

THE EFFECT OF REDUCED FREQUENCY OF SAMPLING AND ANALYSIS AT SUGAR MILL LABORATORIES

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Abstract

A comprehensive survey was undertaken at fifteen South African sugar mill laboratories to establish if consolidation of the frequency of sampling and analysis could be achieved without impairing good factory control. By merely cutting down on what was not strictly necessary, it was concluded that the number of analyses could be reduced by 25%. Furthermore, if the day shift performs the bulk of the analyses while the other two shifts concentrate only on essential shift analyses and the compositing of samples, then an additional 12–15% reduction on the number of analyses could be attained. This would reduce the number of staff required per day to twelve or thirteen for raw house control plus an additional two people where a white-end refinery is attached to the raw house. The possible savings in labour and the use of chemicals could be about R20 000 per annum per factory.

Introduction

During the latter half of the 1981/82 season SMRI undertook a survey of nine South African sugar mill laboratories. Aspects considered were the type and frequency of analysis performed, the labour used to perform these analyses and the cost of chemicals. The nine factories chosen to give a good cross section of the whole industry included factories with milling tandems, diffusers, tandem plus diffuser and also factories with and without back-end refineries. The results of the survey showed that there was a wide variation in the number of analyses and also the manpower utilised per laboratory, e.g. laboratory staff varied in number from 16 to 35 leading to substantial differences in costs. It thus became obvious that there is ample scope to rationalise laboratory analyses and to attempt to lay down specific recommendations in so far as sampling, number and frequency of analyses and optimum staffing per laboratory are concerned.

Procedure

The Tongaat-Hulett Group Laboratories

The SMRI was represented in discussions with the Tongaat-Hulett Group of factories where sampling, analyses and frequency of analysis in mill laboratories were considered. A manual was compiled with the aim of ensuring standardisation in both sampling techniques and analytical frequency throughout the Group.¹ It was stressed that the recommendations be seen as the minimum required for good factory control, and when processes differed, the requirements would change. In general it was envisaged that a reduction of 25% in the number of analyses could be achieved (excluding analysis of traces of sugar in condensates, and the analysis of boiler and feed waters).

The C. G. Smith Group Laboratories

With regard to the C. G. Smith Group, SMRI was requested to visit the individual laboratories and assess the needs of each one. An analysis programme agreeing fairly closely with that drawn up for the Tongaat-Hulett mills was suggested to NB, PG and UK, while the other three C. G. Smith mills, i.e. IL, SZ and GH were keen to cut the number of analyses even further. This resulted in the concept of doing mainly day shift analyses and this was introduced at SZ where staff complements

employed by the two night shifts were reduced to three each, and during these shifts the analysts performed only those analyses essential for process control. At the same time samples of other products were taken and, where applicable, were preserved and/or composited to be analysed by the day shift.

Analyses for Raw House Control

The suggested programme of analyses is attached to this report (Appendix 1) and a blank column is provided so that individual laboratories can enter their figures to compare their existing procedure of analyses with the number of analyses suggested. It can be seen that an additional 12–15% reduction in the number of analyses compared with that of the Tongaat-Hulett analysis programme can be attained.

Sample Preservation and Compositing

To enable a laboratory to operate effectively as suggested in the attached programme, certain precautions must be taken. Special attention must be paid to sampling and sub-sampling techniques so that composites are truly representative for the period covered. In this respect two factors are of prime importance:

- (a) continuous sampling must be implemented where possible and done in such a way that the sample taken will be proportional to the mass of product produced. The latter is not always possible and in these cases suitable intermittent samples must be taken at preset frequencies;
- (b) having achieved this, adequate steps must be taken to store the samples in such a way that there will be no change in their composition, e.g. by deterioration or contamination. It is strongly recommended that all liquid samples, i.e. from clear juice to syrup, A-, B- and C-molasses, remelt and imbibition water be sampled by means of continuous/semi-continuous means. Details of type of sampling equipment are not discussed here but will be covered in a future report. All samples having a brix of less than 65° must be adequately preserved as prescribed in the Laboratory Manual for South African Sugar Factories.²

It will be necessary for each factory laboratory to purchase a small deep freeze and have facilities to prepare samples for deep freezing. Since most of the analytical procedures are self-explanatory, only some analyses will be discussed in detail.

It has been shown that rapid deterioration of prepared cane samples takes place³ and analysis of such samples must be done as soon as possible after collection. Imbibition water is not normally analysed for pol, but the presence of sugars may have a serious effect on the pol of mixed juice. It is therefore suggested that pol measurements of imbibition water be taken every shift.

Continuous recording of pH, brix and temperature, for instance, should be carried out where possible and only occasional laboratory measurements should be made to check the accuracy of these recordings, e.g. temperatures of diffuser stage juices, pH recording of limed juice, clear juice, syrup and filtrate and brix recording of syrup should be read from gauges, etc.

Analysis of masseccutes must be done on catch samples as soon as possible after the sample has been collected, because settling of the mother liquor occurs on standing and complete remixing of crystal and molasses becomes extremely difficult.

Should the number of strikes become too many for individual analysis, every second or third strike should be analysed. Composites of strikes should never be prepared.⁴

The terms "mud" and "filter feed" must be well defined, i.e. "mud" is the product coming out of the clarifier and "filter feed" is that which goes on to the filter after the addition of any secondary products like lime, bagacillo, flocculant, etc.

For the purpose of this report the analysis of boiler feed and boiler waters has not been considered since treatment and analysis are specified by industrial boiler water treatment firms. In addition water, such as tail pipe water, condensates, etc. have not been considered due to the fact that each factory differs in layout and hence in the control procedures adopted.

Refinery Control

The following types of refining processes are in operation in South Africa:

- (a) Carbonatation plus ion exchange (HR)
- (b) Phosphatation plus Talofloc plus ion exchange (NB)
- (c) Carbonatation followed by light sulphitation (ML, PG and GH)
- (d) Phosphatation plus Talofloc (EN)
- (e) Sulphitation (UF).

Analyses concerning Talofloc and ion exchange have not been covered in this investigation so that the attached programme deals only with analyses involved in carbonatation/sulphitation and phosphatation plants.

Analyses for Refinery Control

Only some analyses will be discussed in detail at this stage; a complete programme of refinery analyses is also attached to this report (Appendix 2).

- (a) *Affinated sugar*
Since no local refineries affinate prior to melting raw sugar, no analysis needs to be performed.
- (b) *Brix, conductivity ash/brix and reducing sugars*
It was found that some refineries monitor these constituents closely from raw melt through to sugar(s), cake and run off(s). The high frequency at which the products are analysed is unnecessary under normal operating conditions and these parameters should be analysed only as indicated in the schedule.
- (c) *Continuous sampling and preservation of samples*
As for the raw house it is strongly recommended that continuous/semi-continuous sampling be carried out wherever possible. All samples with a brix of less than 65° must be preserved with mercuric chloride and deep freeze facilities must be available for storage of samples.

Other South African Sugar Factories

Apart from the six Tongaat-Hulett mills and the six C. G. Smith mills dealt with so far, ML, UC and UF were also visited and similar programmes of analyses were recommended. Only GD and EN factories were not surveyed.

Manpower Employed and Chemicals Used

As mentioned earlier the number of laboratory staff per mill per day at present varies from 16 to 35. A slight increase in the number of day shift analysts is necessary to handle the increased number of samples. Figure 1 illustrates a typical labour distribution in a factory laboratory, while Figure 2 gives the layout of the proposed system. It can be seen that substantial savings could be obtained by the proposed system and a labour force of about 13 per day would be required for raw house control while an additional 2 people per day should suffice when a back-end refinery is attached to the raw house.

Additional savings could be obtained by considering the distribution of the working hours of the three shifts. Better productivity would probably be obtained by having the day shift from 08h00 to 17h00 and the two night shifts from 16h00 to 00h00 and from 00h00 to 08h00 respectively. In financial terms, all this means that the cost of running a laboratory will be reduced by as much as half in certain cases.

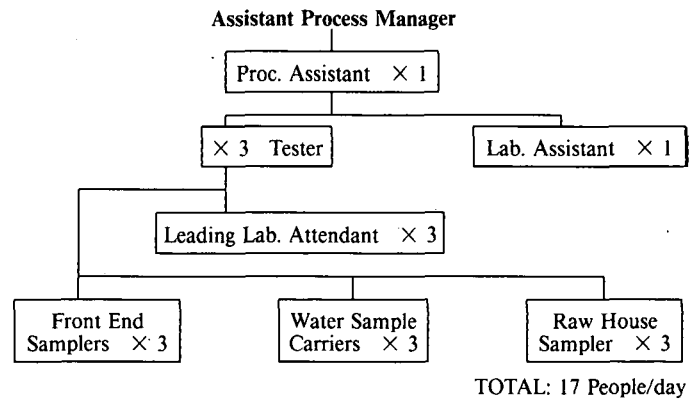


FIGURE 1 Existing staffing in a mill laboratory

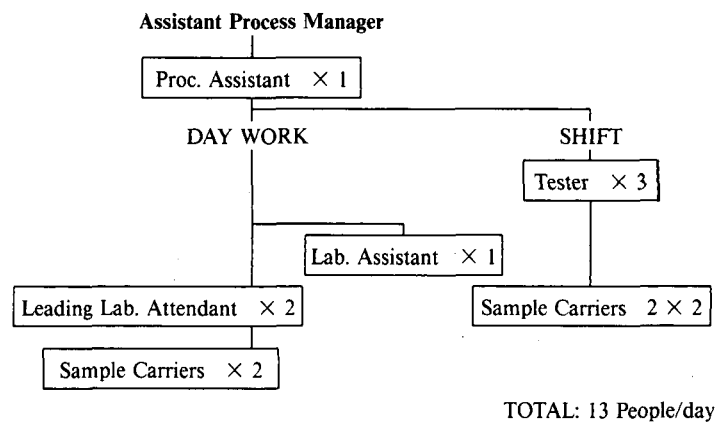


FIGURE 2 Proposed staffing in a mill laboratory

The cost of chemicals is between R10 000 and R15 000 p.a., but because many of the analyses adjusted to lower frequencies do not involve the direct use of chemicals, i.e. temperature and pH measurements, it is not easy to assess what cost reduction could be obtained. Nevertheless it is confidently predicted that some savings in costs will materialise.

Conclusions

Substantial savings can be achieved if a factory laboratory implements the suggested analysis programme. SZ and IL have already started this procedure and so far no major problems have been encountered. Every mill will of course have its own situation to consider and the final sampling, analyses and frequency of analysis will vary from mill to mill.

The initial capital outlay in providing automatic recorders for pH, temperature, brix, etc., and sampling equipment, will probably amount to several thousand Rand, but this should be recovered in a relatively short period due to savings of about R20 000 p.a. once the proposed analysis procedure is adopted.

REFERENCES

- 1 Archibald, R. D. (Sept. 1982). Process sampling and analytical frequencies. Hulett Sugar Limited.
- 2 (Anon). (1977). Laboratory Manual for South African Sugar Factories. S.A. Sugar Technologists Association.
- 3 Koenig, M. F. S. (Aug. 1982). Possible compositing of shredded cane samples for preparation index determination. SMRI Technical Report No. 1319.
- 4 Mellet, P. (Aug. 1979). Sampling and analysis of factory products, with special reference to A-massecurite. SMRI Technical Report No. 1190.

APPENDIX I
ANALYSIS PROPOSALS FOR RAW HOUSE CONTROL

Sample	Method and point of sampling	Composites	Parameters	Frequency of analyses	Proposed No. analyses per day	Present No. analyses per day
1. Prepared cane (mill or diff.)	From SICB hatch	No	Preparation Index	2 per day (see Note 1)	4	
2. Diffuser stage juices	Catch from stage pump	No	pH Brix	8 hourly 8 hourly	3 x 3 x (No. of cells)	
3. Individual mill bagasse	Catch	No	Brix Moisture	Hourly, each mill in turn	24 24	
4. Imbibition water	Cont.	Yes	Pol	8 hourly	3	
5. Mixed juice (mill or diff.)	SICB cont.	Yes	Reducing sugars	Daily (see note 2)	1	
6. Limed juice	Catch from pH controller	No	pH	2 hourly (see note 3)	12	
7. Muds	Catch from clarifier mud outlet	No	pH Pol Brix	8 hourly Daily Daily	3 1 1	
8. Filter feed (on to filter)	Catch from outlet of mixer	No	Mud solids pH	2 x weekly As required	- -	
9. Filter cake	Catch from (a) belt (b) filter	No	Pol Pol Moisture	Hourly Hourly Daily	24 24 1	
10. Filtrate	Cont. from return to mixed juice	Yes	pH Bx, Pol Mud solids	8 hourly 8 hourly Daily (see note 2)	3 6 1	
11. Bagacillo	Catch	No	Particle size	As required	-	
12. Clear juice	Cont.	Yes	pH Bx, Pol, RS	4 hourly (see note 3) Daily (see note 2)	6 3	
13. Syrup	Cont.	Yes	Bx pH Bx, Pol RS, Starch	4 hourly (Note 3) 4 hourly (Note 3) Daily Daily (see note 2)	6 6 2 2	
14. Remelt	Cont.	Yes	Bx Pol	4 hourly 4 hourly (see note 2)	6 6	
15. A-mass. at strike	Catch from pan or gutter	No	Bx, Pol Nutsch Bx, Pol	Every 2nd strike Daily	16 2	
16. A-mass. before curing	Catch from Crystalliser	No	Nutsch Bx, Pol	Daily	2	
17. A-molasses	Cont.	Yes	Bx Pol	8 hourly 8 hourly	3 3	
18. A-sugar	Cont.	Yes	Pol, Moist. % Fines, Col. SGS, Starch (see note 4)	4 hourly Daily Weekly	12 2	
19. B-magma	Catch from mixer	Yes	Bx, Pol	4 hourly	12	
20. B-seed	Catch from pan	No	Bx, Pol	As required	-	
21. B-mass at strike	Catch from pan or gutter	No	Bx, Pol Nutsch Bx, Pol	Every 3rd strike Daily	6 2	
NB On introduction of cont. pans	Sample from pan outlet	No	Bx, Pol Nutsch Bx, Pol	8 hourly 8 hourly	6 6	
22. B-mass. before curing	Catch from crystalliser outlet	No	Nutsch Bx, Pol	Daily	2	
23. B-molasses	Cont.	Yes	Bx, Pol	8 hourly	6	
24. C-magma	Catch from mixer	No	Bx, Pol	2 hourly	24	
25. C-seed	Catch from pan	No	Bx, Pol	As required	-	
26. C-mass. at strike	Catch from pan or gutter	No	Bx, Pol Nutsch Bx, Pol	Every strike Every strike	8 8	
27. C-mass. after cooling	Catch from crystalliser	No	Nutsch Bx, Pol	12 hourly	4	
28. C-mass. after re-heating	Catch from reheater outlet	No	Nutsch Bx, Pol	4 hourly	12	
NB On introduction of continuous procedure follow plan for B-masseccuite						
29. C-molasses	Cont.	Yes	Bx, Pol	8 hourly	6	
30. Injection water condensates, factory drains, etc. Boiler waters			pH Sugar traces Full analysis as recommended by water treatment company	Hourly or as present Hourly or as present		

NOTES

1. Preparation index to be done twice daily - 1st sample to be done at the beginning of the day shift, the second at the end of the day shift.
2. Composites must be kept in the deep freeze.
3. The four hourly analysis must be done to check the readings of the continuous recorder.
4. The % fines will be done by the "quick" method; the SGS must be done in full by the official method.

**APPENDIX 2
ANALYSIS PROPOSALS FOR REFINERY CONTROL**

Sample	How sampled	Composited or not	Analyses required	Frequency	Proposed No. analyses per day	Present No. analyses per day
1. Affinated sugar	-	-	Pol CA	-	-	
2. Raw melt	Cont.	Yes	Brix* pH** Colour CA/Bx RS	4 hourly 4 hourly 1 daily 1 daily 1 daily	6 6 1 2 1	
3. Limed melt	Catch	No	pH	2 hourly	12	
4. Carb. liq.	Catch	Yes	pH Colour CA/Bx	2 hourly 8 hourly Daily	12 3 2	
5. Fine liq. (after sulphitation press)	Cont.	Yes	Bx CA/Bx Colour pH	4 hourly Daily 8 hourly 2 hourly	6 1 3 12	
6. Thick liq.	Cont.	Yes	Bx* Colour CA/Bx	4 hourly 8 hourly Daily	6 3 1	
7. 1st mass.	Catch at centrifugal	No	CA/Bx	4 hourly	12	
8. 2nd mass.	Catch at centrifugal	No	CA/Bx	4 hourly	12	
9. 3rd mass.	Catch at centrifugal	No	CA/Bx	8 hourly	6	
10. 4th mass.	Catch	No	CA/Bx	Each strike	4	
11. 1st run-off	Cont.	Yes	CA/Bx	8 hourly	6	
12. 2nd run-off	Cont.	Yes	CA/Bx	8 hourly	6	
13. 3rd run-off	Cont.	Yes	CA/Bx	8 hourly	6	
14. 4th run-off (return syrup)	Cont.	Yes	Pol Bx CA/Bx	8 hourly 8 hourly 8 hourly	3 3 6	
15. 1st sugar	Catch from centr. discharge (8 hourly)	Yes	Colour CA	Daily	1 1	
16. 2nd sugar	Catch	Yes	Colour CA	Daily Daily	1 1	
17. 3rd sugar	Catch on curing	Yes	Colour CA	Daily Daily	1 1	
18. 4th sugar	Catch	Yes	Colour CA	Daily Daily	1 1	
19. Refined sugar	Cont.	Yes	Colour Moisture	Daily Per lot	1 3	
20. Sweet water	Cont. 1 hourly	Yes	Bx pH Pol	8 hourly 8 hourly 8 hourly	3 3 3	
21. Filter cake	Catch	Yes	Pol Moisture	8 hourly Daily	3 1	
22. Cyclone waters	Catch	Yes	Bx	2 hourly	12	
23. Press water	Cont.	Yes	CA/Bx Pol Pol	Daily Daily Per cycle	2 1 14	

* Continuous brix monitoring; check samples in laboratory every 4 h.
** Continuous pH monitoring; check samples in laboratory every 4 h.