ANOMALIES IN THE MEASUREMENT OF A-MASSECUITE VOLUMES AND EXHAUSTION

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Abstract

A regular discrepancy between massecuite volumes as reported by the mill and calculated volumes led to an investigation being conducted which determined that a certain amount of massecuite remained in the pan after each strike and that reported exhaustions were too high due to incorrect sampling methods.

Introduction

The following calculation shows the discrepancy that existed between actual mass of sugar made and estimated as determined by dispatched mass and stock-taking, and "expected" sugar yield according to the reported figures.

For week ending 16/7/79:

Tons brix in mixed juice	3741,39
m^3 A-massecuite recorded as struck	4013,00
∴ m^3 A-massecuite/ton brix in mixed juice	1,07
Brix A-massecuite	94,22
SG A-massecuite	1,51
∴ Tons A-massecuite	6059,63
Pol % A-massecuite	82,74
∴ Tons pol in A-massecuite	5013,74
Exhaustion A-massecuite (calculated from pol purities)	70,92
∴ Tons pol in sugar from that volume of A-massecuite	3555,74
Actual tons pol in sugar made and estimated	3009,46
DIFFERENCE	546,27 Tons

As shown in Table 1, the difference as calculated above occurred regularly and although of varying magnitude, could not be solely ascribed to a large stocktaking error. From the above example, the magnitude of the error being sought is of the order of 18,2%.

TABLE 1

Difference between actual mass of pol in sugar and calculated mass of pol in sugar

Week Ending	11/6/79	18/6/79	25/6/79	2/7/79	9/7/79	16/7/79
Calculated mass	3372,09	3228,74	3741,96	3699,70	3997,16	3555,74
Actual mass	2942,27	2908,57	3233,26	3153,56	3124,22	3009,76
Difference	429,82	320,17	508,70	546,135	872,94	546,27

This illustrates that either:

(i) Massecuite volumes as reported were over estimated, or

(ii) Massecuite exhaustions as reported were too high, or

(iii) A combination of both caused the discrepancy.

The investigation was initiated to validate the above statements and correct conditions to reduce or eliminate these differences.

Results

(i) *Internal pan inspection*

It is the practice at Illovo to brix the A-massecuites well and not to steam out the pans after every strike. An internal inspection of the pans after discharge showed that significant quantities of massecuite remained on the top tube plates, inside the tubes and on the bottom cones. This appears to have arisen from the fact that as a strike receiver is not installed at Illovo and as the A-crystallizers are operated in series, the crystallizers would inevitably be full after striking a pan so that the following pan, if ready to strike shortly thereafter, had to be discharged slowly in order to control the crystallizer levels, sometimes taking as long as 45 minutes to complete the strike. Once the pan-boiler considered that all the massecuite had been discharged, the next cycle was started and the full volume was recorded as having been struck, whereas some remained in the pan.

To illustrate this:

A 30 m^3 pan strikes 30 times per week and *assuming* that 2 m^3 massecuite remains in the pan:—

Total volume recorded as struck for week	900 m^3
Volume of massecuite retained in the pan	60 m^3
Volume actually struck is	840 m^3

This has the effect of reducing pan capacity by the following margin:

$$\frac{60}{900} \times 100 = 6{,}7\%$$

(ii) *Massecuite sampling and analysis*

A-massecuite was sampled by taking *one* catch sample from approximately the middle of each strike and compositing this sample for 8 hours on the pan-floor, after which the composite was sent to the laboratory for analysis.

This method had a two-fold effect on laboratory data:

(*a*) The catch sampling from the middle of the strike showed bias towards a higher brix and purity than the average for the strike as shown in Table 2.

TABLE 2

Variation of massecuite purity through strike volume

	Pan No. 1		Pan No. 2		Pan No. 3	
	Brix	Purity	Brix	Purity	Brix	Purity
Pan full (start discharge)	92,80	85,51	92,50	87,08	92,35	87,22
Pan full	92,50	85,14	93,30	87,62	91,70	87,35
Pan half full	93,10	86,79	92,65	87,70	91,70	87,79
Below top tube-plate	93,33	86,71	93,90	89,30	91,40	87,75
Average	92,92	86,04	93,09	87,92	91,79	87,53

(*b*) The method of compositing and sub-sampling similarly showed bias towards a higher brix and purity, as shown in Table 3.

TABLE 3
(Mellet[1])
Analysis of layers of massecuite from container after standing for 4 hours

	Top layer	Middle layer	Bottom layer
Brix . . .	94,08	93,78	93,56
Purity . .	88,89	87,99	87,98

The result of these errors was to inflate A-massecuite purity, and hence exhaustion, by increasing the purity drops. These findings were confirmed by Hoareau[2] in theoretical calculations from actual figures.

Discussion

From the observation that a certain amount of massecuite remained within the pans after each strike, it can be seen that compounded over a week, a large discrepancy arose between massecuite recorded as struck and that actually struck. This is illustrated in Table 4 where it can be seen that the A-massecuite volume for the week under consideration was overestimated by 4,8%.

TABLE 4
Pan information as recorded in pan floor log book (w/e 16/7/79)

	No. of strikes	Volume struck	Ave. m³/strike
Pan No. 1 .	60	2352	39,20
Pan No. 2 .	31	869	28,03
Pan No. 3 .	30	792	26,40
		4013	

Volumes struck after correction based on visual estimates of residual massecuite

	No. of strikes	Correction	Volume struck
Pan No. 1 .	60	(39,2−1,0)×60	2292
Pan No. 2 .	31	(28,03−2)×31	807
Pan No. 3 .	30	(26,4−2)×30	732
			3831

The difference in the factors applied to pan 1 and pans 2 and 3 arose from the fact that it was physically evident that less massecuite remained in pan 1 which is of a more modern design than pans 2 and 3 (which are narrow-diameter, high head pans) and by virtue of the pan-cycle where pan 1 had preference in striking which was done normally, resulting in pans 2 and 3 being held back while striking, causing more massecuite to be left in the pan.

It was established that very little, if any, further crystallization occurred in the crystallizers (see Table 5) and steps were taken to ensure normal striking of the pans by operating the crystallizers at a lower level.

TABLE 5
Comparison of strike nutsch molasses purity and nutsch molasses purity on curing

Pty nutsch Mol. @ strike	Pty nutsch mol. @ curing
65,38	65,47

This had the effect of reducing massecuite volume from a reported 1,09 m³/ton brix in mixed juice (for week ending 30/7/79) to 1,04 m³/ton brix in mixed juice for the week ending 6/8/79. (See Table 6).

Improvements to the methods of sampling and compositing of A-massecuite resulted in an immediate decrease in the reported exhaustions as shown in Table 6.

TABLE 6
Comparison of results before and after corrections applied

Week Ending	A-mcte pty	A-mols pty	Exhaustion	m³/ton brix in mixed jce-
16/7/79 . . .	87,82	67,71	70,92	1,07
23/7/79 . . .	87,47	68,65	68,63	1,07
30/7/79 . . .	87,10	67,51	69,23	1,09
6/8/79* . . .	85,61	66,52	66,60	1,04
13/8/79 . . .	86,38	68,07	66,39	1,03

* Corrections applied

In order to evaluate progress, the '"expected' sugar yield from A-massecuite was calculated (for corrected conditions) as follows:

For the week ending 13/8/79:	
Tons brix in mixed juice	3680,01
m³ A-massecuite recorded as struck . .	3806,00
∴ m³ A-massecuite/ton brix in mixed juice	1,03
Brix A-massecuite	92,63
SG A-massecuite	1,51
∴ Tons A-massecuite	5715,78
Pol % A-massecuite	80,01
∴ Tons pol in A-massecuite	4573,19
Exhaustion A-massecuite	66,39
∴ Tons pol in sugar from that volume of A-massecuite	3036,14
Actual tons pol in sugar made and estimated	2953,13
DIFFERENCE	83,01 Tons

The magnitude of the discrepancy obtained (2,8%) verifies that factory data now published is more accurate and reflects the operating conditions more correctly.

Conclusions

Problems arise with reported figures when pan gauge volumes are accepted as being the volume of massecuite struck while incorrect sampling and compositing procedures give rise to extremely misleading performance data being published. Although factory performance was not impaired, the re-circulation of 4,8% of A-massecuite could have reduced A-pan capacity and affected recovery if this part of the factory had proved to be marginal.

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LITERATURE

1. Mellet, P. (1979). SMRI Technical Report Number 1190. Sampling and analysis of factory products with special reference to A-massecuite.
2. Hoareau, J. P. (1979). SMRI unpublished communication.