EVALUATION OF A NEW NUTSCH BOMB DESIGN

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Abstract

The performance of a new design of Nutsch bomb, featuring a vertical screen arrangement with a relatively large screen area was compared to the present model. The results show that the new bomb is superior to the present model in nearly all departments. Extraction times particularly, are greatly reduced.

Introduction

Nutsch purities are used to assess the performance of C-massecuite crystallisers, re-heaters and centrifugals. They provide important processing information in an area where other determinations, such as that of saturation temperature, suffer from various analytical difficulties.

The present bomb design using a horizontal screen arrangement shows various shortcomings, the most serious being the excessive time required to extract sufficient molasses. Apart from being inconvenient, this could cause temperature gradients within the massecuite being treated. This should be avoided, as the objective of the Nutsch analysis is to obtain a mother liquor purity from a sample of massecuite at a specific point in the process and temperature can exert an influence on the result obtained.

It was thus decided to design a new bomb in an attempt to eliminate or at least minimise this problem. At the same time, various other improvements were incorporated.

Materials and methods

A prototype bomb was constructed as shown in Figures 1 and 2, whilst for purposes of comparison Figure 3 gives a schematic diagram of the previous design. The new bomb was designed to offer the following advantages:

(1) For the same overall size of bomb, the screen area and ratio of screen area to massecuite volume is much larger.

(2) Compaction of crystals at the screen surface is decreased. This should also be helped by the vertical nature of the screen.

(3) Any molasses extracted but sticking onto the outlet part of the cylindrical screen support may be removed by scraping with a long spatula.

(4) Massecuite leakage, between the screen support and bomb body, is eliminated.

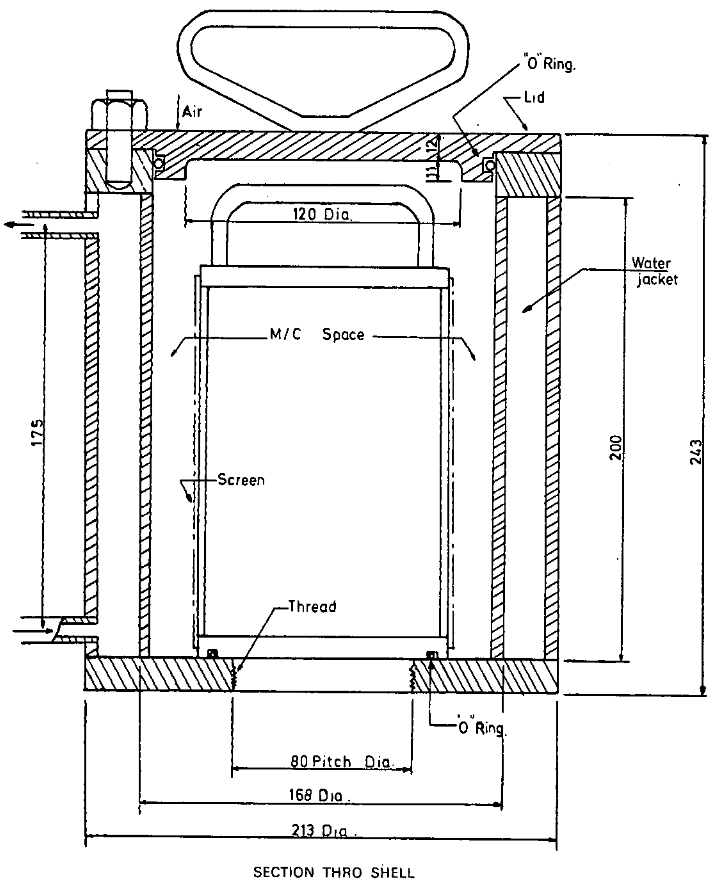

FIGURE 1

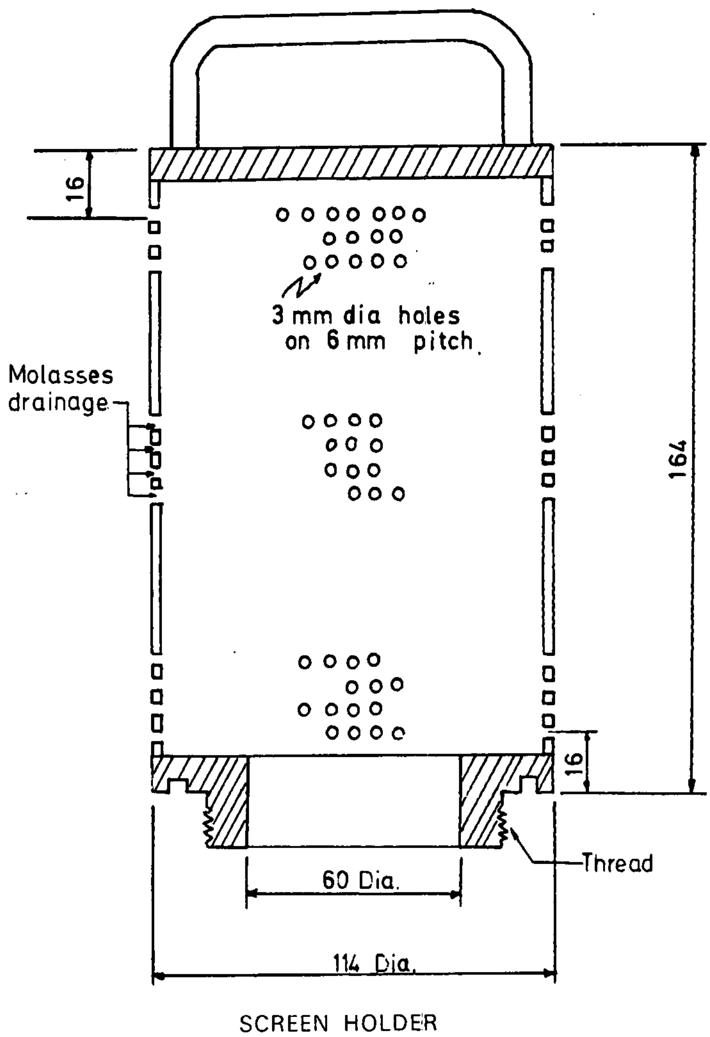

FIGURE 2

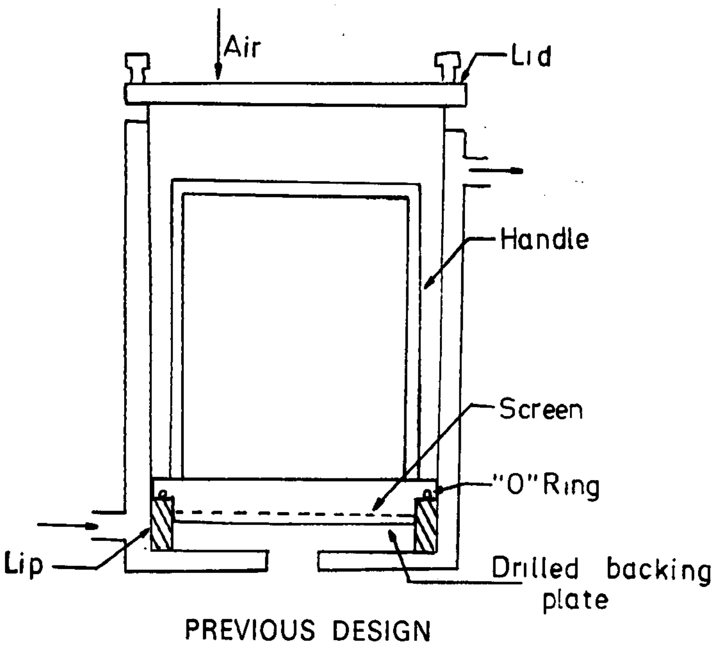

FIGURE 3

Table 1 below shows some basic data concerning the old and new designs.

TABLE 1

	Body Dimensions (cm)		Molasses Outlet Diameter (cm)	Screen Surface area (cm²)	Screen Area / Massecuite Vol (cm² / ml)
	Depth	Diameter			
Old . .	16	11	2,2	54	0,04
New . .	21	15,7	7,8	540	0,21

The new bomb discussed here is not necessarily the optimum design. Two modifications have been suggested. One involves longitudinal grooving of the screen cage to achieve better drainage of molasses to the holes. This was tried at the beginning of the tests and was adopted for all the tests reported here. The second modification involves re-locating the lid "O"-ring, to seal on the top of the bomb wall rather than on its side. This would make the opening and closing of the bomb easier but would involve a change in the location of the studs.

The drawings do not indicate how the screen was fixed to the cage. Two methods were envisaged, one involving brazing of the screen onto the cage (which was used here), the other being the use of metal clamps with screws.

Both bombs are water-jacketed and use 0,06 mm BMA continuous centrifugal screens.

Tests were then run to compare performances. The procedure adopted was to operate both bombs simultaneously, using a water bath to circulate water at fixed temperatures. Original massecuites were analysed for purity. Motive air pressure of 446 kPa (50 psi) was used. Massecuite temperatures at several points on the periphery and in the centre were measured to obtain an average value.

Results and discussion

Molasses extraction times

In Table 2 the amount of molasses extracted at 49° C is shown together with the time taken and the analyses of the original massecuite and the extracted molasses.

TABLE 2

Model	Massecuite			Extracted Molasses			
	Purity	Temp. (°C)		Weight (gms)	Time (mins)	% Brix	Purity
		Start	End				
Old . . .	53,1	49	43	30	290	93,8	27,8
New. . .		49	46	45	159	94,0	28,0
Old . . .	53,4	49	47	36	180	96,2	29,4
New. . .		49	46	100	40	96,0	29,5

Note: In each case the massecuite temperature at sampling and the water jacket temperature were 49°C.

Table 3 gives results of several tests showing the time taken to extract a constant quantity of molasses at 41° C.

TABLE 3
Extraction times for collection of 110 gm molasses

Model	Massecuite			Extracted Molasses		
	Purity	Temp. (°C)		Time (mins.)	% Brix	Purity
		Start	End			
Old . . .	53,6	41	37	200	92,9	32,1
New . . .		41	41	20	93,1	31,9
Old . . .	56,6	41	36	115	91,0	32,3
New . . .		41	41	20	92,5	32,2
Old . . .	54,8	—	—	75	94,3	33,0
New . . .		—	—	10	94,1	32,5

Note: In each case the massecuite temperature at sampling and the water jacket temperature were 41°C.

It is immediately apparent from Tables 2 and 3 that the new design considerably reduces extraction times. A closer look at these results indicates that over the range 40-50° C, massecuite temperature is not the overriding factor governing extraction times. This is evident from the fact that the quantity of molasses extracted per unit time at 49° C in Table 2 is considerably lower than that for the first test in Table 3 at similar massecuite purity where the temperature was only 41° C. The resulting molasses purity was somewhat higher at the lower temperature and hence it would appear that the dominant factor is that of massecuite quality (i.e. viscosity and mother liquor purity).

Effect of extraction rate

The results in Tables 4 and 5 give the comparative data on molasses quality with the two designs for both a slow and a rapid filtering massecuite respectively.

The relative extraction rates are depicted graphically in Figures 4 and 5.

TABLE 4
Extraction rate for a relatively tight massecuite

Model	Molasses extracted (gms)			% Brix	Purity
	5 min.	25 min.	55 min.		
Old . .	2	32	90	94,0	32,9
New . .	—	89	194	93,6	32,8

Note: Massecuite purity was 54,6 and temperature 42°C.

TABLE 5
Extraction rate for a relatively slack massecuite

	Extracted molasses after				Average	
	25 min.	85 min.	125 min.	170 min.	% Brix	Purity
Old design						
Weight (gms)	59	171	217	283		
% Brix . .	92,2	92,5	91,5	92,5	92,3	33,5
Purity . .	33,4	34,0	32,8	33,1		
New design						
Weight (gms)	500	971	1 077	1 143		
% Brix . .	92,3	92,4	92,3	91,6	92,3	33,7
Purity . .	33,6	33,9	33,1	33,5		

Note: Massecuite temperature was 50°C.

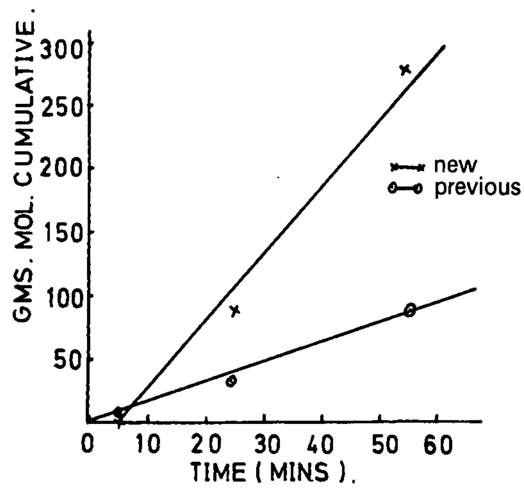

FIGURE 4

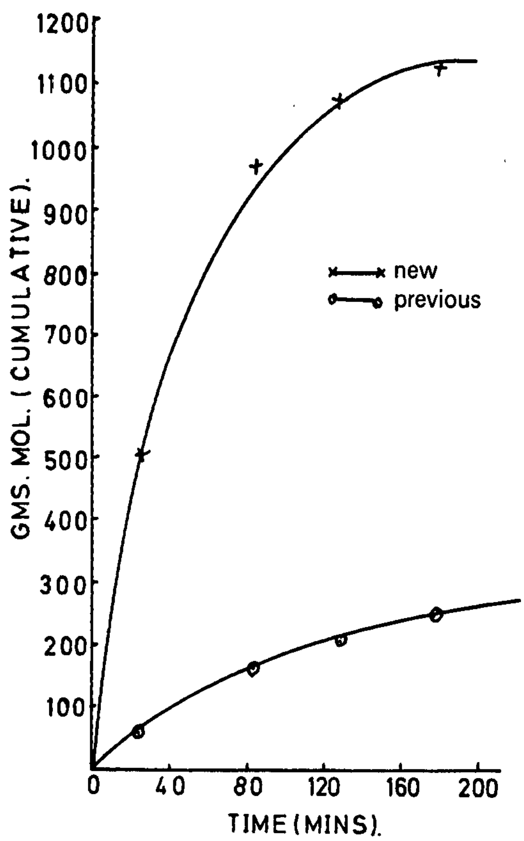

FIGURE 5

In each case it is evident that the new design produces much faster extraction rates. However a comparison of the extracted molasses purities for each pair of tests shows no significant trends. From this it may be concluded that the rate of extraction has no effect on molasses purity over the range covered in the present study.

Effect of massecuite temperature

Comparisons on the molasses extracted from the same massecuite at a number of different temperatures are given in Table 6.

TABLE 6
Effect of massecuite temperature

Model	Jacket Temp. (°C)	Massecuite Temp. (°C)		Molasses Purity
		Start	End	
Old . . .	55	54	54	26,0
New . . .	55	54	54	26,0
Old . . .	60	60	57	29,2
New . . .	60	60	57	29,4
Old . . .	65	64	64	31,4
New . . .	65	63	64	32,3

Note: For all these tests the original massecuite brix was 93,1 and purity 52,9. No molasses was extracted by either bomb below 55° C.

In this test the massecuite was actually a boil off jelly having very high viscosity and irregular grain size. It can be seen that both designs give similar molasses purities at each temperature except for the last case at 64° C where the difference of nearly one unit is as yet unexplained. The effect of temperature on molasses purity is shown graphically in Figure 6.

Conclusions

The results show clearly that the new design results in much faster extractions. This is a definite advantage as far as con-

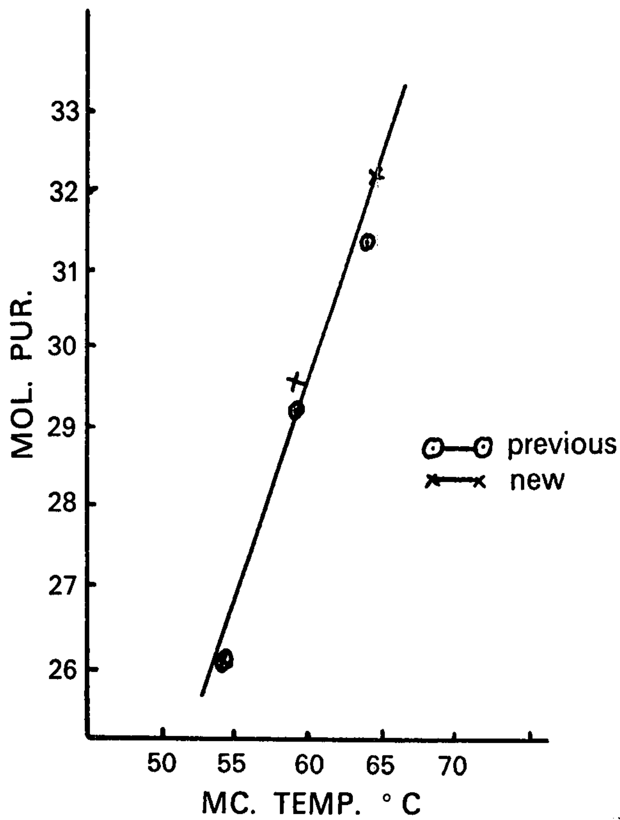

FIGURE 6

venience is concerned. Also with shorter extraction times the possibility of temperature change and thus of a molasses purity change, is reduced.

This would apply particularly in the cases of massecuite at strike (± 70° C) and after the reheater where in some cases massecuite is reheated to 55-60° C and cooling of the bomb and massecuite could well take place with long extraction times. In those cases an extraction time of 5-10 minutes would be ideal. To achieve this, the amount of molasses extracted should be the minimum sufficient for brix and pol analyses.

Long extraction times might affect purity, even without temperature changes, when there are significant differences between actual and saturation temperatures. This could occur when re-heated massecuites are extracted. Again, this highlights the importance of rapid extractions.

Water jacketing of bombs should be viewed with caution. It is considered impossible to change the massecuite temperature uniformly in the bomb by altering the jacket water temperature. Even with stirring of the massecuite, the time needed is impractical for routine purposes. Any change in the water temperature will only affect a narrow layer of massecuite next to the bomb wall. With higher water temperatures, more molasses may be extracted but the measured purity will not be meaningful. The purpose of the water jacket is to keep the bomb temperature as close as possible to that of the massecuite at the time of sampling. This avoids a temperature change when the sample is fed into the bomb. The recommended procedure would thus be to measure the massecuite temperature at the sampling point and to set the water bath at that temperature. When conditions are steady, the massecuite is sampled, fed into the bomb and extracted.

Massecuite feeding on the new design is more difficult compared to the old bomb. Here the massecuite must be poured slowly to fill the gap between the bomb wall and the screen cage completely in order to prevent air leakage direct to the screen.

Acknowledgements

The assistance of the Design Office, Huletts T.M.D., for the original drawing of the bomb and the Darnall workshop staff for its construction is gratefully acknowledged. The authors would also like to thank the Board of Directors of Huletts Sugar Limited for permission to publish this paper.