THE DETERMINATION OF SUSPENDED SOLIDS IN MIXED JUICE

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Abstract

A method is described for determining the suspended solids content of mixed juice. The effect of suspended solids on factory control, in particular undetermined sucrose loss, is discussed and figures given to indicate the magnitude of the suspended solids content in mixed juice from various South African factories.

Introduction

During October and November, 1968, several of the Hulett factories, most noticeably Empangeni, suffered abnormally high undetermined losses which could not be traced to the usual causes such as inversion, entrainment and mechanical loss.

After investigation, it was concluded that the exceptionally high losses were due, at least in part, to an increase in the amount of extraneous material, especially sand and soil, being brought into the factories, most noticeably with mechanically harvested cane.

The undetermined loss caused by suspended solids stems from an error in the method of analysis of the mixed juice. The effect of the error in analysis caused by the suspended solids is shown in the following example.

Example

Factory crushing rate = 6,000 tons cane per day.
Mixed juice % cane = 100.
Tons mixed juice = 6,000 tons per day.
Let sucrose % mixed juice by J & G = 12.00.
Let suspended solids % mixed juice = 0.67%.
Therefore:—

$$\begin{aligned}\text{True sucrose \% mixed juice} &= 12.00 \times (1 - 0.0067) \\ &= 12.00 \times 0.9933 \\ &= 11.92\end{aligned}$$

6,000 tons mixed juice at 12.00 % sucrose	=	720.00	tons sucrose
6,000 tons mixed juice at 11.92 % sucrose	=	715.20	tons sucrose
Difference	=	4.80	tons suc./day

At the current price to the miller of R39.50 per ton, this comes to R190 per day, or in the region of R36,500 per season, at this crushing rate.

When the full effect of the error in analysis was realised, it became obvious that a suitable standard method for the determination of suspended solids in mixed juice was urgently required. Several methods for the determination have been suggested [1, 2, 3]. The method described by Perk[1] is suitable for the determination of heavy particles which settle out within a short time, e.g. thirty minutes, but it is unsatisfactory for juices containing fine mud, clay and silt or any floating material, which will tend to remain in suspension in the juice.

The chief disadvantage of the methods described by Payne[2] is the small size of the sample taken. In the case of a suspension of particles in juice, it is doubtful whether a sample weight of 25 g can be representative.

After available methods had been studied, it was decided to modify Payne's[2] method with the object of making the sample more representative. At the outset a one-litre aliquot was used but difficulties were encountered in filtering such a large quantity of juice, so that eventually a juice weight of 150 g was decided upon as being the optimum weight to use with due regard to filtering time, quantity of filter aid required and convenient filter size.

It is not suggested that the proposed method is the only satisfactory possibility. It represents a compromise between what is theoretically desirable and what is practicable for a routine laboratory test.

Method

Apparatus

Filter aid, free of water soluble matter is prepared by thoroughly washing a suitable grade of filter aid, i.e. Hyflo Supercel, with distilled water. The filter aid, together with sufficient 12.5 cm diameter filter papers of a suitable porosity, e.g. Whatman No. 1, are dried for three hours at 105° C and stored in a desiccator ready for use.

Sampling

A catch sample of mixed juice is taken hourly from a suitable sampling point, preferably from the juice pipe leading to the scale. The sample is preserved with juice preservative, e.g. mercuric chloride, added at the rate of 0.2 ml/litre. The analysis is conveniently carried out once a shift.

Note.—It is of the utmost importance that during sub-sampling, the suspended solids be kept in suspension by vigorous agitation.

Procedure

At the end of the sampling period, the composite mixed juice sample is thoroughly mixed and a 150 g aliquot of juice is poured into a tared 250 ml beaker and the juiceweight noted to 0.01 g.

6 g ± 0.01 g of filter aid are added and the contents of the beaker are well mixed.

A weighed 12.5 cm filter paper, placed in an 11.1 cm Buchner funnel, is precoated with 2.00 g of filter aid, care being taken to ensure a tight fit of the oversized filter paper in the funnel. The juice is filtered by pouring slowly down a glass rod into the filter, taking care to avoid flooding (i.e. the pouring rate is maintained at a rate lower than the drainage rate of the filter).

This initial filtration should be carried out at around 5″ Hg, while constant checks should be made of filtrate clarity to ensure that no solid materials by-pass the filter.

The vacuum is increased to around 15″ Hg, the rinsings poured into the filter, and the filter washed thoroughly with ten 30 ml aliquots of distilled water, draining the filter between additions.

After releasing the vacuum, the filter paper and contents are removed from the funnel and replaced into the tared beaker. The beaker and contents are dried to constant weight at 105°C, cooled in a desiccator, and weighed to 0.01 g.

The weight of suspended solids is expressed as a percentage by weight of the mixed juice (see Table1).

Discussion

Reproducibility tests carried out at Mount Edgecombe using this method gave results with a standard deviation 0.031 on ten duplicate sets of analyses. This represents approximately 5% of the mean value, these values ranging between 0.80 and 0.40% suspended solids in mixed juice. At first sight, the figure of 5% might seem a little high but referring to the example, it will be seen that a value for suspended solids ranging 5% on either side of 0.67 will have a negligible effect on the calculated true sucrose of 11.92% in mixed juice.

Although a weighted average of all determinations carried out at thirteen mills gave a figure of 0.67% suspended solids in mixed juice, a figure of over 6% has been recorded. Applying a similar calculation to that shown in the example to the Industry, which crushed fifteen million tons of cane last season, the cost to the miller works out at well over half a million rand per season, and it is a reasonable surmise that with increased mechanisation, this figure can only increase.

Effect on Undetermined Loss

Any suspended solids in mixed juice will cause a corresponding undetermined loss of the same magnitude as the suspended solids present, i.e. a 1% suspended solids level in mixed juice will immediately give a 1% undetermined loss *before* the juice leaves the juice scales. This is due to an overestimation of the sucrose in the juice. The effect of the overestimation on factory and mill calculations is obvious.

It is therefore felt that it would be in the interests of every factory to keep a check on the level of suspended solids in juice to enable a more precise interpretation to be made of the nature of their undetermined losses.

Acknowledgements

Acknowledgements are due to the S.A.S.T.A. Chemical Control Committee for some of the results in Table I.

References

1. Perk, C. G. M. (1964). "Determination of the Percentage Sediment in Mixed Juice", S.A. Sug. Journal, April 1964, 48, 4, 305.
2. "Sugar Cane Analytical Control" (1968), edited by J. H. Payne, published by Elsevier.
3. Laboratory Manual for Queensland Sugar Mill. 1961. 4th Ed., Chapter VIII, p. 113.

TABLE 1

Suspended Solids in Mixed Juice for Various South African Factories (see acknowledgements)

Mill	No. of Samples	Avg. S.S. % M.J.
Empangeni	33	1·68
Jaagbaan	21	0·81
Malelane	3	0·80
Felixton	15	0·69
Umzimkulu	16	0·66
Tongaat	6	0·61
Mt. Edgecombe	11	0·61
Sezela	10	0·57
Amatikulu	42	0·56
Illovo	8	0·54
Gledhow	10	0·42
Darnall	12	0·41
Pongola	35	0·37
	Total 222	Av. 0·67

Note.—The figure of 0·67% is a weighted average.

Discussion

Mr. Alexander (in the chair): The Chemical Control Committee of S.A.S.T.A. recently recommended to the South African Sugar Association that the Jackson and Gillis method should be corrected for the amount of suspended solids in mixed juice, and although this has apparently been accepted the method has not been decided.

All Hulett's factories this season will determine suspended solids. We will be able to make corrections to figures such as undetermined loss in order to get true figures. Any difficulties in the suggested method should also be revealed.

Mr. Bruijn: In the system proposed in this paper all suspended matter is filtered out but there is no distinction between normal and abnormal suspended matter.

It is fair to filter out clay and other extraneous matter but starch and other components, which are normal in a clean factory juice, are also filtered out. Starch, for instance, amounts to .03%.

Mr. Alexander: As payment is not involved here, I do not think that the composition of a normal juice is important. All we are trying to do is determine accurately the sucrose content by taking a representative sample of the juice as weighed. When mixed juice is prepared for the J & G sucrose determination it is not only filtered but also clarified and thus the amount of suspended matter removed in practice includes some which is precipitated by lead acetate. The amount removed by the proposed problem in that it proposes an analytical method overestimation.

Mr. Jennings: This paper has dealt with half the problem in that it proposes an analytical method for the determination of suspended solids.

But we have to have accurate sampling and I understand various devices are being considered.

Mr. Loudon: The Chemical Control Committee has discussed this matter. Mr. Clayton and Mr. Price of Australia, who visited us recently have worked on this and their recommendation was to aim at simplicity and to sample at the point of most agitation, which is in the pipeline feeding to the scales.

We suggest taking an hourly catch sample from the feed to the pump feeding the scales.

Dr. Graham: There are two aspects of this problem to be considered.

Firstly, for a good factory balance, we need as accurate a figure as possible for the amount of sucrose entering the factory and this can be obtained right away by the adoption of the best sampling and analytical procedures available.

Secondly, for cane payment purposes, all factories must conform at present to existing legislation in regard to sampling and analysis.

Consequently, on this count the introduction of procedures to take account of the error resulting from the presence of appreciable quantities of sand in mixed juice will have to be postponed until the necessary legislation has been made.

Mr. Dedekind: At Sezela we do a daily test to check on our screening efficiency by using a hand centrifuge with a graduated cylinder.

One of our mills showed a consistent $2\frac{1}{2}\%$ on volume whereas the big mill showed up to 8%.

In view of the amount of R36,000 mentioned by Mr. Prince as being overpaid for sucrose, a lot of money could be spent on proper screening to prevent this.

Mr. Prince: We tried centrifuging juice but the results were lower than by this proposed method.

In this paper we are trying to arrive at a correct figure for sucrose in mixed juice so the question of screening does not arise.

Mr. Kramer: Should not the first step in any method be the removal of sand, particularly in view of the damage done to factory plant and also its possible effect on cane payment?

Mr. Alexander: We do not think it should be obligatory on a factory to remove sand and bagacillo in order to get a correct sucrose determination.

In an area where a lot of clay comes in with the cane, a factory should not be penalised because of an incorrect recording of sucrose in mixed juice.

How much suspended matter should be removed is an economic problem for factory engineers.

Mr. Kramer: There is some difficulty in determining the sucrose in the bagasse or clay removed.

Mr. Loudon: If the material removed is put back onto the carrier so that it can be measured in the bagasse there is no problem.

Mr. Hulett: Mr. Clayton suggested taking a time cut sample to avoid the problem of classification if it is divided into a thin stream.

A time cut could be made on an inch line off the main line.

I believe that hydroclones have been used in the industry for removal of solids.

Possibly the general use of DSM screens has caused an increase in bagacillo.

Mr. Gunn: At Cambalanche in Puerto Rico three large hydroclones are used and the undercut from them goes into three small ones.