

# A FURTHER REPORT ON THE "TRUE" SEEDING OF VACUUM PANS

By E. BEESLEY

## Introduction

Since the initial work on "true" seeding carried out by the S.M.R.I. at Umfolozi in 1953-54 and reported at the 1954 Conference<sup>1</sup> the subject has received a good deal of attention both by the author and by Illovo Sugar Estates personnel.

During this time further grain establishment tests have been carried out at Illovo and Tongaat Sugar Company and graining purities of both syrup and A molasses purities have been used.

As it is impossible to cover all this work in a paper sufficiently short for the Conference, this report will only cover the main conclusions reached from the tests at Umfolozi, Tongaat and Illovo using variations of the basic technique outlined in the 1954 paper,<sup>1</sup> and tests carried out at Illovo during 1956 using a considerably modified technique.

The full report is due to be published as a communication from the S.M.R.I. in the very near future, and so this paper can be said to be confined to the latest developments only.

Before reporting on the conclusions reached using the basic technique mentioned above, it seems just as well to briefly describe it again here.

The graining charge is boiled down under normal steam supply until it is just undersaturated, whereupon the steam supply is cut back to give gentle boiling, while maintaining reasonable circulation. As concentration continues and the graining point is approached, the water feed is turned on and adjusted until the conductivity is constant at the graining point, at which stage the slurry is sucked into the pan. The conductivity (supersaturation) is then held constant until the grain has grown sufficiently to form a masseuite, whereupon feed is started. During this growing period the steam valves are slowly re-opened to their normal value.

### *Conclusions drawn from Tests using Variations of the above Technique*

The following conclusions were drawn from the tests at Umfolozi, Tongaat and Illovo in which the above technique or modifications thereof were used:

(a) That the metastable (true seeding) zone covered a very wide range of conductivity, the minimum width was about 25 mA (at Umfolozi) and the maximum about 45 mA (at Illovo), and seemed to be controlled more by pan design and cuitometer set-up than by graining charge purity.

(b) That when graining using the above technique on purities below  $80 \pm$ , the author could obtain a high degree of grain size reproducibility in any one vacuum pan for most test grainings. However, when the results using S.M.R.I. slurry at each mill were compared, it appeared that equivalent quantities of slurry at Illovo gave a much finer grain than similar slurry at Tongaat, and while the slurry at Umfolozi was definitely coarser than that at Illovo and Tongaat (ground for only  $7\frac{1}{2}$  hours compared to 23 hours), the resulting grain size compared very favourably with the Tongaat figures. Hence it was concluded that pan characteristics could govern the amount of slurry required per strike (which bore out Gillett's<sup>2</sup> findings but is clearly at odds with the basic concept of true seeding) but that very careful attention at the graining point would usually lead to the same loss of slurry at each graining in any one pan.

(c) That when "true" seeding was applied by the above technique as routine factory practice (at Illovo) the grain size was not sufficiently reproducible.

(d) That almost invariably this lack of grain size reproducibility was due to loss of slurry and never to extra grain being "shocked" in.

(e) That the main reason for loss of slurry was a hot undersaturated layer of mother liquor next to the calandria tube surfaces due to the use of steam to maintain circulation. This would in fact account for the above three points ((b), (c) and (d)).

A possible secondary reason for loss of slurry was the use of feed (water) to balance the concentration at graining.

(f) That the effect of vacuum (and hence temperature) fluctuations on supersaturation were reduced to almost insignificance provided the conductivity was held at its predetermined value. This statement is not meant to condone the use of one vacuum pump to many vacuum pans—individual vacuum systems for each pan (especially the C pan) will always be necessary for safe, sure sugar boiling. However, it does give conductivity control a great advantage over the elevation of the boiling point method.

Interpreting these conclusions further, it appeared that for true seeding, the graining conductivity should not be very critical, provided it was within the metastable zone range, nor should it matter what the graining charge temperature was within reasonable limits (say 130 to 160°F) *provided* the steam to the heating surfaces could be shut off completely *before* drawing in the slurry.

The problem posed by these conclusions was that of circulation, as, on the face of it at least, no steam, no circulation, and no circulation is supposed to result in conglomerate.

However, there appeared to be no alternative but to try graining a static graining charge, and arrangements were made to carry out tests at Illovo on A molasses, and Tongaat on syrup, and to use Illovo slurry at both mills to allow comparisons to be drawn.

The first test at each mill (E.G.81 at Tongaat and E.G.82 at Illovo) therefore followed the same pattern, i.e. the steam was shut off at a fairly high conductivity and the condenser and vacuum pump left on, with the result that the graining charge continued to boil down under its own heat. At Tongaat the condenser was left on and finally equilibrium was reached at maximum vacuum, and the conductivity became constant. The slurry was then drawn into the pan and shortly after this (4 minutes) the steam was turned on again and boiling restarted.

At Illovo, the condenser was also left on after shutting off the steam; however, when the conductivity had dropped to 5 mA above the required graining point, the condenser water was also shut off, whereupon equilibrium was established, the conductivity became constant and the slurry was drawn into the static graining charge. Thirty minutes later, the steam valves were reopened, followed by the condenser water valve and then the water feed. The conductivity had not materially altered during this period.

As far as these two grainings were concerned, the results were most interesting.

At Tongaat, the percentage of conglomerated crystals was rather higher than usual, but the crystal size compared very closely to later tests at Illovo. This was very promising, but unfortunately, further tests, with the technique modified as described hereunder, were not so satisfactory.

At Illovo, contrary to expectations, the increase in deformed crystals (conglomerate and twins) was negligible (it was estimated to be about 8 per cent compared to the normal 5 per cent) and the size of the final grain confirmed the belief that in all previous grainings slurry was lost to some extent, but never was extra grain shocked in.

However, the main contribution of these two grainings was that they pointed the way to graining without steam heating, with circulation and without artificial agitation.

To show how this can be obtained, it is necessary to describe the conditions in a vacuum pan when boiling down a graining charge.

Due mainly to the high rate of evaporation, supplying a large volume of vapour to the condenser, the boiling graining charge is considerably superheated with respect to the vacuum that *can* be attained by the vacuum pump and condenser and maintained by the vacuum pump alone.

Hence if the steam supply is shut off and the condenser and vacuum pump left on, the vacuum will increase and the graining charge will continue boiling under its own heat, maintaining very brisk circulation. Now as this spontaneous boiling takes place, the graining charge cools rapidly, hence the supersaturation increases both by evaporation and cooling and the conductivity drops very rapidly until finally maximum vacuum is attained and equilibrium restored.

Now, it was known from previous boiling experience that this did occur; however, it was the two grainings at Tongaat and Illovo that really showed the remarkable rapidity of the conductivity drop (less than 2 minutes) and the range it covered (i.e. 30 to 40 mA), which in turn is of the same order as the width of the metastable zone.

The following technique therefore followed as a logical consequence of these observations:

The graining charge is boiled down under normal vacuum and steam supply for about half to two-thirds of the usual boiling down time. At this stage the condenser water is reduced slightly to reduce the vacuum, as this will ensure that the vacuum is considerably lower than that actually attainable by the pump and condenser. Following this, the steam supply to the calandria is reduced considerably; if this is not done, the drop in conductivity after shutting off the steam will be so rapid that it will drop far too far even in the short time required to shut the steam and then the condenser.

When the conductivity drops to a value roughly equal to that of the metastable zone upper limit, the steam supply, followed immediately by the condenser water supply, is shut off. The conductivity continues to drop for a few mA (4 or 5) then equilibrium is reached and it remains constant, whereupon the condenser water is re-opened ( $1\frac{1}{2}$  turns for the Illovo No. 6 pan) just sufficiently to give brisk boiling with a fair rate of decrease in conductivity (say  $1.5 \pm$  mA per minute).

The slurry is sucked into the pan when the conductivity is still fairly high in the metastable zone and the spontaneous boiling down is allowed to continue until the conductivity reaches a value one or two mA above that at which to bring the grain together, whereupon the condenser water is again shut off completely.

Ebullition at this point comes to an end; however, there is a continual heaving of the mass and hence a certain amount of circulation. Also, the conductivity and hence supersaturation, remains almost constant and so the crystal nuclei continue to grow.

When the grain appears to have grown sufficiently to be safe from dissolution in the calandria hot zones (30 minutes in the case of A molasses grain), boiling is restarted. This is best achieved by opening the steam valves slightly, then opening the condenser water to its normal extent; both conductivity and temperature start to rise at this point and some measure of control can be achieved by adjusting the steam valves. When the conductivity starts to drop again, the balancing water feed is turned on and the conductivity held at the desired value for the rest of the bringing together period. The steam supply is increased steadily to its normal value during this period.

Theoretically, the technique should give—

- (a) a homogeneous graining charge, so ensuring no loss of slurry nuclei;
- (b) a graining concentration so low that the possibility of shocking in extra grain is absolutely non-existent;
- (c) freedom from the risk of conglomerate grain due to
  - (i) the low supersaturation at graining;
  - (ii) the brisk circulation during the initial life of the crystals;
- (d) complete reproduceability of grain size due (apart from (a) and (b) above) to the remarkable simplicity of the method and the wide range of latitude of the graining conductivity and temperature.

Six tests using this technique and one graining into a static charge (mentioned previously) were carried out at Illovo on A molasses, with highly satisfactory results.

Four tests with this technique and one with a static charge were carried out at Tongaat on syrup. Unfortunately samples of finished massecuite were only taken for the static test and two of the others, and the latter were not so satisfactory. However, there is sufficient evidence to warrant further tests on syrup.

The Illovo tests are reported hereunder:

*Grain Establishment Tests at Illovo, using the "No Steam" Technique on A Molasses (70± Purity)*

Previous experience at Illovo had established that the metastable zone limits with both recorder and indicator "cuitometer" in circuit were 35 and 80–85 mA, and therefore they did not have to be determined afresh. However, where they are unknown, the following time-honoured method can easily be used to find them. This is to make grain by any method (preferably by the technique described in 1954<sup>1</sup>), then bring it together until it has grown to a fair size (say half way to forming a massecuite). At this stage the conductivity is slowly decreased until microscopic observation shows new grain forming. This reading plus 5 mA establishes the lower safe limit. Wash water is then applied to raise the conductivity slowly until observation shows the grain rounding off. This reading minus 5 mA establishes the upper safe limit.

The results of the Illovo tests are given in Table I.

Examination of this Table will show:

- (a) the slurry used came from different batches but all from the same pebble mill;
- (b) different quantities of slurry per finished C strike were used;
- (c) the steam and condenser water were shut off at different conductivities (which were, however, always close to the metastable zone upper limit) and at different temperatures;
- (d) the slurry was drawn into the pan at different conductivities (19 mA range) and different temperatures (14.5°F range);
- (e) all the grainings were finally brought together at the same conductivity no matter what the temperature;
- (f) the bringing together times varied somewhat but this was purely due to the whim of the author. It is safe to say that time required to bring together is controlled by the quantity of slurry per graining charge provided the conductivity is held at the same value.

Now, of course, the criterion of success of the technique is the reproduceability of the grain size, and hence this has been determined for each strike with as much accuracy as possible, and in itself deserves a short note.

TABLE I  
**ILLOVO "A" MOLASSES GRAIN ESTABLISHMENT TESTS WITH THE "NO STEAM" TECHNIQUE**

1956

Experimental Graining No. ... ..	82	90	91	84	89	85	87					
Date Grained ... ..	20/9/56	17/10/56	18/10/56	26/9/56	16/10/56	27/9/56	28/9/56					
Source of Slurry ... ..	Illovo	Illovo	Illovo	Illovo	Illovo	Illovo	Illovo					
Slurry Batch No. ... ..	34	38	38	34	27	34	34					
Vol. slurry ml/1000 cu. ft. ... ..	500	500	500	750	750	1,000	1,000					
Wt. sugar in slurry gm./1000 cu. ft. ... ..	137	137	137	205	205	273	273					
No. C strikes/graining ... ..	2	2	2	2	2	1	1					
Graining purity ... ..	69.9	72.2	73.2	70.3	71.8	71.8	70.8					
Steam and condenser shut *Time min. ... ..	-4	-6	-7	-12	-7	-7	-9					
and condenser re-Cond. mA ... ..	75	88	88	82	82	82	82					
openedTemp °F ... ..	154	158	158	158	158	165	149					
Slurry started in... ..	0	0	0	0	0	0	0					
Cond. mA ... ..	56	75	75	66	71	66	66					
Temp °F ... ..	144	152	154	149	153	157	142.5					
Slurry finished in ... ..	1	1.5	1.5	2	1.5	1.5	1.5					
Cond. mA ... ..	56	72.5	73	62	66	62.5	62					
Temp °F ... ..	144	149	152	147	149.5	156	141					
Condenser shut ... ..	-3	9	13	7	4	5	6					
Cond. mA ... ..	60	62	55	56.5	56	56.5	56.5					
Temp. °F ... ..	144	140	142	144	143.5	152.5	136.5					
Steam re-opened ... ..	30	44	32	30	31	30	32					
Cond. mA ... ..	57	70	—	55	56	56.5	55					
Temp. °F ... ..	143	140	—	142	—	148.5	132.5					
Condenser re-opened ... ..	32	44	30	30	31	30	32					
Cond. mA ... ..	—	70	60	55	56	56.5	55					
Temp. °F ... ..	—	140	140	142	—	148.5	132.5					
Water feed started ... ..	33	64	40	33	37	34	35					
Cond. mA ... ..	63	55	55	58	58	58	58					
Temp. °F ... ..	152	—	141	—	—	156	134					
Conductivity brought together mA ... ..	55	55	55	55	55	55	55					
Total time to bring together.min. ... ..	120	170	90	120	90	120	120					
Illovo C Strike No. ... ..	968	972	1214	1218	1226	1233	1016	1020	1200	1206	1027	1040
Masse. purity ... ..	59.2	57.4	59.9	59.9	61.7	61.6	58.7	59.5	58.1	59.2	59.0	59.6
Masse. Brix ... ..	97.8	97.6	96.9	97.3	97.6	97.05	96.7	96.8	97.8	98.05	98.1	96.95
Mother liquor purity ... ..	33.1	31.6	34.8	32.4	32.4	32.8	35.0	33.8	33.7	33.3	31.8	33.4
Crystal % Masecuite ... ..	38.75	36.95	37.85	40.2	42.9	42.2	35.8	38.1	36.55	38.7	39.7	38.7
Av. Crystal Length mm. ... ..	0.405	0.402	0.409	0.425	0.449	0.436	0.354	—	0.340	0.350	0.313	0.302
Av. Crystal Breadth mm. ... ..	0.297	0.289	0.285	0.282	0.308	0.293	0.246	—	0.237	0.252	0.201	0.220
Breadth/Length ratio ... ..	0.735	0.719	0.697	0.663	0.687	0.673	0.695	—	0.698	0.720	0.643	0.729
Corrected Av. Crystal Length mm. ... ..	0.388	0.381	0.382	0.387	0.416	0.400	0.330	—	0.317	0.332	0.280	0.288
C.A.C.L.C. mm. ... ..	0.385	0.384	0.382	0.380	0.399	0.386	0.337	—	0.321	0.330	0.276	0.286

\* The times noted in minutes against each stage are based on starting to draw in the slurry as zero time.

Firstly, the photomicrographic technique has been used to obtain the average dimensions of the fully grown crystals in each strike. An extensive investigation has shown that one hundred consecutive crystals from any part of a strike will give the average crystal length to an accuracy of  $\pm 2.12$  per cent standard deviation, and the average crystal breadth to  $\pm 2.65$  per cent standard deviation. At least one hundred crystals were measured for each of the test strikes, so the basic dimensions are highly accurate.

Secondly, the breadth-to-length ratio is only very rarely the same between strikes, hence a correction is made to give a standard breadth-length ratio of 0.8. Unfortunately the depth of the crystals, which also varies, cannot be taken into account without a very complicated technique.

Finally, the crystal per cent massecuite is very rarely the same between strikes, and so a further correction is made to a standard of 38 per cent based on brix, apparent massecuite and mother liquor purities and a crystal purity of 99. This final figure is called the Corrected Average Crystal Length Corrected which is better written as C.A.C.L.C.

Figure 1 shows the C.A.C.L.C. values for each strike from each graining plotted against slurry volume in ml per 1000 cu. ft. massecuite (one strike). The full black circles are the average C.A.C.L.C. values for each slurry quantity.

The continuous dotted curve on Figure 1 is a plot of the cubic function.

$$A^3 \times B = C^3 \times D \dots \dots \dots (1)$$

where A = C.A.C.L.C. resulting from B	} determined from test grainings
B = Slurry vol./strike to give A	
C = C.A.C.L.C. resulting from D	} desired
D = Slurry vol./strike to give C	

with the average 500 ml C.A.C.L.C. value (0.3859 mm.) and 500 ml substituted as A and B respectively, to give

$$C = \sqrt[3]{\frac{28.734}{D}} \dots \dots \dots (2)$$

However, this function would only be expected to apply if sucrose crystals were non-variant in shape from nucleus to finished crystal, which they most certainly are not, hence the average C.A.C.L.C. values diverge from this curve.

However, the continuous solid curve on Figure 1 fits the average C.A.C.L.C. values very well indeed, and has the equation

$$C = \sqrt[3]{\frac{28.734}{D}} - 0.000044 D + 0.022 \dots \dots (3)$$

Comparing equations (2) and (3) it will be seen that the only difference is the factor

$$- 0.000044 D + 0.022$$

the sole effect of which is to increase the slope of the cubic relationship (equations (1) and (2)).

That this should be so is entirely logical, due to the fact that as sucrose crystals grow, the secondary faces (111,011 and 101) or "shoulders," develop more and more, hence the more it departs from the rectangular cuboid shape, and hence the C.A.C.L.C. dimension (which involves breadth too) becomes more and more inflated.

This in itself is strong evidence of true seeding; however, further support is gained from

- (a) the greatest divergence of any single graining from the curve (equation (3)) is only 3.2 per cent on C.A.C.L.C.;
- (b) the very smallest C.A.C.L.C.'s, indicating least loss of slurry, from both Illovo grainings and the author's previous tests at the mill, using the former technique, agreed well with the curve. But most of the points fell well above it.

All the evidence, both theoretical and practical, is therefore in support of true seeding having been achieved in these Illovo tests.

What is more, according to the theory of the technique it appears to be the only method that has the potential to eliminate the effect of the characteristics of individual vacuum pans.

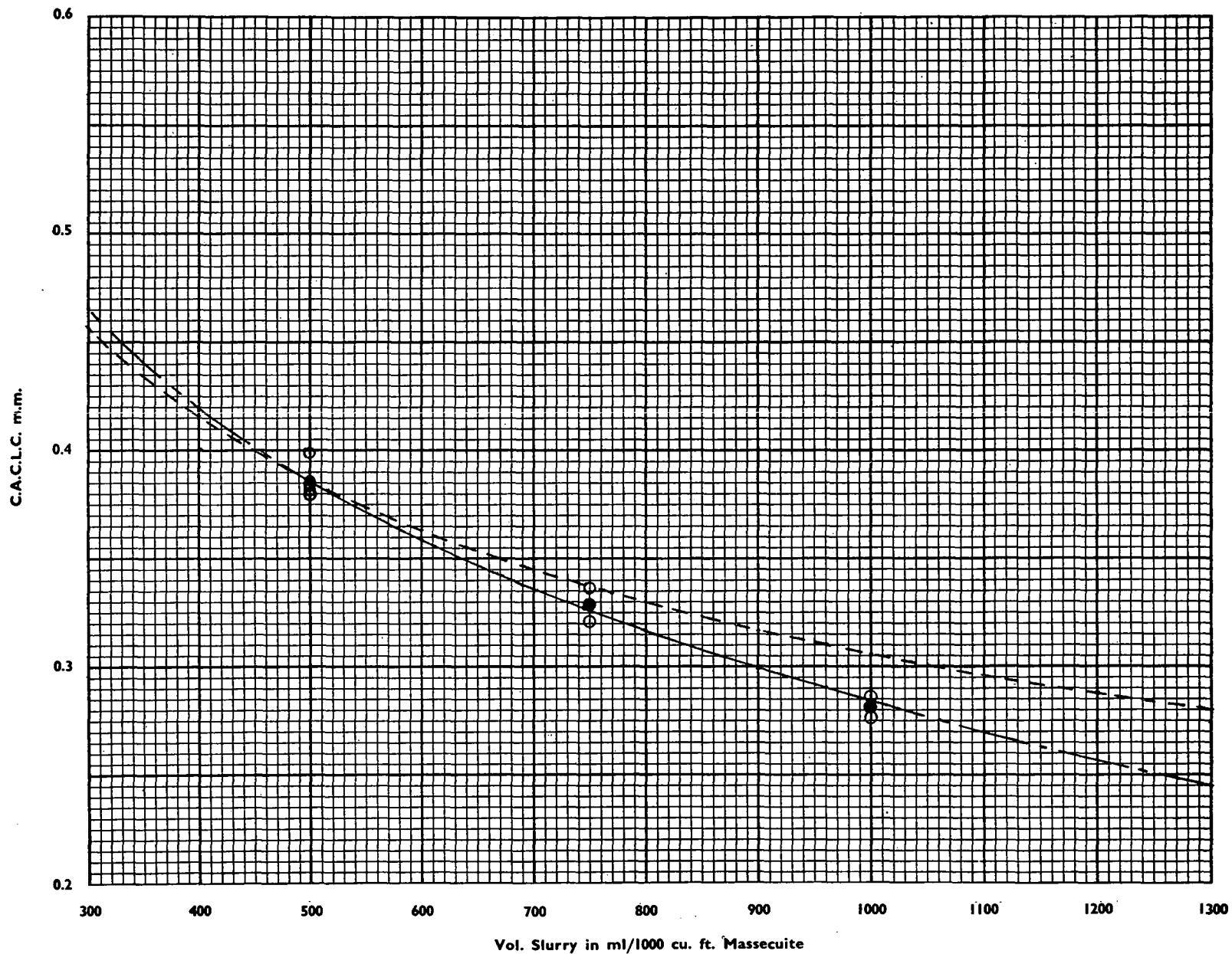
A further point of interest is that the incidence of deformed crystals in all the grainings except the first, was no different to that normally experienced at Illovo (i.e. about 5 per cent).

# GRAPH SHOWING C.A.C.L.C. TO SLURRY VOLUME FOR TESTS AT ILOVO USING THE "NO-STEAM" TECHNIQUE 1956

○ C.A.C.L.C. values for individual strikes ● Average C.A.C.L.C. values for each slurry quantity

Dotted Curve = Simple Cubic Relationship (Equation 2)

Continuous Curve = Practical Relationship (Equation 3)



### Final Conclusions

The final conclusions are therefore:

- (a) That the use of steam heating during the graining period when attempting true seeding, almost invariably results in the loss of some nuclei.
- (b) That a very simple foolproof true seeding technique that eliminates the use of steam at graining without necessitating artificial circulators, has been evolved.
- (c) That the results obtained with it when graining A molasses at Illovo are very satisfactory indeed, and that true seeding was in fact achieved.

### Summary

The conclusions reached from tests on "true" seeding covering the past four crushing seasons are given.

The evolution of a seeding technique, whereby the steam to the calandria is shut off well before the graining point, is given as a logical sequence to the above conclusions.

Results of tests using the technique for seeding A molasses are reported.

Evidence from these tests and from tests using the previous technique is then used to show that the new technique gave true seeding.

### Acknowledgments

The author wishes to thank the Management and Staffs of Umfolozi, Tongaat and Illovo for the co-operation received when carrying out tests at these mills, and the Illovo personnel headed by Mr. K. W. Pearce, for the availability of the tremendous amount of data collected from work carried out as routine or private tests, at this mill.

### REFERENCES

- <sup>1</sup> Beesley, E. (1954): Some Notes on "True" Seeding of Vacuum Pans. Proc. S.A. Sugar Technologists' Association, **28**, 111-114.
- <sup>2</sup> Gillett, E. C. and Kenda, W. (1950): Development of the Gillett Process of Sugar Crystallization. Hawaiian Planters Record, **LIII**, No. 3.

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**The Chairman, Dr. C. Van der Pol**, said that the tendency of present-day activity was to substitute the art in sugar making by a science. The method outlined by Mr. Beesley was more scientific than was usually carried out at most sugar factories.

**Mr. Rault** enquired if graining on a purity of 68 or 75 one could still be sure of getting the same number and size of grains in the pan.

**Mr. Beesley** replied that this was so as in his experience graining purity variations of a few degrees had no noticeable effect when graining at low purities.

**Mr. Ducasse** expressed doubt that the slurry was the only grain which was introduced into the pan. He pointed out that when the pan was boiling at a high temperature, when the temperature was reduced it would automatically form new grain. He wished to know, among other things, the lbs. of sugar per cubic foot massecuite obtained in the experiments.

**Mr. Beesley** replied that his 1954 paper was based on his experience in Australia, where the technique of that time appeared to give satisfactory results, and his work at Umfolozi in 1953-54, where the grain size reproducibility was also satisfactory. However, later work at Tongaat and Illovo had shown that the technique was not satisfactory, hence the development of the "no-steam" technique.

As far as the possibility of having shocked in grain through rapid temperature drop, was concerned, he was perfectly satisfied from the correlation between C.A.C.L.C. and slurry volume, and his practical knowledge of sugar boiling, that this had not occurred.

**Mr. Rault** stated that two different pan boilers had employed twice the amount of slurry in the pan and found a surprisingly small difference in the size and amount of the final grain.

**Mr. Beesley** replied that this was quite possible when steam was used on the calandria at graining point, as variations in rate of steam supply caused variations in the amount of slurry lost. He stated that Illovo figures appeared to show that on occasion as much as 80 per cent of the slurry could be lost due to this.

**Dr. K. Douwes Dekker** enquired if Mr. Beesley could say what would happen if one doubled the amount of slurry used. It may be if the crystals were not measured exactly one would not notice whether the grain size was decreased.

**Mr. Beesley**, quoting from his paper, showed that by doubling the slurry quantity from 500 to 1000 ml, a difference of 0.1 mm in grain size would result. This, he thought, would be noticeable under a microscope; however, he said that most of his rough comparisons between strikes had been carried out using the photomicrographs, when such a difference would be quite obvious.

In reply to a question by Mr. Sargent, Mr. Beesley said that when both calandria steam and condenser water were shut off, ebullition as such rapidly came to an end, and that when the condenser water was reopened ebullition recommenced almost immediately.

**Mr. N. V. Sargent** said that Mr. Beesley had grained at 70° purity and had said that no conglomerates

appeared, and he asked if conglomerates ever appeared at this purity.

**Mr. Beesley** replied that the danger did appear to be very small at this purity, and quoted the static graining (E.G.82) as giving only  $\pm 8$  per cent deformed crystals against the usual  $\pm 5$  per cent. However, by inducing circulation as described in the paper, an added safeguard was introduced and amongst other advantages, the slurry particles were rapidly distributed throughout the graining charge.

**Mr. Leclezio** said that the 1954 paper was the cause of their originally starting to use slurry for seeding in Mauritius. He enquired of Mr. Beesley whether and how his method of seeding could be applied in cases when several pans were connected to the same condenser.

**Mr. Beesley** replied that he would not like to give a definite answer to this question without first looking into the matter more closely. It did appear, however, that a butterfly valve in the vapour line might provide an answer.

Later considerations make it appear probable that the technique could be applied, provided a vacuum pump connection was installed between the butterfly or gate valve in the vapour line and the pan, and the pan vacuum was controlled (by the valve) such that even at the bringing-together conductivity, it was slightly less than in the rest of the system.

**Mr. Elysee** said that although the three mills of his company had all adopted slurry seeding they would have much liked to have had Mr. Beesley's work done at their factories. He found by slurry seeding they got a much more regular grain and they found that by introducing quantities of slurry they could change the crystal size. They had found that on occasion actual grain also came out with a slurry seeding. Without the use of circulation water in the pan he asked if it would not be preferable to use mother liquor instead. He asked if beside the use of the cuitemeter if Mr. Beesley had not also used a refractometer, to determine the slurry introduction point.

**Mr. Beesley** said that as far as using mother liquor rather than water during the bringing-together period was concerned, it was very satisfactory when the graining purity was very high (syrup), because the rate of crystallization was then sufficiently high for it to outstrip rate of feed and so form a massecuite. However, when graining at low purity the rate of crystallization was so slow, that mother liquor feed would result in a pan full of concentrated mother liquor and widely-separated underdeveloped crystals even though the total number of crystals might be correct.

**The Chairman** enquired of Mr. Pearce if the slurry method were more, or was it less difficult than the normal method used.

**Mr. Pearce** replied that this method was much easier. He related that in his factory the pan boiler on C pans had a fair amount of work to do but those on A and B pans had less to do.

**Mr. Rault** had been informed that in Rhodesia by using instrumentation it has been possible to train natives without much sugar sense to boil reasonably well a final massecuite on the indications of the cuitemeter.

**Mr. du Casse** enquired if the crystal size had any connection with the actual yield of sugar.

**Mr. Beesley** said that the yield depended on a number of factors, e.g. the purity of the massecuite, the actual boiling technique, the effect of various impurities and the crystal surface area provided. The crystal per cent massecuite, as calculated from massecuite and mother liquor purities had therefore been used in the report to correct crystal size to a standard crystal per cent massecuite, before comparing results.

**Mr. du Casse** enquired if slurry graining had been compared with the ordinary method as far as crystal yield was concerned.

**Mr. Beesley** replied that this had not been done, as the object of the work was to develop a reproducible graining technique and so bring one of the major variables in sugar boiling under control.