

A USEFUL YARDSTICK FOR VOLUME OF C-MASSECUITE

by L. T. FOURMOND

Hulett's Sugar Corporation Ltd., Amatikulu

It is common practice in the sugar industry to calculate the ratio cu. ft. 3rd massecuite boiled per ton of solids in mixed juice as a guide to whether we boil too many thirds or not. Process Managers swear by this yardstick and even Mr. Perk quotes this figure in his Annual Report of Chemical Laboratory Control.

If quantity of molasses is directly proportional to non sucrose present in mixed juice, it is obvious that the quantity of 3rd massecuite boiled will follow the same pattern. We can, therefore, conclude that cu. ft. 3rd massecuite will be inversely proportional to the purity of the mixed juice. Hence this yardstick has only a relative value which can easily lead to confusion and the following figures, taken at random from the 1964 Annual Chemical Laboratory Report, will clearly prove the fact.

Mills	Purity Mix. Juice	Cu. ft. 3rd massecuites boiled per ton solids in mixed juice
Umzimkulu	88.2	6.58
Entumeni . . .	87.8	6.18
Renishaw . . .	87.2	8.85
Illovo	85.8	9.18
Tongaat	85.6	8.61
Amatikulu . . .	85.5	7.73
Natal Estates	85.4	7.83

It can be seen that Umzimkulu and Entumeni have the lowest figures on account of the high purity mixed juice. On the other hand, Illovo and Renishaw have extremely high figures which could be due to bad clarification, high inversion, excessive recirculation of non sucrose, inaccurate calibration of crystallisers and wrong measurement of strikes or high purity 3rd massecuite.

Amatikulu and Natal Estates have the lowest figures for the same purity of mixed juice. However, nobody can say what the ratio should be at any given purity of mixed juice and the aim of this paper is to discuss this issue.

The problem, therefore, is to find a yardstick which will take care of the mixed juice purity level, have an absolute value, and give accurate guidance.

If quantity of molasses is directly proportional to non sucrose in mixed juice and the quantity of 3rd massecuite boiled follows the same pattern, then the answer appears to be quite simple, i.e. "Cu. ft. massecuite boiled per ton non sucrose in mixed juice", as this will take care automatically of the mixed juice purity at any level. If we wish to be really precise, we can also bring the brix of the massecuite into the picture and relate it to 100 brix.

It is, therefore, suggested that for the control of 3rd massecuite boiling, the following yardstick be used; *CU. FT. 3RD MASSECUITE BOILED AT 100 BRUX PER TON NON SUCROSE IN MIXED JUICE.*

What would this figure be like in practice? To arrive at it the following factors must be taken into consideration;

- (a) removal of non sucrose during clarification, which for a 1.5 rise in the purity of clear juice represents some 13% non sucrose removal;
- (b) loss of sucrose in F.C. which is usually 0.50% sucrose in mixed juice;
- (c) the % undetermined losses through entrainment and the purity level. As a rule such losses average 1.5% at a 50 purity level, which represents some 8% of non sucrose lost;
- (d) the increase in volume of the massecuite at striking temperature;
- (e) the purity of the 3rd massecuite, which is taken at 60.

If we agree to the above figures, we arrive at a ratio of 46-47 cu. ft. per ton non sucrose.

In practice we shall never reach this target for two reasons, namely, the appreciable quantity of massecuite which adheres to the wall and stirrers of the crystallisers and the impossibility of draining completely the bottom of crystallisers, factors which lead to an apparent higher volume of massecuite boiled.

A realistic mean would be in the vicinity of 48-50 cu. ft.

Interpretation of Yardstick

A high ratio of massecuite boiled can be as a result of many factors:

- (a) The higher the purity of the massecuite, the greater will be the volume of massecuite boiled. We should always bear in mind that there is a relative fixed quantity of non sucrose to be eliminated in the molasses and the selection of the 3rd massecuite purity should be with an eye to achieving target purity in the final molasses.

There are two factors governing the crystallisation of sucrose and the exhaustion of molasses.

- (1) The chemical aspect where one non sucrose will immobilise a certain amount of sucrose according to reducing sugars ash ratio.

- (2) The physical aspect (viscosity), as the rate of crystallisation is inversely proportional to viscosity. Any attempt to lower the 3rd massecuite purity to a dangerous zone of viscosity will only create bad circulation in the pans and in the crystallisers, with consequent bad massecuites which will cure poorly and result in excessive recirculation of non sucrose and higher purities of final molasses.

Rule of thumb: Boil the 3rd massecuite at the highest purity permissible to still achieve the target purity in the final molasses, because such massecuites will boil and cure better and there will be less non sucrose recirculated. After all, our aim is only to achieve target purity (true D.D) and the hypothesis that target purity of final molasses can be lowered by lowering the purity of the massecuite has proved to be fallacious in practice.

- (b) Removal of non sucrose during clarification will have a marked effect on massecuite boiled and molasses produced and will vary indirectly. As a rule we can expect a minimum removal of 10% in the defecation process.
- (c) Recirculation of non sucrose through bad massecuites, which cure poorly, will also contribute to a higher ratio of massecuite boiled.
- (d) Inversion of sucrose and high destruction of reducing sugars will also increase the ratio of massecuite boiled.

On the other hand, a low figure for this ratio does not necessarily mean that good work is being achieved. It could be the result of either high losses in filter cake or of high undetermined losses through entrainment, and the level of its purity.

The purity level of entrainment will influence the ratio of 3rd massecuite boiled. The ratio will vary indirectly to purity level of entrainment. However, purity level of entrainments will also affect indirectly, the boiling house performance, as the higher the purity level the greater is the loss of crystallisable sucrose.

Conclusions

The rules which lead to high recovery of sugar are as follows:

- (1) Removal of as much non sucrose as possible during the clarification process and the minimisation of losses in filter cake.
- (2) Avoidance of unnecessary destruction of sucrose or reducing sugars through too high or too low a pH in tempering the juice.
- (3) Minimisation of losses through entrainment, especially at high purity levels.
- (4) Taking advantage of the high rate of crystallisation in the 1st and 2nd massecuites in order to recover as much crystallisable

sucrose as possible from these massecuites, bearing in mind the relatively lower exhaustion which is achieved in the 3rd massecuite.

- (5) Avoidance, by all means, of unnecessary recirculation of non sucrose as this constitutes the worst crime which can be committed in sugar boiling. Viscosity retards tremendously the rate of crystallisation and recirculation of non sucrose is bound to affect the exhaustion of the 1st and 2nd massecuites, especially when 2nd and 3rd sugars are remelted.
- (6) Selection of 3rd massecuite purity according to cane quality. The purity of mixed juice can easily lead to confusion. A cane deteriorating from 88 to 80 purity is a totally different proposition from a fresh immature cane of 80 purity, the difference being that the deteriorated cane contains organic compounds such as gums and pectins etc. which by increasing the viscosity of the juice, retard tremendously the rate of crystallisation hence leading to bad massecuites and poor exhaustion. It is common knowledge that after severe droughts, cane containing a higher % of organic non sucrose will yield a poor boiling house performance.

The yardsticks are useful to provide guidance. However let us bear in mind that to interpret them correctly, we often have to correlate different factors as otherwise we could easily be lead up the garden path.

Chief Chemists and Process Managers are well advised to remember that crystallisers must be accurately calibrated and volumes of strikes correctly measured should they wish to use this yardstick as a measure of good pan boiling. Also, the variance in stock should be taken into consideration and the quantity of 1st and 2nd molasses which have not been boiled into massecuites at weekends.

The following represent the figures for Amatikulu:

Purity rise in clear juice	1.6
Non sucrose removal during clarification	14.5
Lost in F.C. % sucrose in Mx. juice . .	0.58
Undetermined loss % sucrose in mixed juice	0.94
True purity—D.D. target purity	+0.7
Cu. ft. 3rd massecuite boiled @ 100 brix per ton non sucrose in mixed juice ...	49.0
Purity 3rd massecuite	59.2

Great attention is paid to the calibration of the crystallisers and the measurements of every strike at Amatikulu.

Summary

The suggestion has been made to correlate the volume of 3rd massecuite, boiled at 100 brix, to tons non sucrose in mixed juice as this yardstick will take care of the mixed juice purity at any level.

Some guidance is also given for the correct interpretation of this yardstick.

Discussion

Dr. Graham: Mr. Fourmond says on page two, "our aim is only to achieve D.D. target purity". This is not correct as our aim is to recover as much sugar as possible and to achieve maximum exhaustion. The D.D. target purity was evolved as a result of a statistical analysis of data from some Java factories which were considered to be operating satisfactorily. The data were collected in 1939 and with improved equipment we should nowadays achieve lower purity. If we apply this D.D. formula in South Africa the purity it predicts need not be the minimum purity that can be achieved.

There is the criticism that the formula may not apply exactly here but in the absence of any other more suitable formula we are at present obliged to use it.

We carried out tests some years ago and Umzimkulu regularly produced purities about $2\frac{1}{2}$ degrees below the target figure.

Mr. Fourmond: Very few factories in South Africa reach the D.D. target purity. Amatikulu, which had the lowest purity of molasses, was however +.7 above D.D. target purity.

I am surprised at your figures for Umzimkulu because their BHP that year was not particularly good.

Mr. Hulett: Mr. Fourmond says that it has been proved fallacious that lowering the purity of the third strike lowers the purity of the final molasses. I checked a whole year's third massecuites at Darnall and some of the highest purity strikes produced the lowest purity molasses. Someone in Puerto Rico plotted the massecuite purity from every third strike for all the mills of Puerto Rico and he definitely showed that the lower purity massecuites on average produced lower purity molasses.

The odd high purity massecuite does produce a low purity molasses but this may be tied up with pan boiling.

Mr. Fourmond: I think we should stick to figures from South Africa. At Amatikulu a massecuite of 60 did give a lower purity molasses than one of 57—but the purity of the first sugar cured was 95 and the other was 91 respectively, indicating the amount of recirculation of non-sucrose.

Mr. Robinson: Figures from all Hulett mills showed that the lowest average final molasses purity came from the lowest average C- massecuite purity. Provided the factory can be kept running at the desired speed we must endeavour to keep our massecuite to the lowest possible boiling purity to get the lowest possible molasses purity.

Mr. Fourmond: In my paper it is said that there is a limit to which massecuite purity can be lowered as otherwise the viscosity of the massecuite is so high

that it defeats the object. This will depend on cane quality.

It might be advisable to determine the viscosity of the second molasses as a guide to the process manager.

Mr. van Hengel: Mr. Hulett referred to a paper by Mr. Serbio from Puerto Rico. As a result of this paper all Hulett factories carried out an investigation into the relationship between C- massecuite purity and final molasses purity. We plotted the figures and the graph showed that there is a 1° purity drop per $2\frac{1}{2}$ massecuite purity drop. If you go from 60 to $57\frac{1}{2}$ you will go from 40 to 39.

It also appeared that below 58 spindle purity there is very little advantage to be gained.

Last year Amatikulu worked their C- massecuite at 59.3 and their final molasses purity was 37.25 on spindle.

Mr. Fourmond: Mount Edgecombe, boiling from a lower purity, 58.0, got 37.37 purity molasses. So where is the advantage? Masses-cuites of 59.3 are easier to boil and cure than masses-cuite of 58.0.

Mr. Hulett: It is not possible to compare one factory against another in this fashion owing to a completely different set of conditions. It is only possible to follow one factory's own performance figures.

Mr. Hulett: Mr. Fourmond says it is important to get as much exhaustion as possible from the first and second strike of high grade purity. If you do this how can you boil a third strike on B- molasses at 60 purity? You would have to add a lot of syrup.

Mr. Fourmond: At Amatikulu we got 68 exhaustion in the first massecuite, 66 in the second and only about 57 in the third. Whatever sugar you are going to boil in the third massecuite will be the difference in exhaustion between those two.

In drought years it pays to raise the purity of the third massecuite because of the higher viscosity.

Mr. Chiazari: Invert sugar appears to have a pronounced effect on the purity of final molasses.

Do we not stress purity too much? I have often observed that molasses purity may increase but recovery will improve. We should pay more attention to total sucrose losses in molasses.

Mr. Fourmond: It is possible to estimate fairly accurately what the losses in molasses should be by applying factor 'f', but differences in juice quality must be kept in mind.

In my paper it is clearly said 'boil the 3rd massecuite at the highest purity permissible to still achieve target purity in the molasses'. I did not say that the higher the purity of the 3rd massecuit, the lower will be the purity of the molasses. The purity of the 3rd massecuite must be selected according to cane quality, viz. reducing sugar's ash ratio and viscosity.