SOME NOTES ON "TRUE" SEEDING OF VACUUM PANS

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Introduction

One of the misfortunes of the sugar industry is that the raw material supplied to the pan stage for the recovery of sugar, is by no meas consistent, and that, due to the nature of sugar cane, it is most unlikely that it ever will be so. However, it is only logical to attempt to recover the maximum amount of sugar of the required quality.

Now the A and B strikes provide the bulk of the bagged sugar, and the C strike is important mainly because it is the "last chance", so to speak, to recover sugar. Due to this it is obviously worth while to give the greatest attention possible to the treatment of this "last chance" strike. To do this, the following conditions are generally accepted as being most desirable.

1. A pan with the best possible characteristics, namely, a low graining volume, good circulation and good draining properties. These properties will lead to better grain formation, successful heavy boiling without stagnation and quick dropping of high bri massecuites.

2. A reasonably consistent steam supply with appropriate pressure gauges, so that the pan boiler has control over the boiling rate.

3. Some type of vacuum control, or failing this, a vacuum system independent from external interference, so that striking other pans on the stage will not involve the danger of false grain formation in the C strike.

4. A pan control instrument, to enable the conditions in the pan to be controlled far more closely than is possible by the pan boiler's judgement. A recorder, in conjunction with this instrument, also enables the Factory Manager to keep a strict check on boiling.

5. Sufficient crystallizer capacity, to allow the massecuites to be thoroughly cooled and exhausted.

6. A system of reheating the massecuite prior to spinning, to facilitate the separation of the molasses.

7. Ample C sugar centrifugal capacity, to give molasses separation without danger of increasing the final molasses purity through its becoming necessary to use water.

And last, but by no means least:

8. Constant and controlled massecuite conditions. This requirement calls for:

(*a*) The massecuite purity of all strikes to be controlled to within $\pm$ 1 unit of a set value.

(*b*) The massecuite to be boiled and struck at as high a density as the plant will allow.

(*c*) Check purities to be taken on the mother liquor in the crystallizers, to determine when the desired degree of exhaustion has been reached, and

(*d*) A consistent and controlled C sugar grain size, which is itself controlled by the number of crystals per stike and the purity limits used, i.e. points (*a*) and (*c*) above.

Requirements *a*, *b* and *c* are relatively simple to carry out, but *d*, on the face of it at least, appears to offer some difficulty and so warrants a great deal of attention.

It is worth while at this stage, to stop and consider just how important a consistent C sugar size and quantity is towards achieving maximum recovery. This is best illustrated by the following considerations, which apply to any boiling system:

1. A large C sugar crystal size occurs when insufficient crystals are present and leads to poor exhaustion, due to insufficient crystal surface area being presented to the sucrose in solution. This condition means that recoverable sugar is being sold to the distiller at much less than its true value.

2. A fine C sugar size occurs when too many crystals are present. Theoretically this leads to better exhaustion, but, if the sugar is too fine the centrifugals will not be able to cope with it, unless washing is practised at some stage of the spinning cycle, but this again leads to high purity molasses and hence wasted sugar, ro to excessive re-cycling of impurities.

When these two points are considered in conjunction with constant massecuite purity and density and constant crystallizer molasses purity, it will be seen that the operation of the centrifugal station will become more balanced and so a higher average out-put will be possible, i.e. its capacity will be increased and hence recovery can be increased.

Returning to the requirement for consistency of C sugar size and quantity. This assumes still further importance when the magma system of boiling is in operation. In this case, too large a C sugar grain will lead to insufficient magma being available, with the resultant necessity of graining for certain A and B strikes. Too small a grain size will result in an excess of magma, so that a certain amount will have to be remelted.

From this it follows that smooth, balanced operation of the magma system also depends largely on a consistent C sugar grain size.

This required consistency can be achieved by the normal "shock" graining technique only when operated by expert pan boilers in conjunction with a regular steam supply, independent vacuum control and some type of pan control instumrent.

However, when a "true" seeding technique is used in conjunction with a pan control instrument, the first three requirements are somewhat modified. The pan boiler's judgement on quantity of grain is entirely eliminated, the steam supply may fluctuate within reasonable limits and, in the case of conductivity pan contol at least, the effect of vacuum fluctuations can be minimized to a large extent by holding a steady conductivity value. However, to achieve this control over the effect of vacuum fluctuations, the pan boiler must be extremely watchful, especially during the initial growth of the crystals, when they are very far apart and the risk of secondary grain formation is very real.

A corollary to the elimination of the pan boiler's judgement in graining, is that the responsibility for the final crystal size moves from the pan boiler to the Factory Manager.

The "True" Seeding Technique

The requirment for "true" seeding, is that the number of sugar particles drawn into the pan at graining should equal the number of sugar crystals in the finished stike. (It follows that by controlling the number of crystals present, the final crystal size is also fixed for any given set of conditions).

There are two methods of achieving this:—the dry powder method developed by Alewijn and Honig[1] in Java and used in Natal by Steyn[2], and the slurry method, developed along slightly different lines by Gillett[3] in America, and Pollard[4] and Cameron[5] in Australia.

The former method is fully described in S.M.R.I. Tech. Comm. No. 9 and by Steyn in a paper at the present Conference. Steyn's figures agree closely with those of Honig and Alewijn.

The American slurry method, consits of mixing a very fine commercial powdered sugar into a slurry with some sugar insoluble liquid, such as isopropyl alcohol. Unfortunately this powdred sugar is not readily obtainable outside the U.S.A. and so severely limits the use of this method.

The Australian practice on the other hand, overcomes this difficulty by grinding refined sugar in methylated spirits, in a high speed vertical ball mill.

In either method, whether dry powder or slurry is used for seeding, the basic boiling pattern is the same.

The graining charge is boiled down until a small degree of oversaturation is obtained, at which point the seed is introduced. Balancing water is then used to hold the charge close to this supersaturation value until the grain has grown to sufficient size to safely take syrup or molasses feed. Hereafter the supersaturation is increased to a normal boiling value with the required feed (syrup or molasses).

During the past 1953 54 crushing season, the S.M.R.I. carried out a series of preliminary tests with slurry graining at Umfolozi.

The following is a brief report on this work and some tentative conclusions are reached.

1. *Slurry Preparation.*

The slurry was prepared in a horizontal pebble mill of internal dimensions, 5½" long by 7½" diameter. The apparent volume of the pebbles half filled the mill, which was driven at 60 r.p.m.

1220 gms. of Hulett's refined sugar and 1500 ml 95 per cent. alcohol were ground in this mill for 7½ hours, and then made up to 1 gallon and divided equally into six bottles. One slurry batch was made with methylated spirits instead of 95 per cent. alcohol.

2. *The Graining Tests.*

As these tests could only be regarded as preliminary trials into the applicability of the method to South African conditions, and the Umfolozi pan stage is usually severely pressed for capacity, it was decided to follow the normal Umfolozi boiling procedure, modifying it only to take slurry seeding.

This normal boiling procedure is:— to shock-grain a blend of 80° purity in No. 5 pan, build the pan up to 1,100 cu. ft. and 74° purity, and cut two thirds to a seed vessel. This makes one C strike in No. 5 pan and two in No. 7, giving a total of about 2,300 cu. ft. of C massecuite.

The modification merely consisted of boiling down the graining charge to just over saturation, noting the conductivity reading, and holding it at this reading with hot balancing water. When this was achieved, three bottles of slurry were sucked into the pan, via a funnel and graining cock, and the pan held on balancing water until the grain had grown sufficiently for syrup feed to be started. The operation usually took about 40 minutes from graining to start of syrup feed. Boiling was then continued in the normal manner.

Unfortunately calandria steam pressure cannot be given for these strikes due to No. 5 pan lacking a pressure guage. However, the plan followed was to vigorously boil the charge down to the graining point, then cut the steam back to give gentle boiling and gradually increase it while using water feed. Full boiling rate being used again at the start of syrup feed.

All the strikes were boiled with conductivity control. The aim being to keep these values as steady as possible notwithstanding the effect of vacuum fluctuations. These fluctuations can be quite severe at Umfolozi, where six pans all work off the same vacuum line.

Typical conductivity readings for these seed strikes were:

(1) Graining point... ... ... = 51 mA.

(2) Syrup feed started ... ... = 48 mA.

(3) Pan full ... ... = 43 mA.

In all, six grainings were carried out:—

4 in No. 5 pan using ethanol slurry.

1 in No. 5 pan using methylated slurry.

1 in No. 7 pan using methylated slurry.

The first attempt in No. 5 resulted in a very poor grain. This was due to the pan being heavied up too much immediately after syrup feed was started, and resulted in a second crop. This was washed out, but the washing caused a high percentage of conglomerate of form. However, this had the value of defining the conductivity limits. No measurements of the resulting grain could be obtained.

The other three grainings with ethanol slurry, were most satisfactory from the consistency point of view. The finished seed grain sizes were 0.222, 0.221 and 0.233 m.m and the percentage deformed crystals was 20.5, 21.0 and 25.6 per cent. respectively. These latter figures may appear rather high and will be discussed later in this paper.

The fifth graining in No. 5, and that in No. 7, were both carried out with the same batch of methylated slurry, and therefore, even though only one graining is being examined in each case, a certain amount of significance can be attached to the results.

The finished seed in No. 5 showed an extremely high percentage of deformed crystals, viz. 54.7 per cent., and so rendered the size determination most unsatisfactory. However, this appeared to be about 0.273 mm., i.e. considerably higher than with the ethanol slurry grainings. Against these figures, the graining in No. 7 pan gave only 10 per cent. deformities and the large crystal size of 0.362 mm.

3. *Conclusions from the Umfolozi Tests*

No definite conclusions can be drawn from the results at Umfolozi, due to the small number of results obtained, however they do indicate several important points.

1. Conductivity readings may be used to reproduce the graining point, even at high purities—all graingings in No. 5 pan were effected between 50 and 54 mA., even though one series was carried out in October and the other in January.

2. Crystal size reproductibility between strikes is good, providing the slurries are made up in the identical manner with the same materials.

3. No. 5 pan has poor boiling properties when compared with No. 7, as is shown by the deformed crystal percentages recorded for both pans.

This was expected from the design of the two pans. No. 5 pan is of very poor design, with a high floating calandria and fairly steep conical bottom, giving a large dead volume under the calandria. In the original design, coils were installed in this dead volume to assist the circulation, however, at some time during their life, these coils became leaky and were removed, a procedure which must have materially affected the performance of the pan. Added to this, a belt in the pan wall was installed to increase the strike volume from 750 ± cu. ft. to 1100 ± cu. ft. This increase in strike volume is suspected to account, to some extent, for the high deformity percentage recorded in the methylated slurry graining in this pan.

In this case the strike was carried up slightly lighter than the others, and, while the proofs taken during the stike appeared to be quite normal, the finished strike showed a very high percentage of deformities.

The question arising from this is:—was the supersaturation at the end of the stike sufficiently low for the effect of hydrostatic head to cause undersaturation at the calandria, with resultant crystal dissolution and hence conglomerate formation? Unfortunately this was the second to last strike boiled in the series, and, while photographs were taken to the grain at various stages of the next strike to enable deformity counts to be taken, the strike was run up somewhat heavier than the other and showed a reasonably constant value of about 20 per cent. deformities throughout its life.

No. 7 pan on the other hand, is of modern "centre flow" design with excellent boiling properties, however, the graining volume is very high, being 40 per cent. of the normal pan capacity. This means that the grain is very widely separated at the beginning of the strike and so the pan must be handled most delicately at this stage.

4. Slurry graining in conjunction with a conductivity instrument largely minimizes the effect of vacuum fluctuations on graining.

Discussion

Two methods of "true" seeding have been mentioned in the paper, one with dust and the other with slurry. Unfortunately it is impossible to say at present which is the better method, for to determine this, one must take into account the distribution of crystal size about the mean, as well as the reproducibility between strikes, and too few analyses showing this are to hand as yet.

Further work on this subject is planned for the coming crushing season.

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REFERENCES

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(For discussion on this paper see page 119.