

THE EFFECT OF VHP SUGAR CRYSTAL SIZE AND OF METHOD OF SEEDING ON SUGAR COLOUR AND PAYLOADS

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Abstract

The effect of crystal size on VHP sugar colour was evaluated on a factory scale over the 1988/89 season at Sezela.

Generally, smaller crystals produced lower sugar colour but the difference was not significant (at the 5% level) in the size range tested.

Smaller crystals produced lower affinated sugar colour and the difference was significant at the 5% level.

The mass of sugar in a full rail truck was related to the method of crystal preparation. There was no significant relationship between crystal size and the mass of sugar in a full rail truck.

Introduction

The introduction of the cane diffusion process and declining cane quality have resulted in Sezela producing sugar of high crystal colour during certain months of the season. Many process related modifications have been carried out during the past few years, as reported by Mann.² During the 1988/89 season it was decided to determine the effect of crystal size on sugar colour. The Sezela factory produces sugar seven days a week and it was decided to produce sugar of big and small crystal size on alternate weeks. From past experience it was known that sugar seeded on Wednesday would reach the South African Sugar Terminal (SAST) on

Monday, which was the start of the SAST week. Since the SAST laboratory was conducting all the analytical tests, the weekly average results would then be for the different crystal sizes. The sugar was sampled and analysed using the recommended SASTA methods.

The Sezela factory uses the modified 3-boiling system, where all B and C sugar is dissolved and mixed with evaporator syrup, to produce VHP sugar. This modified system was adopted about three seasons ago to improve VHP sugar colour. The sugar crystals were grown on slurry and about 4 x 85 m³ of massecuite was produced from 42 m³ of seed massecuite. The volume of slurry was adjusted to yield the required crystal size. For the sake of completeness, the conventional 3-boiling system with B-magma for A footing was used for two periods during the test.

The VHP sugar is dispatched in 58 m³ rail trucks. The transport contract with the railways states that the cost of transport will be based on 50 tons per truck, irrespective of the actual mass in the truck. For this reason it is important that rail trucks have a payload of at least 50 tons. In this paper, truck mass refers to the net mass of sugar in a full rail truck and the weekly figure is an average of about 140 trucks.

Results

The crystal size was regulated fairly successfully over the test period. All the results pertaining to the test are shown in Table 1.

Table 1
The sugar crystal size test results

Week ending	C. J. colour (ICUMSA) (420)	Specific grainsize (mm)	M.A. (mm)	C.V.	Colour (ICUMSA 420)		POL	Average truck mass (tons)	% Fines
					Affinated	Raw			
07.05.88	22300	0,66	0,78	32	745	1293	99,35	48,84	24
14.05.88	21650	0,64	0,75	36	711	1294	99,35	48,13	29
21.05.88	21292	0,65	0,77	34	826	1384	99,37	48,85	26
28.05.88	22058	0,62	0,72	38	642	1284	99,38	48,03	33
04.06.88	20733	0,64	0,76	35	827	1451	99,31	48,23	28
11.06.88	22636	0,60	0,70	38	657	1184	99,38	48,32	35
18.06.88	19107	0,69	0,82	33	909	1270	99,43	48,99	21
25.06.88	22773	0,58	0,67	41	517	1079	99,49	47,64	40
02.07.88	20558	0,69	0,83	30	585	991	99,55	49,20	18
09.07.88	17220	0,61	0,72	38	578	841	99,68	48,76	33
16.07.88	18778	0,73	0,86	30	820	1046	99,67	48,93	15
23.07.88	17010	0,64	0,76	36	588	1235	99,45	47,91	29
30.07.88	17720	0,68	0,82	34	735	1416	99,39	49,75	22
06.08.88	17926	0,63	0,76	35	996	1314	99,42	49,30	28
13.08.88	18591	0,69	0,82	30	764	1275	99,49	49,68	19
20.08.88	18417	0,63	0,76	36	595	1314	99,47	49,83	29
27.08.88	18900	0,64	0,77	35	672	1089	99,53	49,72	26
03.09.88	19940	0,56	0,65	42	715	1089	99,56	49,59	42
10.09.88	19098	0,66	0,80	34	839	1323	99,44	49,78	23
17.09.88	22441	0,61	0,72	35	677	1122	99,58	49,73	31
24.09.88	18374	0,66	0,80	33	925	1397	99,53	50,04	22
01.10.88	17519	0,60	0,72	37	805	1307	99,55	49,81	33
08.10.88	19089	0,66	0,78	33	829	1408	99,46	49,20	24
15.10.88	20450	0,62	0,75	37	750	1437	99,39	47,81	30
22.10.88	19947	0,65	0,78	35	1003	1464	99,54	48,48	26

During the period 07/05/1988 to 23/07/1988 the seed was developed from nuclei obtained from crushed refined sugar, ie the seed was slurry grained. During the period 23/07/1988 to 04/10/1988 the sugar crystal was developed from B-magma and slurry graining was practised for the rest of the period.

Analysis of results

The clear juice colour fluctuated during the test and affected sugar colour accordingly. The trend was similar to that found by Lionnet¹ who reported that there was a seasonal trend in the amount of colour transferred during processing. At a clear juice colour of 17 220 units the mill produced sugar with a colour of 841 units, which is about 37% below the specified maximum of 1 350 units. The sugar pol also fluctuated during the test and influenced sugar colour to a certain extent.

The data collected over the periods when slurry graining was used and the periods when B-magma was used were analysed separately. The statistical method used was the t-test for mean values. The effect of the two different methods of crystal production on the means of specific grain size (SGS), coefficient of variance (CV), mean aperture (MA), and other parameters is shown in Table 2. Clear Juice (CJ) colour was also tested over the same periods to ascertain whether any change in input colour was evident.

Table 2
t-test on means for slurry graining vs B-Magma footing

Parameters	Slurry		B-Magma		Calculated (t)	Significant (yes/no)
	Mean	St. dev	Mean	Std. dev		
CJ colour	20373	1838	19093	1423	1,78	no
SGS	0,64	0,038	0,64	0,039	0,6	no
MA	0,76	0,050	0,75	0,055	0,7	no
Affined colour	732	138	772	122	0,7	no
Raw sugar colour	1244	185	1264	121	0,3	no
Sugar purity	99,56	0,101	99,60	0,060	0,6	no
Truck mass	48,49	0,516	49,72	0,189	6,93	yes

The above results show very clearly that none of the parameters tested, except for truck mass, showed significant differences in their mean values for slurry graining or B-magma footing.

In comparing the effects of big and small crystals the Student's t-test was applied to the parameters of interest (colour, SGS, sugar purity, CJ colour and truck mass) at the 5% level of significance. The results are shown in Table 3.

The relationship between CV and crystal size and % fines and crystal size is shown in Figure 1. It can be seen that small crystals produced a high percentage of fines or stated differently small crystals gave a high CV value. All the data points were scattered in the same region, ie there was no step change in CV or % fines with slurry graining or B-magma footing process.

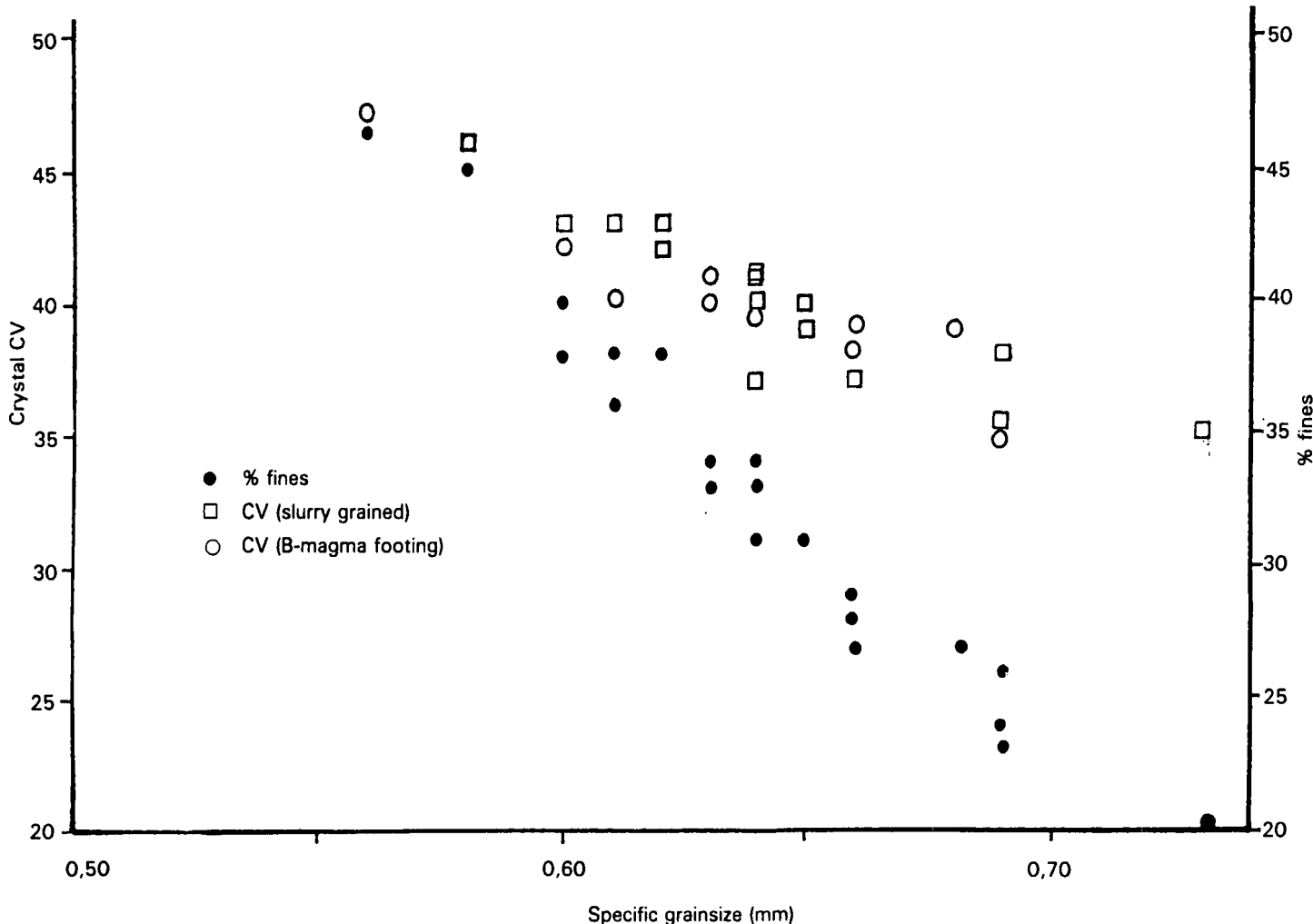


FIGURE 1 Relationship between crystal size, CV and fines.

Table 3
t-test on means with big and small crystals

Parameters	Big crystals		Small crystals		Calculated (t)	Significant (yes/no)
	Mean	Std. dev	Mean	Std. dev		
SGS	0,67	0,026	0,61	0,024	5,50	yes
Affinated colour	806	109	686	127	3,65	yes
Raw sugar colour	1293	157	1206	157	1,3	no
Sugar purity	99,57	0,093	99,59	0,084	0,5	no
CJ colour	19600	1300	20100	1290	0,8	no
Truck mass	48,21	0,55	48,74	0,86	1,57	no

Discussion

Raw sugar colour

Generally smaller crystals produced lower colour but the difference was not statistically significant (5% level) in the size range tested (mean values 0,67 and 0,61 mm for big and small crystals respectively). However, in practice it was found that raw sugar of acceptable colour could be produced by decreasing the crystal size to below 0,60 mm even when the incoming juice colour was high. Since a smaller crystal size produces a higher percentage of fines the mill runs the risk of incurring a fines penalty which is financially more severe than the colour penalty. There was no significant difference in raw sugar colour between slurry graining and B-magma footing. It must be noted that the B-magma method was used in that part of the season where the incoming juice colour was relatively low, as can be seen from Table 1, and this could have influenced the results.

Affinated sugar colour

There was a highly significant relationship between affinated sugar colour and crystal size. In the size range tested the smaller crystal produced a lower colour and there was about 17% colour reduction for a 10% size reduction. This

reduction in affinated sugar colour persisted in the raw sugar colour, although not significant at the level tested. The difference in colour between slurry graining and B-magma footing was not significant but as expected the mean was slightly higher with B-magma footing.

Truck mass

Surprisingly there was no significant relationship between truck mass and crystal size. There was a highly significant difference in truck mass between the slurry graining and B-magma footing processes. The reason for this is not clear. The relationship between CV and truck mass is plotted in Figure 2.

It can be seen from Figure 2 that the data points for B-magma footing sugar are scattered towards the higher mass region and the data points for slurry grained sugar are clearly displaced towards the lower mass region. This is very surprising when one considers that the data points are scattered in the same region in Figure 1, which plots CV and SGS for the two different processes. When on the B-magma footing process, it seems that a truck mass in excess of 49 tons can be achieved even with a poor quality sugar which has fines in excess of 40%. However, even with good quality sugar, a mass of less than 49 tons can be expected with slurry grained sugar.

Conclusion

Generally smaller crystals produced lower crystal colour, but the difference was not statistically significant in the size range tested. However in practice it has been noted that an acceptable colour can be produced with a crystal of less than 0,60 mm even with high coloured juices, but at this small size the chances are that the fines quantity would be more than the specified limit. Since the fines penalty is harsher than the colour penalty this is not a viable option for factories which sell sugar in VHP form. Factories that have a

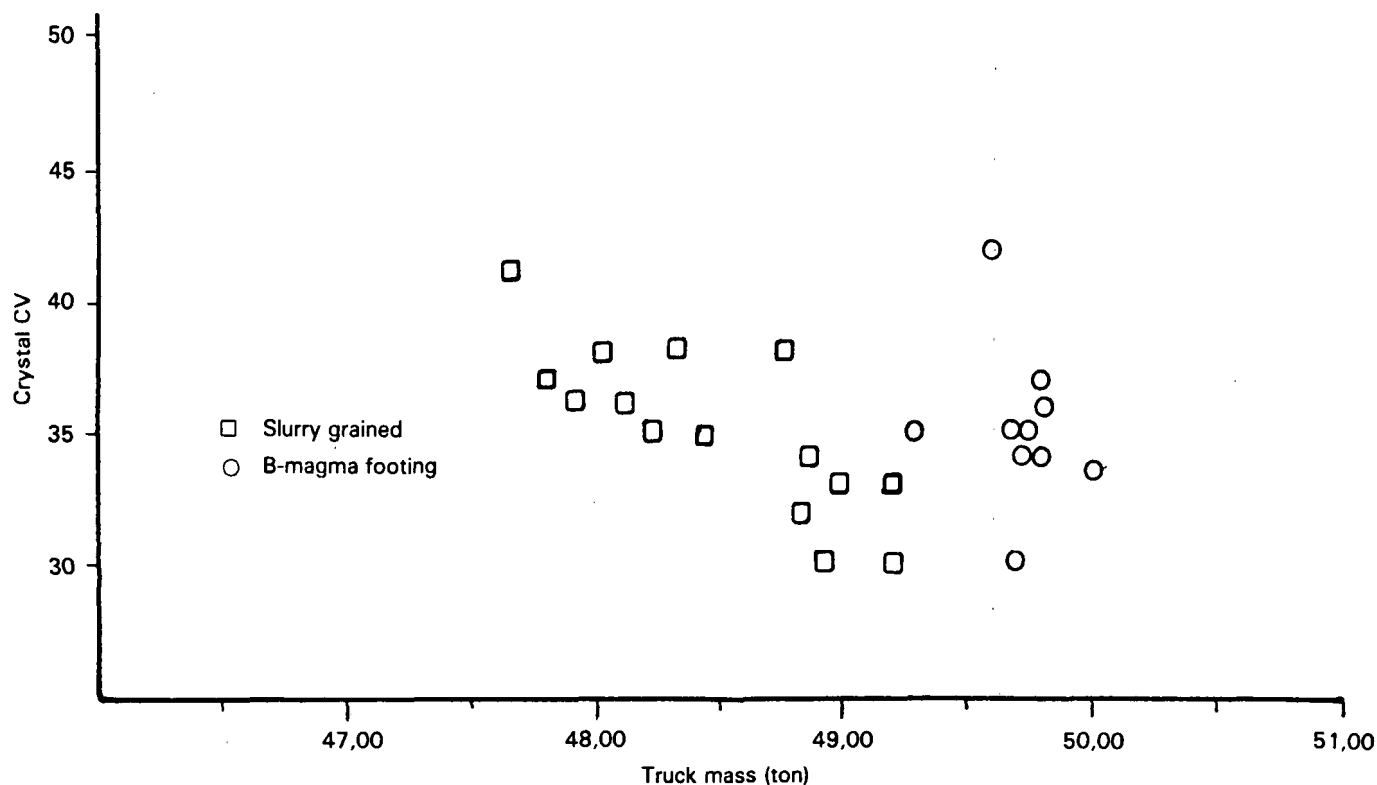


FIGURE 2 Relationship between crystal CV and truck mass.

backend refinery can limit the refinery colour input by producing small crystal in the raw house. The significant relationship between affinated sugar colour and crystal size is of no benefit to producers of VHP sugar, since there is no bonus/penalty for affinated sugar colour. However, refineries that use the affination process would find this relationship very interesting.

For the last three seasons the Sezela mill was plagued by low dispatch truck masses. Since the transport cost is calculated on 50 tons per truck, irrespective of actual mass, the industry was losing money on the transport of sugar from the mill to the terminal. There was pressure on Sezela to rectify the low truck masses, especially when other mills in the industry were achieving 50 tons per truck regularly.

About 3 years ago, Sezela adopted the slurry graining method of raw sugar production to minimise sugar colour and only in the past season did the relationship between the method of sugar production and truck mass come to light. This finding is bound to save the industry a substantial amount of money in sugar transport costs.

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