OPERATION AND CONTROL OF THE MOLASSES MIXING PLANT AT THE SOUTH AFRICAN SUGAR TERMINALS

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Abstract

Modifications to the original design of the molasses mixing plant and its operation are described. The effect of changes in the pol values of the uncoated sugar and of the molasses are discussed. The accuracy of the determination of the pol of the molasses and its relationship to the analysis of the coated sugar is also discussed.

Introduction

The molasses coating plant at the S.A. Sugar Terminals has been operating for two years with satisfactory results. Since the original planning stage, several changes have been made leading to simplification without loss of efficiency.

(i) Originally designed to coat V.H.P. sugar with final molasses, this was changed soon after commissioning to the use of high test mollasses although final molasses could be used, if required, by the turn of a switch.

(ii) With the use of final molasses, it was originally considered essential to wash out the molasses pipe lines after each ship loading run. This produced corrosive conditions inside the pipes. With the change over to high test molasses, it was decided to stop the washing procedure, so that a film of molasses is left on the inside of the pipes instead of a film of moisture. Since the washing out process was stopped, no further problems with corrosion have so far been seen.

(iii) To avoid overloading of the pumps the molasses was heated to 33-36°C by direct steam injection supplied from an oil fired boiler operated automatically from the computer in the control room, according to the heat requirements. This system gave rise to a major proportion of our operating problems so it was decided to run the molasses dosing pumps at a slower speed, thus enabling us to pump colder molasses (as low as 27°C) and to stop using the boiler. During the past summer, no steam injection was required, although this will be necessary during the cold winter months.

It was found, when using cold molasses, that the edges of the twin curtains of molasses falling from the short aprons below the two rows of holes in the single manifold pipe were pulled inwards, so that the molasses fell into one small area of sugar in the centre of the trough. This resulted in poor mixing. Various modifications were made by replacing the single manifold tube with two of smaller diameter, varying the size of the holes and the length and angle of the aprons. At present, we are operating satisifactorily using twin manifolds, 50cm apart, of 7,5cm diameter with a row of 1,1cm diameter holes each and aprons with a length of 15,0cm set at an angle of 20° from the vertical. This is giving well shaped and separated curtains of molasses with good mixing. However, further modifications are planned in the hope of achieving better mixing at lower temperatures than is possible at the present time.

(iv) When final molasses was used, the plant was designed for water to be added in addition to that derived from condensed steam used for heating purposes so that the moisture level of the coated sugar would give a safety factor within the required range. With the change to high test molasses, the addition of water was discontinued. The safety factors obtained were 0,16 - 0,22 for both low and high pol sugars. No complaints have been received about either the quality or the handling properties of these sugars.

Operation of the plant

The operation of the plant is computer controlled with the weight of molasses to be added based on the following formula.

$$W_m = W_s \frac{(P_s - P_e)}{(P_e - P_m)} \qquad \text{Eq.1.}$$

where W_m = weight of molasses
W_s = weight of uncoated sugar
P_s = pol of uncoated sugar
P_m = pol of molasses
P_e = target pol of export sugar.

The weight of uncoated sugar is measured continuously by nuclear belt weigher and this information is fed into the computer. The pol values for the uncoated sugar and of the molasses are based on analysis and these are also fed into the computer via calibrated potentiometers. The required Pe value is set, also by a calibrated potentiometer, according to the grade of export sugar required. This, in theory, should give us a coated sugar at the required pol value. In practice control of the plant has to be maintained by continuously sampling both the uncoated and coated sugars. These are analysed within half an hour. If the Pe value differs by more than an acceptable amount from the target value, changes are made to the Ps setting to bring about the required change. This Ps setting usually differs by a considerable fraction of 1°S. The pol of the molasses is determined at 4 hourly intervals.

In addition, the ratio of tons of molasses to tons of sugar does not remain constant under all rates of sugar flow and this factor can drop the pol value of the coated sugar by as much as 0,5°s. As the computer system does not give 100 per cent efficiency in achieving the target pol, it is proposed to simplify the system. From equation I it can be seen that the value of the denominator (P_e - P_m) is large, approximately 90, and can be considered as constant. The weight of molasses required will then be proportional to the value of the numerator (P_s - P_e) which will vary over the range of 0,6 - 1,9. We intend, therefore, to replace the computer system with a ratio controller calibrated in terms of (P - P_e).

Effect of change in Pe and Pm values.

For any given weight of sugar flow, the amount of molasses required is dependent upon the ratio.

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$$\frac{P_s - P_e}{P_e - P_m}$$

For 100 tons of coated sugar the ratio is then the tons of molasses required.

As the target pol, P_e, is fixed, the ratio is dependent upon changes in P_s and P_m. The effect of changes in these two values can be seen in

TABLE I

Effct of Ps and Pm on amount of molasses required.

Ps	Pm	Ratio (Tons molasses per 100 tons of coated sugar)	
		Pe = 98,7	Pe = 97,7
99,3	8,0	0,66	1,78
99,4		0,77	1,90
99,5		0,88	2,01
99,6		0,99	2,12
99,5	5,0	0,85	1,94
	7,0	0,87	1,98
	9,0	0,89	2,03
	11,0	0,91	2,08

It is obvious that changes in the P_s value during coating can produce large differences in the demand for molasses, it is therefore critical to carry out frequent analysis for both the Ps and Pe values. Changes in Pm value have little effect on the demand.

Weight of molasses used.

The weight of the coated sugar, We is accurately weighed on the servo balans immediately pior to the sugar going into the ship's hold.For internal auditing purposes, it is necessary to know the division between the uncoated sugar and the molasses. Digital integrators, fed from the weighers give the tonnages of the uncoated sugar and of the molasses. In addition, pressure guages on the molasses storage tanks give the tonnage of molasses used. Unfortunately, the sum of the sugar and molasses integrators did not agree with the servo balans figure for We and neither did the molasses integrators agree with the pressure guage on the storage tank. Accordingly, for auditing purposes, the weight of molasses used was calculated from

$$W_m = W_e \frac{(P_s - P_e)}{(P_s - P_m)} \qquad \text{Eq. 2}$$

From Table I, it is seen that the critical factor is (P_s - P_e). Rather than rely upon the accuracy of single analysis of the two composite samples of uncoated and coated sugar, the values taken were the weighted mean of the 30 - 100 half hourly samples taken during the run. However, when an oportunity for stock-taking occurred, it appeared that we had gained a few hundred tons of molasses.

When molasses was next received from the mill, the opportunity was taken to correct the calibration of both storage tanks. A calibrated tank was also constructed to receive molasses from the dosing pumps and used to recalibrate the two digital integrators. It was then found that the integrated weight of molasses was in agreement with that given by the pressure guages on the storage tanks, to within the accuracy of reading the latter. The integrated value is now the accepted one.

Discounting the possibility of an error in the value for We, any error in the calculated weight of molasses would be due to errors in the analytical values. The numerator in the equation is the difference between the analysis of the uncoated and coated sugars. As the same method is used and the values are of the same order and obtained by averaging a large number of determinations, it is considered that the difference between the two values is reliable. The denominator, however, is dependent upon the value of the pol of the molasses. The accuracy of the method is questionable. Using equation 2, the weights of molasses used, calculated from the weighted average values obtained for Ps, Pe and Pm, are shown in Table II for several shipments. In all cases, the calculated value was less than the integrated value. By calculation, values were found for Ps and Pm that would give calculated weights of molasses approximating to the integrated values. These are also shown in Table II.

It is considered that the change required in the Ps value is more than could be accounted for by inaccuracies in the determination of the average values for Ps and Pe, particularly as the required changes are biased in the one direction. The change in the Pm value is large but not impossible. Obviously, the method of analysis for

TABLE II

Comparison of calculated against integrated weight of molasses used.

Ship	P_s	P_e	P_m	W_e	W_m Calculated	W_m Integrator
Hellas in Eternity 17-9-71	99,45 99,45 99,49	98,72	6,50 11,60 6,50	26 883,837	212,808 225,266 224,469	255,2
Sugela 22-9-71	99,46 99,46 99,58	97,74	7,16 12,90 7,16	23 624,188	448,594 478,943 479,679	479,0
Falmouth 5-10-71	99,41 99,41 99,55	97,68	6,83 13,38 6,83	13 815,673	263,083 283,524 284,373	283,6
Bulk Pioneer 7-10-71	99,46 99,46 99,56	97,71	6,83 11,70 6,83	17 074,840	328,756 347,412 347,584	347,8
Falmouth 23-12-71	99,57 99,57 99,64	97,61	7,34 10,30 7,34	13 737,150	298,270 308,382 308,922	308,4
Dona Ourania 4-1-72	99,46 99,46 99,49	98,61	7,30 10,10 7,30	11 832,423	110,147 113,632 114,035	113,6
Kavo Delfini 27-1-72	99,37 99,37 99,43	98,64	7,27 14,24 7,27	15 244,355	121,795 131,853 131,805	131,8
Sugela 16-2-72	99,37 99,37 99,41	97,58	7,64 9,58 7,64	23 624,810	470,185 480,550 480,691	480,5

the pol value and its relationship to sucrose value in high test molasses requires investigation.

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