

NOTES ON LOSSES KNOWN AND UNDETERMINED IN THE FACTORY SUCROSE BALANCE SHEET.

By J. RAULT.

The ultimate results of chemical control of a sugar factory present themselves under the form of a balance sheet, in which the sucrose recovered in bags, added to the sucrose in various products of the factory should, as near as possible, balance the sucrose originally present in the raw material cane.

The amounts of sucrose left uncrystallized in the various residues of factory operations, namely, bagasse, filter-cake, molasses, are the known losses; whilst the "as near as possible" shortage constitutes the unknown losses. In our balance sheet they are the "sundries" which, with true scientific modesty, we have dubbed "undetermined."

Are these undetermined losses real sugar losses, or are they book mistakes in a too highly organised system of technical accountancy, which can only be true and effective when analyses are accurately carried out, when aliquot samples are genuinely representative, and when bulky factory products are weighed on reliable scales?

The average factory worker finds it difficult to visualise tons of sugar disappearing in a mysterious way in evaporated waters, or in small leaks, or even by chemical decomposition.

Such losses may not have been apparent in the past so long as the control was obscured by reporting "molasses and undetermined" under one heading.

It is also probable that they have lately decreased in well equipped factories run by experienced staffs.

Nevertheless, they do exist, and steps taken to reduce them, as well as the other known losses

in bagasse, filter-cake, molasses, must prove remunerative.

What has already been done in the past decade can be seen by comparing the average composition of South African factory residues, and also the overall factory recovery, with those of an older sugar land reputed for the high level of its scientific control.

The year 1928 marks the year immediately following the first activities of the South African Sugar Technologists' Association.

| | Average S.A. factories, 1928 season. | Average Javan factories, 1928 season. |
|--|--------------------------------------|---------------------------------------|
| Sucrose per cent. bagasse . . . | 4.10 | 2.90 |
| Sucrose per cent. filter cake . . . | 5.15 | 3.70 |
| Purity final molasses | 45.3 | 30.10 |
| Sucrose recovered per cent. sucrose in cane (overall recovery) | 75.06 | 85.80 |

As judged by the high sucrose content of bagasse and filter-cake, and specially by the high purity molasses, our losses were excessive and consequently the overall recovery fell short by 10.74 per cent. of the results obtained in the progressive tropical sugar land.

Let us follow the same figures with their effect on the sucrose balance sheet and recovery for the next few years up to the present season (December, 1939).

| | SOUTH AFRICA. | | | | JAVA. |
|---|---------------|-------|-------|-------|-------|
| | 1928. | 1932. | 1936. | 1939. | 1938. |
| Sucrose per cent. bagasse | 4.10 | 3.83 | 3.40 | 3.05 | 2.90 |
| Sucrose per cent. filter-cake | 5.15 | 4.50 | 3.20 | 2.87 | 3.70 |
| Purity final molasses | 45.3 | 45.1 | 43.9 | 42.6 | 30.10 |
| Loss in bagasse per cent. sucrose in cane | 10.53 | 10.14 | 8.92 | 7.67 | 5.40 |
| Loss in filter-cake per cent. sucrose in cane | 1.78 | 1.81 | 1.13 | 0.86 | 0.57 |
| Loss in molasses and undetermined per cent. sucrose in cane | 12.63 | 12.32 | 10.31 | 9.21 | 8.23 |
| Sucrose recovered per cent. sucrose in cane (overall) | 75.06 | 75.73 | 79.64 | 82.26 | 85.80 |
| Sucrose recovered per cent. sucrose in juice (boiling house recovery) | 83.90 | 84.27 | 87.44 | 89.10 | 90.70 |

The above table shows that between the year 1928 and the past one the loss in bagasse per cent. of the sucrose in cane has been reduced by 2.86 per cent., the loss in filter-cake by 0.92 per cent., the

loss in molasses and undetermined by 3.42 per cent., making a total gain of 7.20 per cent. in overall recovery.

A remarkable feature of this progress is the rise in boiling house recovery, which has been brought nearer the Java standard, notwithstanding the large difference of 12.6 degrees still existing between the purity of final molasses of the two countries.

The large advance of 5.10 points in boiling house recovery cannot be credited entirely to a better exhaustion of molasses, the purity of which has barely been reduced 2.7 degrees in the last decade.

It is not necessary to go into lengthy S.J.M. or other available sugar formula, to confirm our views that the large losses that were taking place in the boiling house in years past were not merely losses in high purity molasses, but to a large extent also attributable to those undetermined losses so difficult to locate, when the factory control has to

rely on inferential figures in the place of the positive weighing of products.

Quite a few factories are now meeting with great success in their efforts to lower the purity of molasses, and one in particular has during the past few years maintained its lead in boiling house recovery by virtue of this excellent work. This same factory has nevertheless shown a progressive increase in boiling house recovery without any further drop in its already low purity molasses.

If, however, we compare the results of five factories (1939 season) listed in order of exhaust molasses purity, the comparison will not indicate that there is a direct relationship between low purity molasses and high boiling house recovery, as follows:—

| Factory No. | ... | ... | ... | 9 | 4 | 11 | 18 | 14 |
|---------------------------|-----|-----|-----|-------|-------|-------|-------|-------|
| Purity of mixed juice ... | ... | ... | ... | 87.30 | 87.60 | 85.64 | 87.51 | 87.27 |
| Purity of molasses ... | ... | ... | ... | 35.82 | 39.40 | 40.79 | 45.25 | 46.33 |
| Boiling house recovery... | ... | ... | ... | 87.92 | 89.39 | 85.01 | 90.41 | 89.64 |
| Sucrose per cent. cake... | ... | ... | ... | 4.86 | 0.19 | 3.46 | 3.24 | 3.84 |
| Pol° of sugars ... | ... | ... | ... | 98.64 | 98.31 | 99.10 | 98.40 | 98.16 |

Should we not infer that the first three factories, where molasses are exhausted at a purity of 40 and under, must be experiencing undetermined losses in a higher degree than the two last ones, where, in spite of comparatively high molasses purity, better recoveries are obtained.

We will now bring definite evidence of the effect of undetermined losses on the overall recovery by presenting the detailed sucrose balance sheet of our factory for the past five years. It is evident that the most significant improvement consisted in reducing the undetermined losses, while the known losses remained more or less constant.

Sucrose Balance Sheet for Five Seasons.

| | 1935. | 1936. | 1937. | 1938. | 1939. |
|--|---------------|---------------|---------------|---------------|---------------|
| Lost in bagasse per cent. sucrose in cane ... | 5.48 | 5.38 | 5.20 | 5.21 | 5.35 |
| Lost in filter-cake per cent. sucrose in cane ... | 0.54 | 0.46 | 0.43 | 0.48 | 0.41 |
| Lost in molasses per cent. sucrose in cane ... | 6.22 | 7.02 | 7.36 | 7.30 | 6.36 |
| Lost in undetermined per cent. sucrose in cane ... | 4.59 | 3.46 | 2.32 | 1.53 | 2.11 |
| Recovered in bags per cent. sucrose in cane ... | 83.17 | 83.68 | 84.69 | 85.48 | 85.77 |
| | <u>100.00</u> | <u>100.00</u> | <u>100.00</u> | <u>100.00</u> | <u>100.00</u> |

In order to have a better insight of these undetermined losses, which have been minimised but not eliminated, the control was further tightened by the additional check of a syrup scale, which revealed on some occasions certain anomalies that could not have been detected previously.

It is now possible to separate the unknown losses as losses taking place up to the pans and losses during boiling and curing.

In the course of the past season, when a definite improvement in boiling house technique and cooling equipment resulted in a smaller molasses loss, we were puzzled by a setback in undetermined losses,

75 per cent. of which were taking place in boiling and curing, and 25 per cent. up to the pans.

By a process of elimination the location of these losses was narrowed down to the rich boilings.

This diagnosis by technical accountancy was subsequently confirmed in a practical way by detector-samplers placed on the vapour pipes of the pans. These detectors revealed that heavy density liquors up to 60° Brix were entrained at practically every stage of the rich purity strikes. In one case the sampler collected a large amount of well formed crystals mixed with the entrained syrup.

Regular routine testing of the circulating waters from the pans had only given the usual bare indication of "traces of sugar."

Enough has been said to create an interest and start a discussion on undetermined losses which can take place by—

- (1) Entrainment in the evaporator and pans.
- (2) Loss of juice at filtration of soft cakes.
- (3) Leaks in heaters and pipings as well as by spillage.
- (4) Decomposition by heat and inversion, particularly when processing deteriorated or over-ripe canes.
- (5) Repeated circulation of molasses and jelly boilings.

The first three causes, being the result of mechanical inefficiencies, can be minimised by suitable equipment.

The remedy for the last ones is of a more complex nature, as these losses may be inherent to the process of manufacture such as white sugar, or to the state of the raw material to be processed.

Constant vigilance and attention to details goes far in combating these losses. The easiest way of solving the undetermined losses problem is to throw doubts on the reliability of the juice scale, discuss the competency of the chemist, or blame some obscure "quality of the cane."

This unfortunately too common attitude of some practical sugar workers does not help in the least to recover the sugar really lost.

It is our experience that undetermined losses are seldom less than 0.50 per cent. of the sugar in the juice, and may under unfavourable conditions rise up to 4 per cent.

The first step in their elimination is to locate them, by a detailed control showing separately the loss in filter cake, in molasses, and in undetermined.

With this object in view, it is essential that no factory should be without a molasses scale, so that the practice of reporting molasses and undetermined losses as one combined item should be discontinued.

Mr. Rault, on reading his paper, stated that while it was not a very complete paper he hoped it

would give rise to discussion. He had read in the latest International Sugar Journal that much money was being spent in Italy to overcome these undetermined losses in factories there.

The PRESIDENT, in the chair, stated that the subject was an important one and very involved. He quite understood how one could get a number of undetermined losses. By working with the clarified juice, one could work on a definite figure. With regard to entrainment, he said he had some years ago installed an evaporator which allowed no entrainment. But entrainment had recently started, which fact he regarded very seriously.

Mr. BERCHARD said that his experience in looking for "Undetermined Losses" had been successful up to a point but that he lacked measuring plant to make the search more definite. At the end of a season the total molasses made was known because its weight was shown in the returns from the tank cars shipped from the factory. Some years ago his undetermined losses were about $2\frac{1}{2}$ per cent. of the sucrose in cane, which amounted to about 26 tons of sucrose per week. The loss by entrainment estimated by tapping the vapour pipe, and here was collected syrup as high as 40 Brix, at this figure the loss was due to the usual creeping up the vessel. Heavy losses occurred when the brix fell to 18 or so and was caused by loss in vacuum in the evaporators. This in turn would cause a rise in temperature which, as soon as the vacuum was again built, caused flashing, with the result stated.

A Webre Save-All was installed, and now the liquor collected from the vapour pipe has not been higher than 0.5 Brix and small in volume. At the time of installing the Save-All the vertical height of the vapour pipe was raised also, which of course helped. Thirteen tons of sucrose per week were collected from the return of the apparatus, which reduced the losses to the neighbourhood of 60 per cent. of the figure previously quoted.

Another place which accounted for some losses was the filter-press station. About 1,500 gallons of muddy juice containing about 9 per cent. sucrose was daily run away in the dunder water. This amounted to about 3 tons of sucrose a week. *Now*, no press is opened unless the bottom contained only water.

By hot screening our juice the losses of sucrose in crush-crush was reduced by some 6 tons per week, and by examining every source of loss it has been possible to reduce the losses to about $4\frac{1}{2}$ tons per week, which amounts to about 0.4 to 0.5 per cent. of the overall recovery.

With regard to the purity of exhaust molasses and its correlation to recovery since Java is a tropical country we are not correct in comparing our reducing sugars with those of Java. Louisiana and some parts of Queensland form a better comparison. The speaker did not look upon reducing sugars as an impurity. The beet sugar industry, for example, cannot get down to a low purity, but the recovery is satisfactory. The net result is that this industry makes less molasses, and that is the real criterion.

Mr. Bechard felt that Mr. Rault omitted some useful data when he did not tell us what treatment the mixed juice had undergone, since the purity increase from mixed juice to clarified juice is an important figure.

It is a regrettable fact that the chemist is required to produce a sucrose balance sheet on *quality* measurements when the only proper and satisfactory way to do it is to follow the sucrose *quantitatively* through the factory.

Mr. DYMOND drew attention again to yesterday's discussion on the analytical results of overseas molasses. He thought further samples ought to be obtained from overseas and analysed by our methods, since our factory results were compared with those from overseas.

Mr. DODDS welcomed Mr. Rault's paper and said the matter of losses was a weak point in the annual records. This record every year could not be complete without an account of the losses in molasses separately from undetermined losses. At

present less than half the factories were able to give the figure for losses in molasses apart from total undetermined losses. Few factories weighed their molasses and the methods of measurement by volume were not satisfactory at some mills. Unfortunately, Java gave up circulating their figures about 1933, but his impression was that the work in Java had fallen somewhat from its high standard. At all events our undetermined losses or losses in molasses or both combined were mostly lower than in Java. Factory control overseas varied a lot. He had an experience in Louisiana a few years ago. Failing to discover any apparatus for testing bagasse, he made enquiries of the foreman as to the methods used up to now. The foreman replied: "Well, I guess I never seen any bagasse testing here. The old boss went round, took a mouthful of the bagasse every day, and if he could taste anything sweet he sure raised hell." In Cuba, Mr. Dodds went on, the chemical control was excellent, both in the factory where he worked a crop and in many others that he visited.

Mr. RAULT remarked that the object of the paper was to give more efficient control, so that by that control we would be able to increase the recovery of what we lost.

Dr. HEDLEY concluded the discussion by pointing out the advantages of these short papers in bringing about discussions, and which could even be taken up by the committees. Questions were raised and they should be answered by the factories as well as by the members of the Association at these meetings.