AN EXHAUSTION FORMULA FOR SOUTH AFRICAN MOLASSES

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Abstract

Using specific conductance instead of sulphated ash a new Target Purity formula for final molasses has been developed, the formula being:

Target Purity =

$$39,94 - 19,60 * \log \left(\frac{RS}{8,4 * 10^{-3} * \text{Spec. cond.} + 0,8} \right)$$

The degree of exhaustion of final molasses is usually judged by the difference between True Purity and Target Purity. Since True Purity involves dry solids determination a correlation (0,98) was established between True Purity and Refractometer Gravity Purity. Thus, both Target Purity and True Purity can now be arrived at by utilising easily determinable parameters.

Introduction

Experience extending over several seasons has shown that the difference between True Purity and SMRI Revised Target Purity serves as a good measure of the degree of exhaustion obtained for a specific molasses. The Target Purity formula [1,2] is based on reducing sugars and sulphated ash, and has the following form:

$$\text{SMRI Revised Target Purity} = 39,94 - 19,60 * \log \frac{RS}{Ash}$$

Sulphated ash and dry solids, which are needed, amongst others, in the calculation of the Target Purity and True Purity are not determined as a matter of routine in most sugar factory laboratories and it was felt that these parameters should be replaced by others which are more readily available.

In a previous study[3] transformations from SMRI Revised Target Purity to a Target Purity using conductance measurements and refractometer brix were attemped, but figures used for conductance were only valid for conditions under which they were determined at the time, so recently another study was undertaken.

Regression analyses reported in this paper were obtained using 200 individual results from South African molasses for the 1974/75 and 1975/76 seasons.

Experimental

Sucrose and reducing sugars

The Mackay Research Institute inversion method,[4] as modified by Beams and MacGillivray,[5] was used. Reducing sugars were determined by Lane and Eynon titration using an aliquot of the sample prepared for analysis of sucrose by the chemical method.[4]

Sulphated Ash

Sulphated ash was determined as described by Bruijn *et al.*[1]

Specific conductance

After dissolving 2 g of the molasses sample in distilled water it was transferred to a 200 cm³ volumetric flask and brought almost to volume. The flask was placed in a water bath at 20°C for 30 minutes, brought to volume, then thoroughly mixed and the conductance read. The conductance was multiplied by the cell constant to obtain the specific conductance of the solution.

Refractometer brix

Refractometer brix was determined as described by Mellet.[6]

Dry solids

These were determined according to Bruijn *et al.*[1]

Statistical analysis

Statistical evaluations, based on the least squares method, were calculated with a WANG-computer, system 2200, and the graphs plotted by a connected Digital Plotter.

Results and Discussion

Sulphated ash vs *specific conductance*

The specific conductance of the molasses solutions was compared with sulphated ash in a regression analysis and the equation was found to be:

Sulphated ash % molasses $= 8,4 * 10^{-3} *$ Specific conductance $+ 0,8$

with correlation coefficient = 0,89 and standard error = 0,70. The regression is graphically illustrated in Fig. 1.

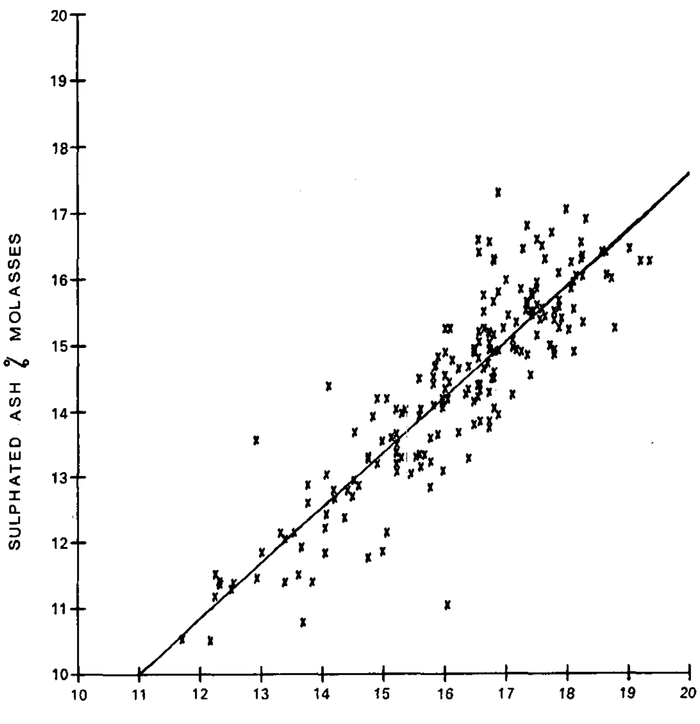

FIGURE 1 Regression analysis between specific conductance and sulphated ash content of final molasses.

Because of the high correlation between sulphated ash % molasses and specific conductance the above mentioned formula can be used. In order to demonstrate whether a measured or a calculated value for sulphated ash % molasses has been used the result from the derived formula is called conductivity ash % molasses. Therefore the equation becomes:

Conductivity ash % molasses $= 8,4 * 10^{-3} *$ Spec. conductance $+ 0,8$.

In a previous study[3] conductivity ash and specific conductance were correlated as follows:

Conductivity ash % molasses $= 3,9147 * C^2 - 11,8406 * C + 21,9021$ with standard error $= 0,925$, where C = specific conductance $* 10^2$.

The constant factors of this relation are only valid for the experimental conditions under which they are determined. Applying the data used in the present study to a second order linear regression the following correlation was obtained:

Conductivity ash % molasses =
$- 1,1006 * 10^{-6} * C^2 + 1,1840 * 10^{-2} * C - 1,8702$

C = Specific conductances, with standard error = 0,71 and correlation coefficient = 0,89.

The standard error has almost the same value as that found for the first order relation. Further, the constant factor of the C^2-term indicates that, for the measured C-values, the curve is almost a straight line. Therefore the proposed linear relation of first order, being a simpler calculation with equal precision, is to be preferred.

True Purity vs *Refractometer Gravity Purity*

Comparing Refractometer Gravity Purity with True Purity the following regression analysis was obtained:

True Purity = 0,932 + 1,013 *Refractometer Gravity Purity, with correlation coefficient = 0,98 (see Fig. 2).

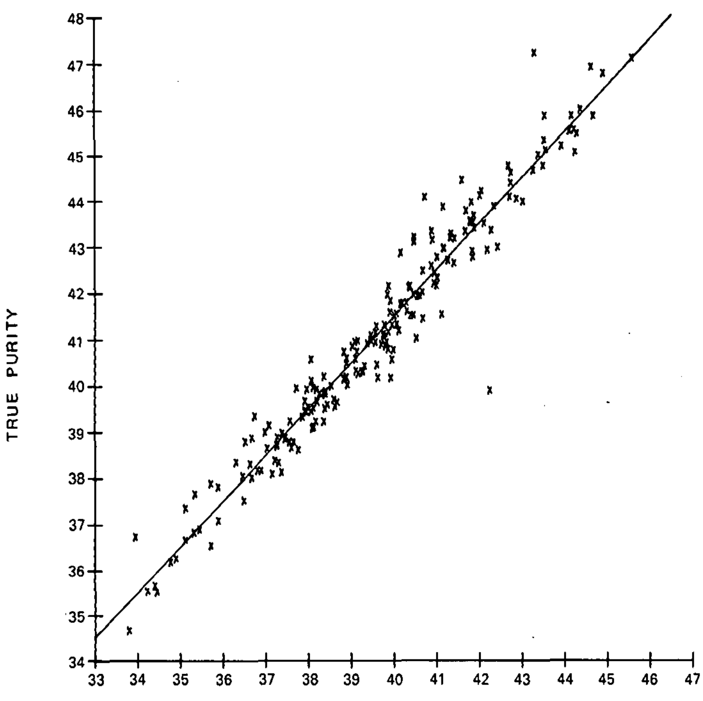

FIGURE 2 Regression analysis between Refractometer Gravity Purity and True Purity of final molasses.

Because of the high correlation between True Purity and Refractometer Gravity Purity the measured True Purity can be substituted by the Calculated True Purity as derived from Refractometer Gravity Purity.

All brix determinations were done using Whatman No. 42 filter paper to prepare the molasses solution for refractometer readings. Because it is known[6] that refractometer brix is dependent on the clarity of filtrate, serious errors can be introduced in the conversion of Refractometer Gravity Purity to True Purity should coarser filter papers be used.

In a recent study at the SMRI[7] however it has been found that Whatman No. 6 filter paper can be substituted for Whatman No. 42 without any significant change in refractometer brix. Whatman No. 6 filters much faster than Whatman No. 42 and either of these filter papers can be used when determining refractometer brix.

Comparison of the differences between True Purity and SMRI Revised Target Purity with differences found using the derived formulae

In view of the high correlations discussed earlier, the Target formula can now be written as:

Target Purity =

$$39,94 - 19,60 * \log \left(\frac{RS}{8,4 * 10^{-3} * \text{Spec. cond.} + 0,8} \right)$$

The degree of exhaustion obtained in a final molasses is judged by the difference between True and Target Purities. Applying the results obtained from 200 molasses samples used in this investigation a comparison was made between differences obtained using True Purity and Revised Target Purity and between the differences obtained using Calculated True Purity and Target Purity. The correlation was found to be 0,94 (see Fig. 3).

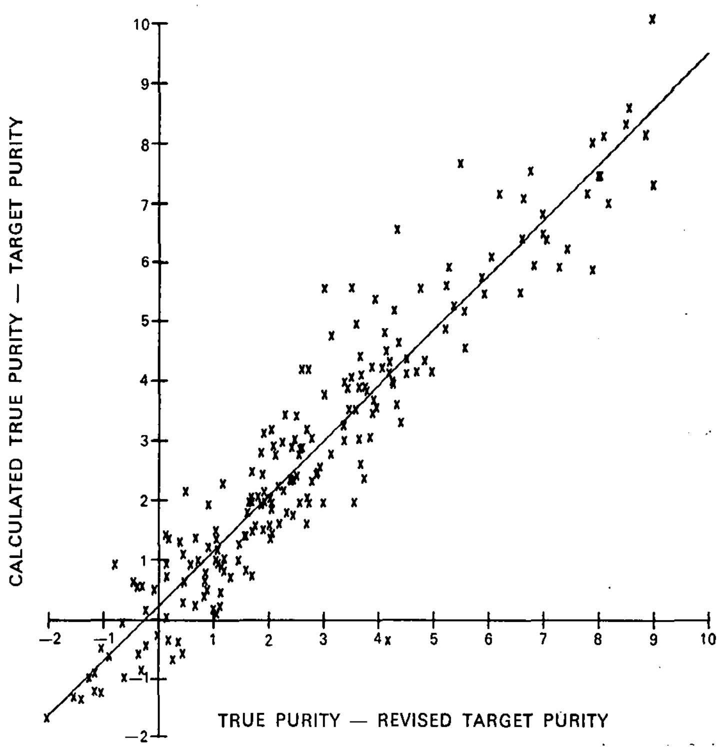

FIGURE 3 Correlation between differences obtained using True Purity and SMRI Revised Target Purity and differences obtained using Calculated True Purity and Target Purity.

Conclusions

Using Calculated True Purity, reducing sugars and conductivity ash in the molasses exhaustion formulae instead of True Purity, reducing sugars and sulphated ash, it was found that a high degree of correlation (0,94) exists. Since Refractometer Gravity Purity and specific conductance can easily be determined on a routine basis by mill laboratories it is considered that the new formulae are suitable for factory control purposes.

REFERENCES

1. Bruijn, J.; FitzGerald, J. R.; Koenig, S. and MacGillivray, A. W. (1972). Exhaustion of South African Final Molasses. SASTA Proc **46**, 103-109.
2. FitzGerald, J. R. and MacGillivray, A. W. (1972). SMRI Internal Report No. 25/72.
3. FitzGerald, J. R. and Wallace-Tarry, R. (1973). SMRI Internal Report No. 14/73.
4. Proc. 15th Session ICUMSA (1970). 76.
5. Beams, W. F. and MacGillivray, A. W. (1971). The determination of sucrose in final molasses. SASTA Proc **45**, 114-120.
6. Mellet, P. (1975). Influence of ageing and turbidity on refractometer brix of final molasses. S.A. Sugar Jnl **59**: 215-221.
7. Mellet, P. Unpublished data.