PROGRAM FOR SEASON-END BOIL-OFF BALANCE

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Abstract

A program was written to perform a balance of the various intermediate and final products in the Darnall factory during the season-end boil-off. This information was used to decide when to stop producing production stocks, and to start producing 'jellies' and carry-over stocks. The volumes and tonnages predicted by this program during the 1986 boil-off agreed closely with actual figures obtained.

Introduction

Season-end boil-offs at Darnall have traditionally been 36 hours or less. This has been due to a lack of coal burning facilities at the mill, with the boil-offs being carried out on stockpiled bagasse only. It is thus imperative that these be as short as possible in order that fuel be conserved for the following season startup. This calls for a well planned boil-off, with the quantities of massecuites to be boiled being predetermined. It is possible to manually calculate these quantities during the boil-off, but the calculations are laborious, as product recirculation has to be taken into account. A computer program was written which would perform these calculations. The program was written on an Apple //e in interpretive BASIC, and then compiled for increased speed.

Purpose of the Program

The program informs process management what volumes of 'A', 'B' and 'C' massecuites have to be boiled and cured out before the 'jellies' and carry-over massecuite stocks are produced. The progress of the boil-off can also be monitored by comparing actual sugar and molasses production with predicted productions. It must be noted at this stage that at Darnall the C crystallisers are emptied prior to the boil-off, and then the carry-over massecuite stocks are struck into these empty crystalisers at the end of the boil-off. This helps reduce the time of the boil-off, as remelt from these massecuites does not have to be processed.

Input

Data is input in two stages:

1. All brixes and purities of the factory products are input. These can be saved to disk for later recall and use. This obviates the need for the re-input of values which do not change during the boil-off.
2. The volumes of the various factory products are input. Each product can be input in two parts: massecuites, magma and seeds as pan and/or crystalliser volumes, and syrup, remelt and molasses as pan and/or tank volumes.

Output

The output is produced after every 'run', ie whenever the input data is changed.

The output is presented in two forms:

- *Screen Output*

The following is produced on the screen for 'A', 'B' and 'C' massecuite in matrix form:

Cubic metres of total massecuite in stock. This includes massecuite in stock at the stock-take, plus massecuite still to be made from various products in the factory such as syrup, clear juice, etc., as well as from recycled remelt.

Cubic metres of massecuite to strike. This is the total massecuite volume in stock minus the massecuites in the crystallisers.

Cubic metres of massecuite still to be boiled. This is the total massecuite volume minus massecuites in pans and crystallisers.

Cubic metres of massecuite to cure out. This is the total amount of massecuite in stock minus the amount to remain in the factory as stock – ie carryover massecuites and jellies.

Tons of raw sugar and final molasses to be produced.

Hard Copy

If a hard copy of the output is desired, all of the above is printed out, together with the input pols, brixes, purities and volumes of the input products.

An example of the hard output is given in Appendix I.

Calculation Procedure

A diagram of the product balance is used in the program is given in Appendix II.

The program calculations consist of two parts or 'passes':

Pass 1: The primary calculations of massecuite volumes using existing products in the factory.

Pass 2: The secondary calculations of massecuites which will be produced from remelt. These secondary calculations can be performed from 2 to 9 times, with a default value of 3 (ie the program will perform the calculations three times unless otherwise instructed). This is to take into account the continuous recycling of remelt to the front end.

As the primary calculations are carried out, the volumes of massecuites produced are stored as variables. The massecuites 'produced' in the secondary iterations are then added onto these volumes to give the total volumes.

In performing the calculations, the following should be noted:

- The 'C' massecuite 'produced' in the first pass is made up of 'A' and 'B' molasses to obtain the same massecuite purity as that in stock at last cane. This is not done in the second pass as the volumes of 'A' and 'B' molasses are very small, and it is not always possible to obtain the correct proportion of the two molasses to obtain the desired massecuite purity. The 'C' massecuite is thus made up of 'B' molasses only in the second passes.
- No remelt is produced from carry-over massecuite and jellies. These carry-over volumes are deducted from the total massecuite volumes before the beginning of the first pass.
- The 'SJM' formula is used in the recovery calculations. No 'recovery factor' is used, ie it is assumed that no undetermined loss takes place.

Use of the Program

Immediately the last cane is crushed, a stock of all factory products is carried out, and the results input into the program, together with the relevant brixes and purities. The program will then give the volumes of massecuites still to be boiled and cured out. Using this information, the number of 'A', 'B' and 'C' pans still to be boiled from the time of the stock-take can then be calculated.

Further 'running' stock-takes are carried out at regular intervals throughout the boil-off, and the program re-run after each stock-take. Once the pans which are to be cured out are struck, the 'jellies' and carry-over massecuites (if any) can be boiled.

The actual sugar and molasses tonnages produced throughout the boil-off can also be compared to the predicted final totals. This gives an indication of how close the boil-off is to completion.

Obviously the accuracy of the program depends to a large extent on the accuracy of the stock-takes. It is imperative that these are carried out quickly and accurately.

Actual Results vs Predicted Results - 1986 Boil-off

Figure 1 gives a comparison between the actual results obtained during the 1986 season boil-off and the results predicted by the program.

Table 1

Actual vs Predicted Values 1986

Massecuite to strike - cubic metres

	A		B		C	
	Pred	Act	Pred	Act	Pred	Act
09h16	441	435	267	267	254	314
18h15	267	250	216	222	193	202
21h15	158	145	164	176	132	146
00h15	138	145	127	150	94	118

Massecuite to boil - cubic metres

	A		B		C	
	Pred	Act	Pred	Act	Pred	Act
09h16	256	250	222	222	198	258
18h15	172	155	164	170	115	124
21h15	158	145	140	152	90	104
00h15	93	100	92	115	39	63

Output tonnages

	Sugar		Molasses			
	Pred	Act	Pred	Act		
09h16	321	290	266	247		
18h15	215	166	153	139		
21h15	155	135	108	94		
00h15	108	98	46	40		

Carry-over stock - cubic metres

	Massecuite		Jellies		Total	
	Pred	Act	Pred	Act	Pred	Act
	175	162	110	135	285	297

The mill stopped crushing on 8 January at 09h16, the first stock-take was carried out, and the program run. Three more stock-takes were undertaken, and the program was again run after each one.

Except for the 'C' massecuite volumes at 09h16, and the sugar tonnages at 21h15, the predicted results correspond closely to those finally obtained.

The 1986 boil-off was carried out in the record time of 23 hours, due partly to the stricter control of the boil-off provided by the use of the program.

Conclusions

The program is an invaluable aid in planning and executing the season-end boil-off. The precise cut-off point when the boiling of massecuites is stopped, and the boiling of 'jellies' is commenced can be accurately determined, with a large part of the guesswork being taken out of the exercise.

Acknowledgements

The author wishes to thank Mr DJ Muzzell for his advice and support during the design and writing of the program.

APPENDIX 1

8/1/86	09h16			
Product	Pol	Brix	Pty	Vol
Clear Juice	6,9	9,0	77,0	550
Syrup	32,0	40,0	80,0	126
Remelt	54,0	60,0	90,0	4
A m/c	76,3	92,5	82,5	208
A Sugar	99,3	99,8	99,4	0
A Molasses	53,2	82,0	65,0	4
B m/c	63,7	93,0	68,5	126
B Sugar	89,2	97,5	91,5	0
B Molasses	37,1	75,0	49,5	17
C m/c	52,2	95,0	55,0	188
C Sugar	87,1	98,5	88,5	0
C Molasses	33,2	81,0	41,0	0
A Seed	71,7	87,0	82,5	46
B Seed	60,6	88,5	68,5	24
C Seed	61,2	89,5	68,5	20
Magma	80,5	89,5	90,0	3
Tons Pol in Stock	694			
Tons Brix in Stock	986			
Tons Non-pol in Stock	292			
Cubic metres Stock	1 316			
Carry-Over 'Jellies'	58,5	90,0	65,0	110
C m/c Stock	51,4	93,5	55,0	175
Tonnage/Volume Results	A	B	C	
Total Stock	464	348	386	
M/c to Strike	441	267	254	
M/c to Boil	256	222	198	
M/c to Cure	464	238	211	
A Sugar to Make	321 tons			
C Mols to Make	266 tons			
3 iterations				

APPENDIX II

Product Balance Calculation Sequence