WEIGHING THE SYRUP—A TIGHTER CONTROL OF THE SUGAR FACTORY

By J. ANTONOWITZ

On drawing up the Annual Summaries of Chemical Laboratory Reports for several years past, Mr. Chas. M. Perk has repeatedly stressed the importance of drawing up a complete Sucrose Balance. As some factories do not weigh their Final Molasses, a factor (Non-Sucrose Ratio=0.83) was estimated for all factories. With the help of this factor the Tons of Sucrose lost in Molasses and the approximate undetermined losses can be calculated.

This factor is based upon the assumption that a constant 17 per cent. of the non-sugars is eliminated by the clarification at the filter station.

Examination of Table L—Thirtieth Annual Summary of Chem. Lab. Reports, 1954-55 season, which reviews the non-sucrose ratios of several factories during recent years—discloses the fact that rather abrupt deviations from the mean are prone to occur. A striking deviation was that calculated for the AK factory for the 1954-55 season, the values being 0.82, 0.81, 0.84, 0.86 and 0.74. Values reported for UF were regular at 0.82, 0.89, 0.83, 0.85, 0.82. For no immediately apparent reason, this, 1955-56 season, this average ratio has dropped to 0.74. From consideration of the comment given by Mr. Perk on Table L, it was concluded that this drop is due to a greater elimination of non-sugars at the filter station.

The non-sucrose ratio has been calculated on a weekly basis and graphed together with the B.H. Recovery to shew the dependance of good factory recoveries on better clarification, or rather, on better non-sucrose elimination. The greater overall elimination of non-sucrose at the filter station at UF this season could be attributed to the very high percentage of muddy cane crushed.

This is by the way, but illustrates how apparently reliable factors can be rendered misleading by unsuspected occurrences. It also emphasises the value of a sucrose balance computed on properly weighed constituents. Even if the molasses are weighed, a reliable sucrose balance can not be secured if the weight of filter cake produced is estimated by expedients. The utility of carefully weighed filter cake is still dubious, if no allowance is made for the sucrose reintroduced into the process by the bagacillio added at the filter station. Mr. W. A. Powe, of the Oliver Filter Corporation, clearly describes a method for the estimation of this reintroduced sucrose, in an article in the "Proceedings of the Sixth Annual Congress of the I.S.S.C.T., 1938."

It is contended by many that a great deal of lattitude can be allowed when computing the tonnage of filter cake discarded—because, after all, the amount of sucrose involved (expressed as sucrose per cent. sucrose in cane) rarely exceeds 1.0 per cent.; a big error in the calculated weight would have to occur before a significant increase or decrease of this parameter would become evident. This lattitude becomes an acute embarrassment when exceptionally high undetermined losses are disclosed by the calculation of the sucrose balance, particularly if the molasses per cent. cane figure shews a relatively marked increase.

If the weight of sucrose in filter cake discarded at the filter station is accurately known, the undetermined losses can be calculated in a perectly straightforward manner.

To avoid the weighing of trucks of filter cake, or the use of expedients of a doubtful nature to secure the approximate weight of sucrose lost at the filters, it is contended that a most precise and almost foolproof chemical control could be instituted if the syrup was weighed. The difference between the weight of sucrose in mixed juice and the weight of sucrose in syrup could then be allocated to sucrose lost in clarification and filtration. In this way losses due to entrainment, and/or inversion, and/or negligence at the filter station could be pinpointed. Attention is drawn to Mr. Rault's paper (S.A.S.T.A., 1939) on the calculation of sucrose balances, and to Mr. M. Viger's paper entitled "High Unknown Losses caused by Entrainment during Evaporation and Boiling of Sugar Cane Juice," S.A.S.T.A., 1933; wherein reference is made to the desirability for weighing the syrup.

If one calculates the "sucrose available" in mixed juice by the S.J.M. Formula and compares this figure with the "sucrose available," as calculated on the purity of the syrup, it will be noted that the sucrose actually recovered in the sugar corresponds much closer to that indicated by the calculation using the syrup purity. That is, as is evident, the S.J.M. calculation is made after allowing for the *actual* and not an arbitrarially assumed non-existent clarification effect. This is illustrated by the following calculation made on the figures of the UF 1954-55 crop.

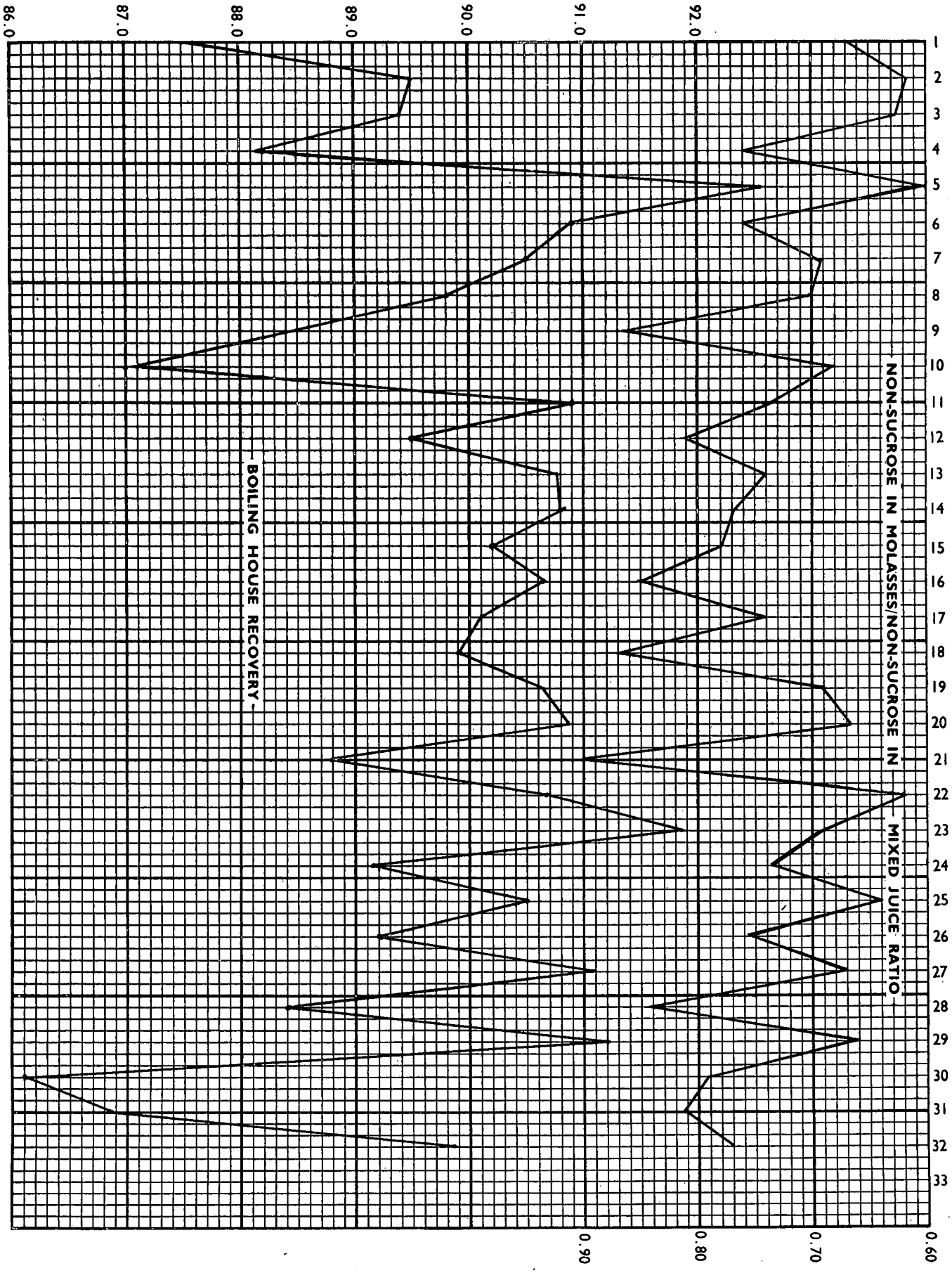
Purity of Sucrose	100.00
Purity of Molasses	38.86
Purity of Mixed Juice	84.84
Purity of Syrup	86.46
Tons of Sucrose in Mixed Juice ...	90394.347
Tons of Sucrose in Filter Cake ...	710.970
Tons of Sucrose in Syrup	89683.377
S.J.M. Retention Factor calculated on Mixed Juice purity	88.645
S.J.M. Retention Factor calculated on Syrup purity	90.049
Tons sucrose available in sugar calculated on Mx. Ju. Purity: $\frac{90394.347 \times 88.645}{100.00}$ ... ... =	80130.069
Tons sucrose available in sugar calculated on Syrup purity: $\frac{89683.377 \times 90.049}{100.00}$ ... ... =	80758.984
Tons sucrose in Sugar actually produced	80768.802
Shortfall on Mx. Ju. purity calculation...	638.733
Shortfall on Syrup purity calculation...	9.818

In the above calculation the average F/S Ratio of the filter cake produced during the season was available, therefore the tons of sucrose returned into process by the bagacillio was calculated. This amounted to 173.245 tons. This tonnage was deducted from the total tons of sucrose in filter cake, so that the proper weight of sucrose in syrup could be found. The difference of only 9.818 tons of sucrose between the calculated value and the amount actually recovered in the sugar made during the season, shews a remarkably close agreement, and appears to be the most convincing illustration of the utility of the proposed positive refinement in the chemical control. It is also one very substantial reason why the weighing of syrup and not clear juice is insisted upon.

Examination of the graph (attached), which shews the almost absolute dependence of recovery on non-sucrose elimination, evokes the conviction that, if the syrup is weighed, a quantitative daily determination of the non-sucrose elimination effected by the clarification procedure will be established. In other words a positive control on clarification, filtration, and boiling will become a reality. It will no longer be necessary to wait until the end of the week to discover from the B.H. Recovery or from the B.H. Performance figures whether the filtration or clarification was operating properly.

In a paper entitled "One Year of Weekly Factory Report Data," S.A.S.T.A., 1951, Dr. Douwes-Dekker points out that the amount of non-sucrose in clarified juice, which in normal cases is nearly equal to the amount of non-sucrose in final molasses, largely determines the weight of final molasses which will be produced. It is therefore contended that the ratio of non-sucrose in syrup to non-sucrose in mixed juice, if determined quantitatively, will give a daily and a positive quantitative estimation of the amount of molasses being made, as well as providing a measure of the amount of molasses formers in the juice, which have been removed by the filters.

The weekly calculation of the non-sucrose in molasses/non-sucrose in mixed juice ratio at UF shews a marked variation from the mean of 0.74 (0.83 for all factories, as calculated by the S.M.R.I.). Values as low as 0.60 and as high as 0.90 have been found. As the low ratios consistently coincide with high recoveries and the high ratios coincide with low recoveries, while the mixed juice purities remain fairly constant, it is felt that a definite proof has been established that the removal of non-sugars in the current clarification and filtration procedure occurs in a most erratic manner. The mixed juice purities do not vary widely week by week, or even day by day for that matter, hence, if the clarification procedure is conducted at its optimum efficiency, with the help of the daily non-sucrose ratio determined by the weighing of the syrup, the fluctuation in the efficiency of the removal of non-sugars would be eliminated and a fairly regular and constant optimum weekly recovery figure would be secured.


86.0
87.0
88.0
89.0
90.0
91.0
92.0
BOILING HOUSE RECOVERY
0.90
0.80
0.70
0.60
NON-SUCROSE IN MOLASSES/NON-SUCROSE IN MIXED JUICE RATIO
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Mr. Rault, in the Chair, said that we were grateful to Mr. Antonowitz for his bringing forward again the idea of such a further refinement in chemical control. Some years ago at Natal Estates, it was customary to weigh syrup but in recent years owing to remelted sugars and other liquids returned back to clarification, it had been abandoned, much to his regret. Without weighing the syrup the correct location of undetermined losses became very obscure. These losses can be heavy by entrainment at the evaporation stage and at other times, later in the boiling house. It was no longer possible to determine the amount of sucrose entering the boiling house before and after evaporation.

Mr. Perk said he wanted to draw attention in particular to the statement made where Mr. Antonowitz says: "The greater overall elimination of non-sucrose at Umfolosi could be attributed to the very high percentage of muddy cane crushed."

The high amount of finely suspended clay would have affected the determination of brix per cent mixed juice and in this manner the ratio figure. Regarding this ratio he wished once more to draw attention to last year's discussion on this subject (Proc. 29th Annual Congress, page 27) which reads:

> "**Mr. Bax** stated that the relationship between non-sugars in mixed juice and the final molasses was not exact when one took into consideration the effect of non-sugars on the brix hydrometers, when the latter were used for determining total solids. He thought that because of this the non-sugars eliminated were actually lower than shown, and that the factor of 83 must be low as compared with the real figure.
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> Mr. Perk pointed out that the ratio of 83 was only a mathematical form. Naturally these factors depended upon how they were calculated and in this case it was meant just as a means of calculating the amount of molasses."

He could not agree with Mr. Antonowitz's statement that the ratio assumes that 17 per cent of the non-sugars had been eliminated by the clarifiction and he could not possibly agree that it was *based* on 17 per cent removal of non-sugars. In this respect he pointed to Mr. Bax's remark. Moreover during the manufacturing process not only were non-sugars eliminated but also non-sugars were formed.

Regarding the weighing of syrup, he had previous experience when at ten of the factories at which he was consultant, syrup weighing was introduced.

It appeared that it was more difficult than anticipated to obtain a representative sample of the syrup weighed. The weighing of syrup showed that 1/4—1/3 of the undetermined losses occurred between mixed juice and syrup weighing; the balance occurred between syrup and sugar weighing.

We must not overlook the fact that weighing of syrup did not reduce undetermined or other losses. To reduce undetermined losses, they had to be tracked down first and appropriate measures had to be taken to reduce or eliminate them. For example, syrup weighing would not tell which of the vacuum pans entrained; this had to be detected by other means. The same had to be said about the prevention of the entrainment by the evaporator.

Mr. Elysee pointed out that Mr. Viger's paper was written because he had found an enormous difference between sucrose entering the factory with the mixed juice and that received in the syrup, due to very heavy entrainment. There was no doubt that there was a big loss between mixed juice and syrup, most of it loss in the evaporator.

Mr. Antonowitz replied that one reason for weighing syrup at Umfolosi factory was the fact that they were considering introducing a belt conveyor to take away the filter cake, which made it impossible to assess the loss in this substance. Lack of weighing syrup reduced the efficiency of the chemical control.

Mr. Carter stated that unless the sucrose introduced at the filters in the bagacillo used were taken into consideration losses could not be determined accurately.

Mr. E. H. Phipson considered that the weighing of syrup would be an advantage at the factory in which he was employed. There they had no idea of what the loss was in filter cake. The difficulties consequent on weighing the syrup however would be brought about by sampling and also the necessity of having to carry out the Jackson & Gillis test. He said that a manually operated scale would be more successful than an automatic one.

Mr. Rault asked Mr. Perk to explain why he considered the sampling of syrup so difficult, against the common practice of weighing thick exhaust molasses.

Mr. Perk replied that in the case of final molasses the variations in per cent brix were small compared with the big variations especially encountered when weighing syrup. These variations in density made it difficult to collect a sample representative of the quantity of syrup weighed. Moreover the molasses quantity was $2\frac{1}{2}$ per cent on cane only, compared with 30 per cent on cane in case of syrup; the sucrose content of the latter being about 55 per cent. This made really representative sampling of syrup of the greatest importance.

Mr. Elysee considered that weighing of molasses was of far greater importance than weighing syrup. As far as loss in filter cake was concerned, this was a very small amount, and not of very great importance.

The Chairman considered that weighing of molasses was an essential part of chemical control and that all factories should weigh their molasses. He stated that even at Tate & Lyle's refinery where the chemical control was a very strict one, they were still not able to trace separately all undetermined losses, three quarters of which were not located.

Mr. Antonowitz stated that provided one knew the loss in filter cake one could definitely say one knew the actual undetermined loss in the factory. Without the knowledge of this loss, it was impossible to do so.

Dr. van der Pol said that there were alternative means of calculating the quantity of filter cake and he quoted those used in Australia.

Mr. Antonowitz said that which ever way one looked at it one had to carry out a certain number of operations even if one used alternative methods determining loss in filter cake, and as a certain number of operations had to be carried out, why not weigh the syrup?

Mr. Elysee pointed out that the loss in filter cake was so small that unless this rose to an inconceivable amount it could not affect the sucrose balance. As the Amatikulu factory weighed the molasses it was able to determine the loss in molasses. The undetermined losses could thus be isolated.

Mr. Phipson said that he had considered trying to arrive at the weight of filter cake by recording the number of revolutions of the filter and taking samples from different areas, but he found that the variation in the thickness of the cake was so great that the figures would be quite unreliable.