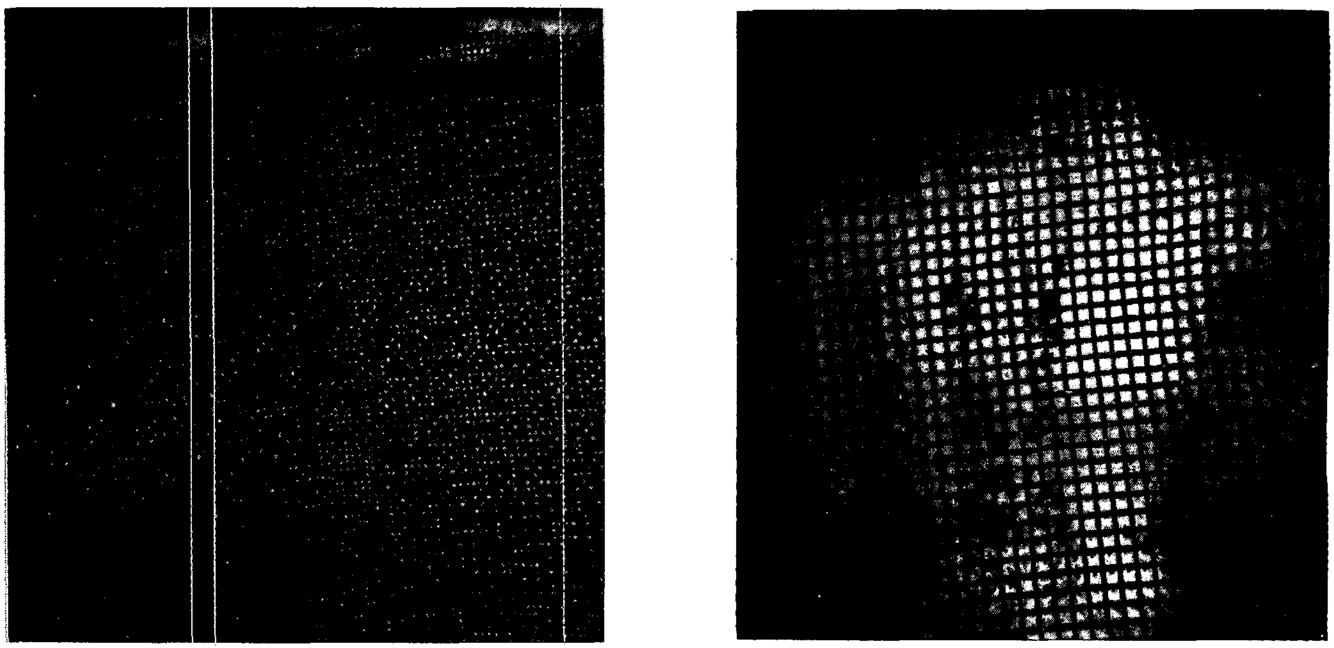

FIGURE 1

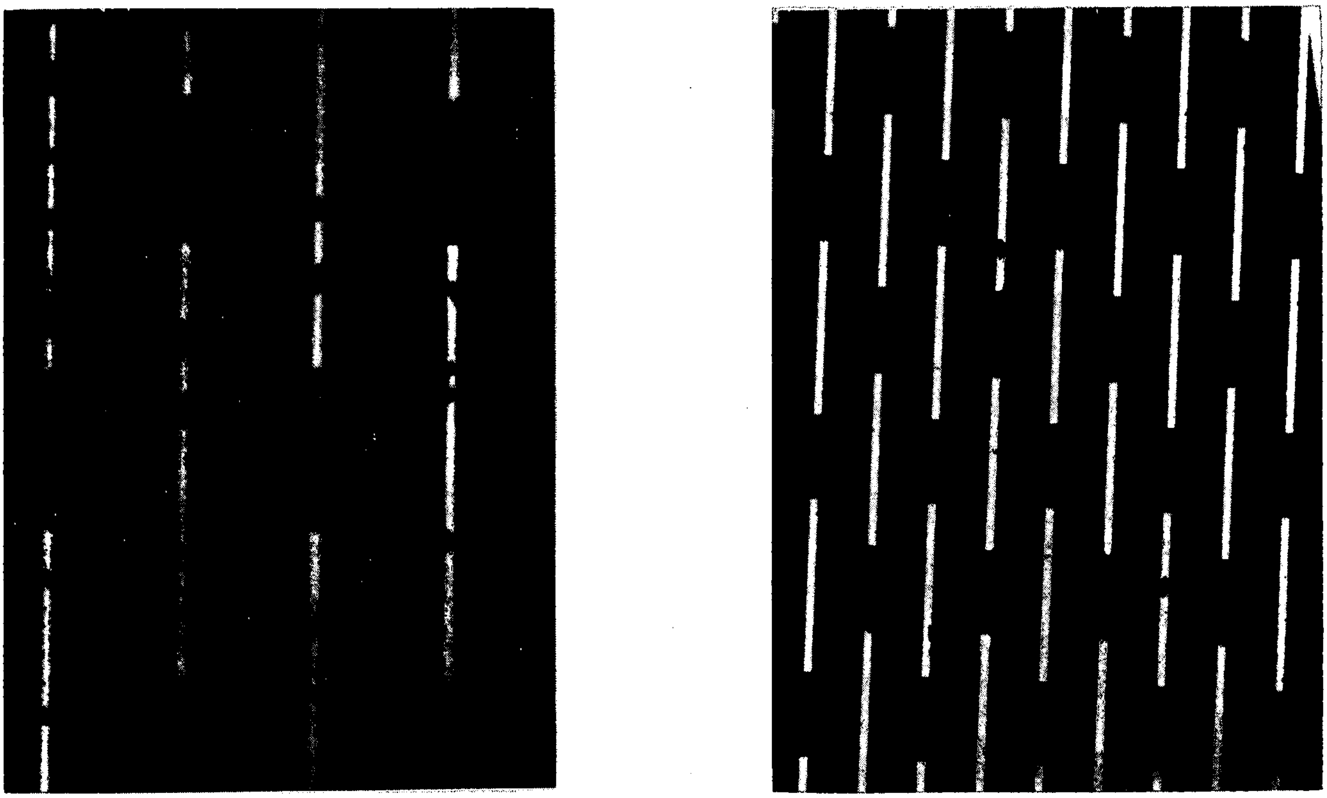

FIGURE 2

separate 200 ℓ drums. By timing the "drumfull", molasses flow rates could be measured.

For a test run, the water rotameter on each machine was set at a predetermined value, usually in the range of 50-80 litres per hour. This setting was carefully watched throughout the test run, with the water being applied exclusively through the annualar ring for all tests. This was felt necessary to avoid possible arbitrary division of the water flow through each of the two water feed devices.

Hot water of 78-80° C was used for all tests except in the "F" Series, where hot *vs* warm water effects were examined.

The steam valves were fully open at all times. The original steam condition was slightly superheated 220 kPa abs. exhaust steam but by the time it reached the B.M.A.'s, it was wet steam at around 165-175 kPa abs.

Massecuite flow was controlled by the iris valves to give sugars of the same visual appearance, hopefully of around 83 purity, the important point being to obtain comparable sugars.

The machines were allowed to settle down, after the final adjustment had been made, for a period of about ten minutes before any actual sampling or monitoring took place.

Sugar and molasses samples were taken from both machines as near-simultaneously as possible at four minute intervals after which the respective samples were well-mixed and analysed by the Mill Laboratory staff.

Results and discussion

The results are placed, in general, in chronological order with some tests repeated at a later date and added to the original data.

An attempt is made to explain the particular route followed as with any work of this nature, the results of one test, or observations during a test often indicate the path to be beaten by the next test.

"A" Series Results—Table 1

This initial test series produced some very interesting results although the factors contributing to these results are not readily apparent.

The throughput was disappointingly low at first with the modified screens. However after only one day of "running-in", the throughput started to improve significantly, averaging out at over 30% greater than for the standard screens for Runs 4 to 8.

Of greater interest were the higher molasses brixes coupled with lower molasses purities achieved by the modified screens, the latter averaging out at 1,6 units lower.

The reason for this improved separation performance is not clear, but a hypothesis is that at the higher throughput, the retention or contact time between sugar crystals and water is reduced, and that further, the improved drainage of the screen requires less water to massecuite to assist in separating the crystals from the mother liquor.

These results held out great promise for the future but as no factual reasons for the improvements were apparent, verification of these results was required. Further, life expectancy of the new, more fragile screens was in question and this same screen set was continued in operation for a total period of six weeks after which, although it showed no significant signs of wear, the longevity trial was stopped to enable further testing to be done with new screens.

"B" Series Results—Table 2

While the life expectancy of the modified screens was being determined, it was thought wise to interchange the complete baskets and screens of the two test machines, in an endeavour to determine whether some machine differences might be responsible for the results obtained in the "A" series runs.

The "B" series of runs indicated that while the greater throughput capability stayed with the modified screens, the differences in molasses purities disappeared. The throughput

TABLE 1 Initial comparison of modified vs standard screens

Date	21.9.76		21.9.76		22.9.76		23.9.76		24.9.76		6.10.76		7.10.76		8.10.76	
Run No.	1		2		3		4		5		6		7		8	
Screen Type	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.
Water Flow ℓh^{-1}	78	69	48	48	63	63	86	87	63	64	91	91	59	58	76	76
Mols Flow ℓh^{-1}	613	544	404	379	431	457	534	648	344	470	451	539	280	382	362	512
Mass. Bx	—	—	—	—	—	—	—	—	97,1	97,1	—	—	94,9	94,9	96,2	96,2
Mass. Pur.	—	—	—	—	—	—	—	—	51,8	51,8	—	—	52,1	52,1	51,5	51,5
Sugar Bx.	97,1	98,1	98,5	98,1	98,2	98,5	98,5	97,8	99,5	99,0	99,9	100,0	96,9	98,3	98,5	98,2
Sugar Pur.	80,3	80,9	85,3	83,6	82,2	83,3	81,6	81,1	85,4	83,7	86,7	86,4	85,4	84,9	86,0	86,3
Mols. Bx.	83,7	86,2	85,1	85,4	85,6	87,6	83,5	86,0	82,1	82,9	79,6	82,7	77,4	81,9	79,6	84,3
Mols. Pur.	37,5	36,6	40,1	38,2	38,7	37,1	39,2	38,0	40,3	38,6	36,4	35,4	39,1	37,0	36,3	33,8
ΔP Standard — Modified	+ 0,9		+ 1,9		+ 1,6		+ 1,2		+ 1,7		+ 1,0		+ 2,1		+ 2,5	
Mass Temperature, °C	63		62		63		68		66		62		62		65	
Δ Flow Modified/Standard	−13%		−6%		+6%		+21%		+37%		+20%		+36%		+41%	

Note: 1. After Run 7, both screen sets were cleaned and refitted for Run 8. 2. New standard and modified screens were fitted for Run 1. 3. Reheater temperatures high due to reheater restriction.

TABLE 2 Further comparisons with different machine bodies

Date	15.10.76		21.10.76		22.10.76		10.11.76		16.11.76		17.11.76		23.11.76	
Run No.	1		2		3		4		5		6		7	
Screen Type	Standard	Modified	Standard	Modified	Standard	Modified	Standard	Modified	Standard	Modified	Standard	Modified	Standard	Modified
Water Flow ℓh^{-1}	55	53	78	82	77	77	82	83	58	56	69	67	57	55
Mols. Flow ℓh^{-1}	357	483	338	360	410	651	459	664	450	472	353	377	574	699
Mass Bx.	96,1	96,1	95,3	95,3	95,6	95,6	97,4	97,4	96,6	96,6	95,4	95,4	97,4	97,4
Mass. Pur.	55,0	55,0	54,0	54,0	53,1	53,1	54,4	54,4	55,2	55,2	55,2	55,2	52,8	52,8
Sugar Bx.	99,0	99,3	96,1	95,9	98,4	98,7	99,1	99,3	99,4	98,5	97,7	97,6	99,3	99,2
Sugar Pur.	85,2	84,4	81,0	82,4	80,2	80,2	81,5	80,9	81,6	79,6	82,8	82,0	* 78,5	83,3
Mols. Bx.	79,3	83,7	78,5	76,9	84,4	86,0	81,7	83,0	84,6	85,2	81,7	80,9	89,5	90,8
Mols. Pur.	40,4	40,3	41,5	42,4	37,4	37,2	40,7	40,3	38,0	38,6	38,9	39,1	36,4	36,6
ΔP Std. — Mod.	0,1		— 0,9		0,2		0,4		— 0,6		— 0,2		— 0,2	
Mass Temp., °C	62		57		62		57		54		50		63	
Δ Flow Modified/Standard	+35%		+ 7%		+59%		+45%		+ 5%		+ 7%		+22%	

Note: 1. Molasses dilution on for all Runs except Run 1. 2. Sugar screens washed before test Runs 3, 4, 5, 6 and 7. 3. New screens fitted on 16.11.76 for Runs 5, 6 and 7.
(Molasses Dilution involves the recycling of 5% final molasses on "C" massecuite on to the last 3 "C" crystallisers.)
* Molasses found on sample thief.

TABLE 3

Comparison of Before and After Washing Screens

Date	24.11.76				26.11.76				1.12.76			
Run No.	1				2				3			
Wash	Before		After		Before		After		Before		After	
Screen type	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.
Water Flow ℓh^{-1}	56	56	58	58	75	75	76	76	58	59	53	53
Mols. Flow ℓh^{-1}	495	578	512	623	480	676	537	720	454	766	439	746
Mass. Bx	95,3	95,3	95,3	95,3	97,4	97,4	97,4	97,4	97,4	97,4	97,4	97,4
Mass. Pur.	54,2	54,2	54,2	54,2	52,0	52,0	52,0	52,0	53,1	53,1	53,1	53,1
Sugar Bx.	98,1	98,4	98,7	99,9	99,1	99,0	100,2	100,5	97,9	99,1	99,5	99,6
Sugar Pur.	81,5	81,4	82,1	80,6	84,0	84,0	82,5	83,7	81,7	85,2	81,9	82,6
Mols. Bx.	85,6	86,8	86,7	88,2	82,7	85,4	83,3	84,9	84,9	87,1	85,1	88,1
Mols. Pur.	40,0	39,4	37,5	37,5	39,6	39,1	37,2	37,3	40,2	38,8	38,4	38,1
ΔP Standard — Modified	+ 0,6		0,0		+ 0,5		− 0,1		+ 1,4		+ 0,3	
Mean Δ P	2,2				2,1				1,2			
Δ Flow Modified/Standard	+17%		+22%		+41%		+34%		+69%		+70%	
Mean Δ Flow	+ 6%				+ 9%				+ 3%			

Note: 1. Molasses dilution on for all runs excepting Run No. 2.

was 38% up on the standard screen until, for Run 5, a second set of new screens was fitted. As for the first screen set, throughput dropped for the first day or so, but then climbed significantly to its former levels. The reasons for this phenomenon are unknown.

The disappearance of the favourable purity differences was perplexing but, as background, it may be useful to bear the following points in mind. Firstly, increased flow problems with the massecuite reheater were encountered at this time, necessitating massecuite temperatures as high as 74° C although no tests were run at this temperature. Secondly, to reduce viscosity to help the flow problem, molasses dilution was practised during all runs after Run No. 1.

During Runs 5 and 6, the reheater was completely by-passed with some reheating done in the last two crystallisers.

A further point of interest emerged during these runs, however. Before starting a test run, both machines were washed internally, with water being sprayed onto the sugar screen with the massecuite feed closed. The result of this procedure was to produce similar molasses purities from both machines but at a lower level than those unwashed machines running next to them. This difference in purity level was around two units. This "discovery" was followed up in the "C" series of runs.

"C" Series Results—Table 3

The initial runs, Nos. 1 to 4, were very encouraging while the latter runs were not. However, the results of Run No. 5, particularly the molasses brixes for the "after" run are questionable as they indicate that at the approximately similar water and molasses flow rates, the molasses brixes are two units lower, which is impossible if the flow rates are correct.

If the results of Run 5 are excluded from the mean ΔP of 0,4, there is a new mean of almost one unit.

Looking at the purity differences between standard and modified screens, they average out at 0,5 units lower for the modified screens.

Flow rate also shows an improvement as is to be expected. The mean increase in flow rate is modest at nearly 6%, while the increase in flow rate of the modified screens over the standard screens is much greater at 37%.

The results of this particular test series were sufficiently encouraging for the practice to be adopted immediately on all machines at Empangeni, i.e. all were washed down every hour. To monitor the result of this technique, the molasses from one machine (the same one each time) was sampled once per shift before and after the hourly washing. The mean results of 82 such tests are shown in Table 4.

TABLE 4

Effect of screen washing on molasses purities on a standard machine

	BX	Pur	ΔP
Before washing	86,2	38,9	—
After washing	86,4	38,3	0,6

There is some doubt as to whether these results could necessarily be expected throughout the season. However, it is suggested that some benefit may be yielded from this technique during times of poor massecuite quality.

"D" Series Results—Table 5

During the latter part of the season, some of Huletts factories experienced abnormally high purity rises across the

17.12.76				26.1.77				2.2.77				3.2.77			
4				5				6				7			
Before		After		Before		After		Before		After		Before		After	
Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.	Std.	Mod.
85	86	77	78	75	75	70	70	75	72	76	76	38	38	38	38
569	1 067	581	1 143	742	778	783	791	873	1 083	1 067	1 231	588	679	574	703
97,0	97,0	97,0	97,0	94,8	94,8	94,8	94,8	95,1	95,1	95,1	95,1	—	—	—	—
52,2	52,2	52,2	52,2	51,8	51,8	51,8	51,8	56,7	56,7	56,7	56,7	—	—	—	—
98,6	97,6	100,5	95,9	97,1	96,2	98,8	97,0	96,1	96,5	97,0	96,2	95,1	94,5	95,9	96,6
80,9	78,0	86,1	81,6	82,3	81,6	80,7	80,2	82,9	82,1	84,3	82,0	83,1	83,1	83,3	85,3
82,2	87,4	83,3	86,8	84,8	85,1	82,5	82,7	80,6	82,4	80,9	80,6	81,4	83,0	83,3	83,0
37,4	37,9	37,8	37,9	35,2	36,3	38,9	37,9	41,3	40,0	41,1	39,5	43,0	41,5	43,1	42,1
− 0,5		− 0,1		− 1,1		+ 1,0		+ 1,3		+ 1,6		+ 1,5		+ 1,0	
− 0,2				− 2,7				+ 0,7				− 0,3			
+88%		+97%		+ 5%		+ 1%		+24%		+15%		+15%		+22%	
+ 5%				+ 4%				+17%				+ 1%			

TABLE 5
Comparison using hot vs warm water

Date	2.2.77		3.2.77	
Run No.	1		2	
Screen type	Standard	Standard	Standard	Standard
Water flow ℓh⁻¹	76	71	38	36
Mols. flow ℓh⁻¹	1 067	818	574	581
Water temp °C	80	38	79	40
Mols. Temp °C	67	65	66	62
Sugar Bx.	97,0	95,8	95,9	93,6
Sugar pur.	84,3	82,0	83,3	82,7
Mols. Bx	80,9	81,7	83,3	84,5
Mols. pur.	41,1	40,1	43,1	41,3
Δ P	+ 1,0		+ 1,8	
Δ Flow	− 23%		+ 1%	

Note: 1. Molasses dilution on
2. All screens washed before tests.

centrifugals. Those factories most affected appeared to be using hotter process water on their centrifugals than those least affected. The "hotter" factories used water at around 80-85° C while the "cooler" factories used water at around 50° C. Unfortunately, only two runs were completed before the season-end, but are thought to be interesting enough to reproduce here.

The two runs showed lowered purity rises across the screens when using cooler water of around 40° C than when using hotter water at around 80° C. As might be expected, the flow rate appeared to be reduced on average.

These results must be treated with caution until further verification tests support them. It is hoped that these tests will be continued in the new season.

"E" Series Results—Table 6

A question that frequently arose was whether the enhanced throughputs were attributable to only the modified sugar screen or to only the modified backing screen or to a combination of both.

In an attempt to answer this question, a series of runs was carried out, the results of which are shown in Table 6.

The results clearly indicate that the highest throughput is attainable with a modified sugar screen on a standard backing screen. Next best is the modified/modified arrangement, followed by the standard/standard arrangement. Worst of all is the standard sugar screen over the modified backing screen.

These results are not too surprising considering the ten mesh backing screen has 100 support "points" as against the four mesh's 16 support "points" per 6,5 cm^2 (i.e. per sq. inch), resulting in a greater closure of apertures by the contact points of the ten mesh screen.

As the highest capacity is achieved on a standard backing screen, why use a modified backing screen? In the author's opinion, greater support is required for the modified sugar screen than for the standard sugar screen. Use of the ten mesh backing screen results in reduced damage by foreign objects to the modified sugar screen. Further, soon after these runs

TABLE 6
Backing screen comparison

Date	4.2.77				11.2.77			
Run No.	1A		1B		2A		2B	
Screen Type (3)	Standard / Standard	Modified / Modified	Standard / Standard	Standard / Modified	Standard / Standard	Modified / Modified	Modified / Standard	Modified / Modified
Water Flow ℓh^{-1}	51	51	57	58	112	113	115	111
Mols. Flow ℓh^{-1}	571	774	550	511	800	1 180	1 384	1 241
Mass. Brix	94,8	94,8	94,8	94,8	93,6	93,6	93,6	93,6
Mass. Pur.	56,0	56,0	56,0	56,0	54,0	54,0	54,0	54,0
Sugar Bx	96,8	96,9	96,2	96,2	97,8	98,7	98,7	97,9
Sugar Pur.	85,3	84,8	84,6	81,0	85,4	86,3	86,2	86,2
Mols. Bx.	85,2	86,8	85,0	85,7	82,4	86,2	86,4	86,8
Mols. Pur.	40,9	39,8	41,9	40,4	41,1	38,9	39,3	39,0
Δ P. Standard-Modified	+0,9		+1,5		+2,2		—	
Flow Rate	Ref. (4)	+36%	Ref.	−7%	Ref.	+48%	+73%	+55%

Note: 1. All screens washed prior to tests.
2. No molasses dilution.
3. Sugar Screen / Back Screen
4. Reference flow rate.

were completed, a section of the modified screen running on the standard backing screen was torn off. The cause is thought to be due to the excessively viscous massecuite being cured at that time. The machine was being fed with a thick (100-125 mm) rope of cold massecuite which entered the machine in slugs, causing it to vibrate. Thus it is possible that those operators who operate their machines with very tight, cool massecuite may not be able to effectively operate the modified screens. However, the fore-mentioned conditions are extreme and are unlikely to be found in general operation.

A most important point to bear in mind when using these modified screens is that they are intolerant of hard, foreign bodies in the feed and anyone contemplating their use would be well advised to ensure that housekeeping is sufficiently good to keep nuts and bolts, welding rods, etc. out of the crystallisers.

Conclusions

Before any hard and fast conclusions may be drawn from these tests results, it would be necessary to carry out further tests, preferably under varying product conditions. It is our opinion, however, that there are strong indications that the main expectation of these modifications has been realised, i.e. that of increased throughputs.

A conservative figure would be around a 25% throughput increase, with figures of over 50% increase attainable. These increased throughputs are achieved at generally higher molasses brixes and at generally equal or lower molasses purities.

As regards screen life, this item still has to be fully explored but lives of over six weeks have been obtained with expectations of further life left in the screens. According to Veco the wear-life of the new screens should equal that of the old screens as the chrome-plating thickness, which determines screen life, is the same on both screens.

Bearing in mind that fewer new screens would be required to handle a given massecuite rate, it is thought reasonable to expect similar screen usage.

Tests will continue in the new season, with two modified screen sets in operation.

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