REVIEW OF STEPS TAKEN TO IMPROVE A-MASSECUITE EXHAUSTION AT NOODSBERG

By I. SINGH

C.G. Smith Sugar Limited, Noodsberg

Abstract

This paper deals with practical steps that have been implemented progressively in A-sugar boiling over a four-year period. It looks at the effect on A-massecuite exhaustion of increasing A-massecuite strike brixes, elimination of pan steamings from crystallisers, improved pan boiling techniques and cooling of A-massecuite.

Introduction

Noodsberg uses a conventional 3-boiling system, using B-magma as a footing for A-massecuite. Since 100% refining is practised, the emphasis is on producing low colour A-sugar. From the commissioning of the Refinery in 1982, the raw sugar colour standard was set at 1000 colour units (ICUMSA 420 nm).

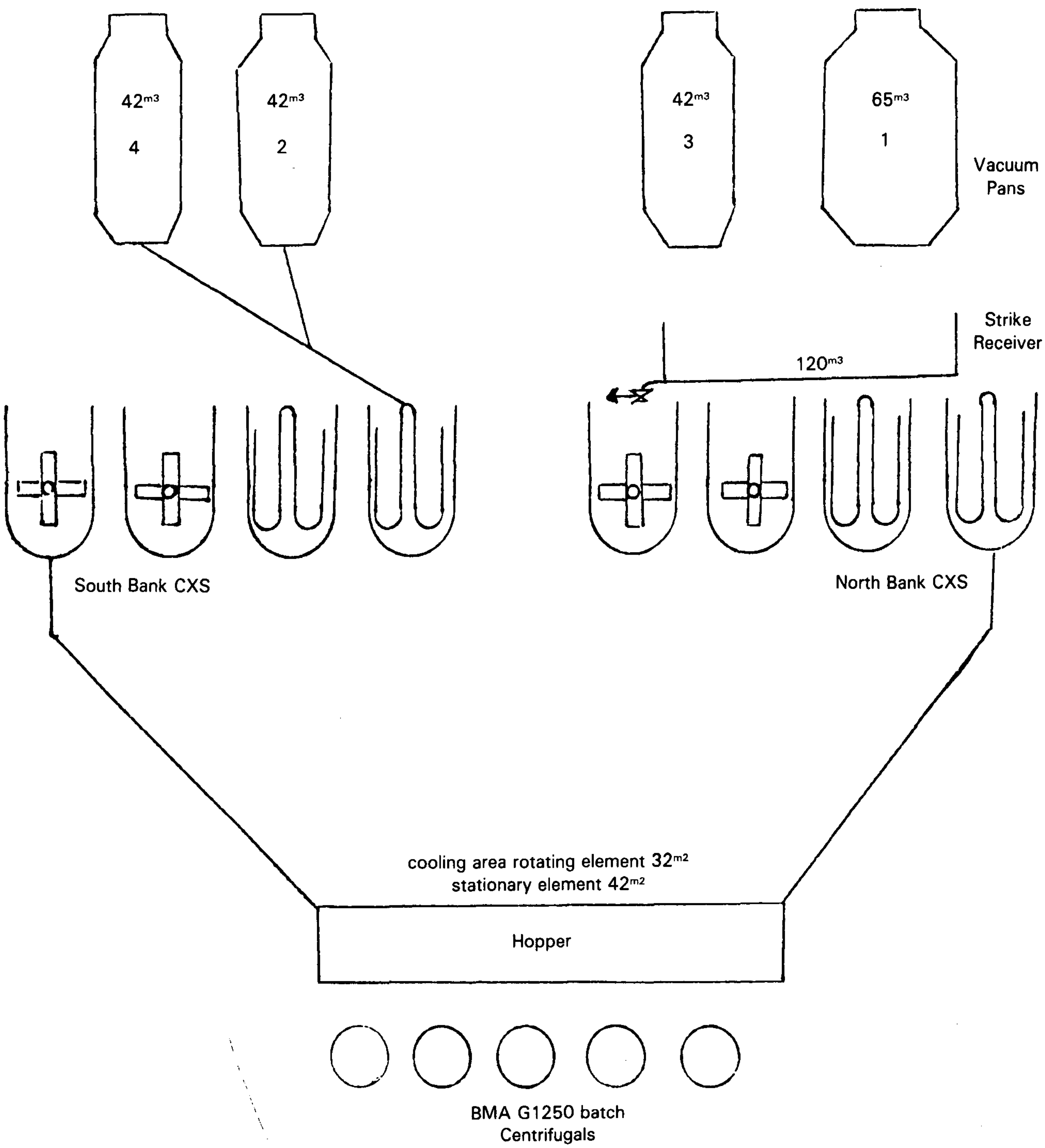


FIGURE 1 Sketch of A-boiling station at Noodsberg.

However, from the 1985 crushing season, raw sugar has been imported from the neighbouring Union Co-op mill and it has been necessary to reduce the raw sugar colour to maximise refined sugar throughput. This generally resulted in a decrease in A-massecuite exhaustion. Noodsberg has aimed to boil a small to medium grain size, averaging 0,6 mm SGS, since there are some benefits in a small and regular grain size in achieving lower colour sugar.

In setting objectives for the pan boiler to monitor performance, the purity difference between A-massecuite and A-molasses was used, since this figure was available to the pan boiler on a shift basis. Increasing A-massecuite brix and cooling of A-massecuite as a means of improving A-massecuite exhaustion is well documented in work done by Jullienne[1] who has said the following: "The brix of the massecuite at strike has a strong positive effect on the pan exhaustion performance which is at a maximum level when massecuite is boiled to a tightness resulting in the maximum tolerable striking time. Generally an increase of 1 point in the massecuite brix yielded a 2 point drop in A-molasses purity. The cooling of high brix massecuite yielded on average a drop of 1 point in molasses purity for each 4°C of cooling". This set the background against which Noodsberg looked for options to offset exhaustion loss resulting from the washing necessary in the A-centrifugals.

The following options were reviewed:

- Increasing A-massecuite strike brixes
- Elimination or reduction of pan steamings from the crystallisers
- Improved pan boiling techniques
- Cooling of A-massecuite.

The Description of Plant and Discussion

The A-station at Noodsberg is a split pan floor, comprising the south bank of 2 × 42 m^3 Elgin pans and 4 × 42 m^3 crystallisers, and the north bank of 1 × 42 m^3 and 1 × 65 m^3 Elgin pans, 1 × 120 m^3 strike receiver and 4 × 42 m^3 crystallisers. Vapour 1 is used as the heating medium, at a pressure of 50 kPa gauge. Figure 1 shows a diagram of the equipment installed.

Massecuite brix

At Noodsberg the massecuite gutter configuration and pan discharge door design limit the handling of very high brixes. A survey of pan striking times for the 42 m^3 pans was undertaken. It was found that as the brix increased from 92 to 93, the pan striking time increased from 2,5 minutes to 15 minutes. An operating policy of achieving a massecuite brix giving a 15 minute striking time was adopted.

Pan steamings

Measurements were undertaken on the effect of diverting pan steamings from the crystallisers.

Pan control

High brix massecuite should not be achieved at the expense of compromising on massecuite quality. The problem faced by the pan boiler in producing quality strikes is reproducibility. For this reason, at the start of the 1987 crushing season, Noodsberg installed a PC to do automatic boiling. This replaced the manually regulated feed valve operation. The system involves a basic computer control process using dedicated boards to generate a remote setpoint for pan conductivity relative to level. The system is locally manufactured and is versatile enough to be used in conjunction with data logging and a VDU. The system has proved to be relatively maintenance-free and offers easy reprogramming facilities. A schematic diagram of the pan control system is shown in Figure 2 and typical values of conductivity and level achieved during an automatic boiling are shown in Figure 3.

Massecuite cooling

The installation of cooling elements was undertaken over two seasons. In the 1986 offcrop Noodsberg installed water-cooled elements in the first two crystallisers of each bank. The following year this was extended to include the remaining two crystallisers of each bank. The first phase involved replacing defective Blanchard paddles with pipe elements as shown in Figure 4. This provided a 7 - 8°C drop in temperature at the centrifugals. The second phase involved the installation of fixed cooling elements according to a design supplied by the SMRI. The cost of installing fixed cooling elements in four crystallisers was R50 000, which is half the cost of installation of new hollow shaft rotors with radial cooling elements.

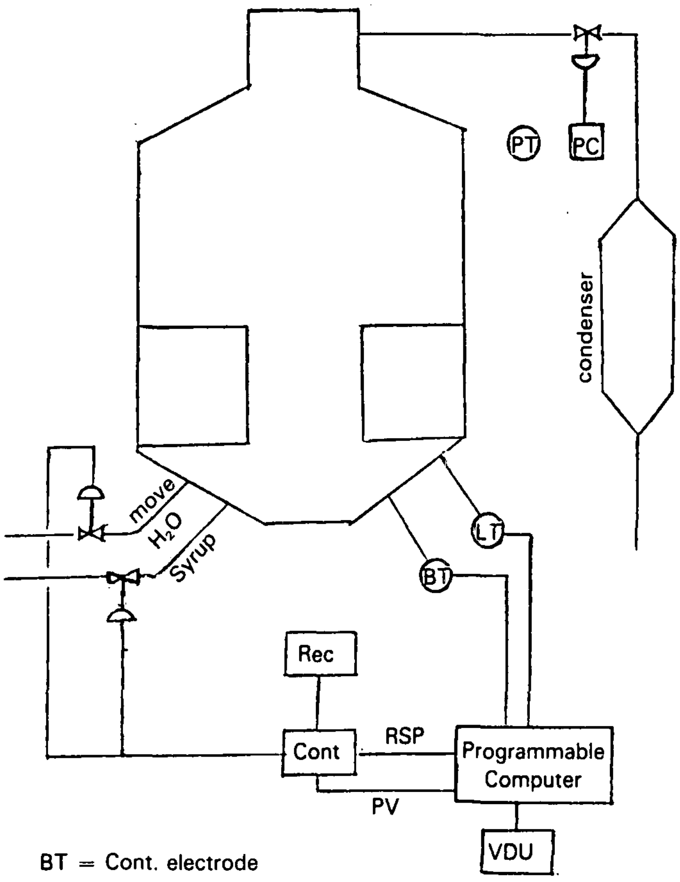


FIGURE 2 Schematic layout of pan automation.

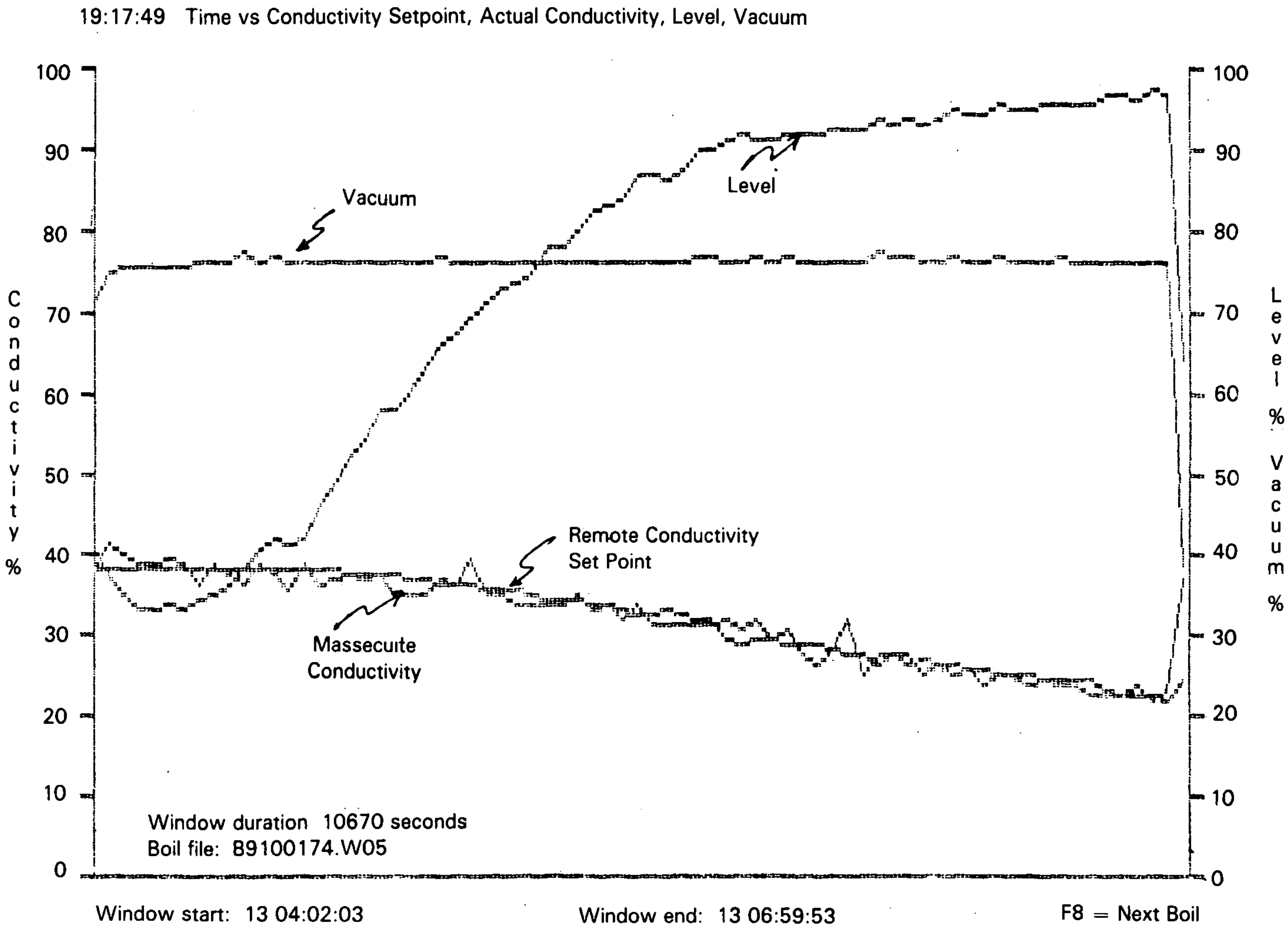
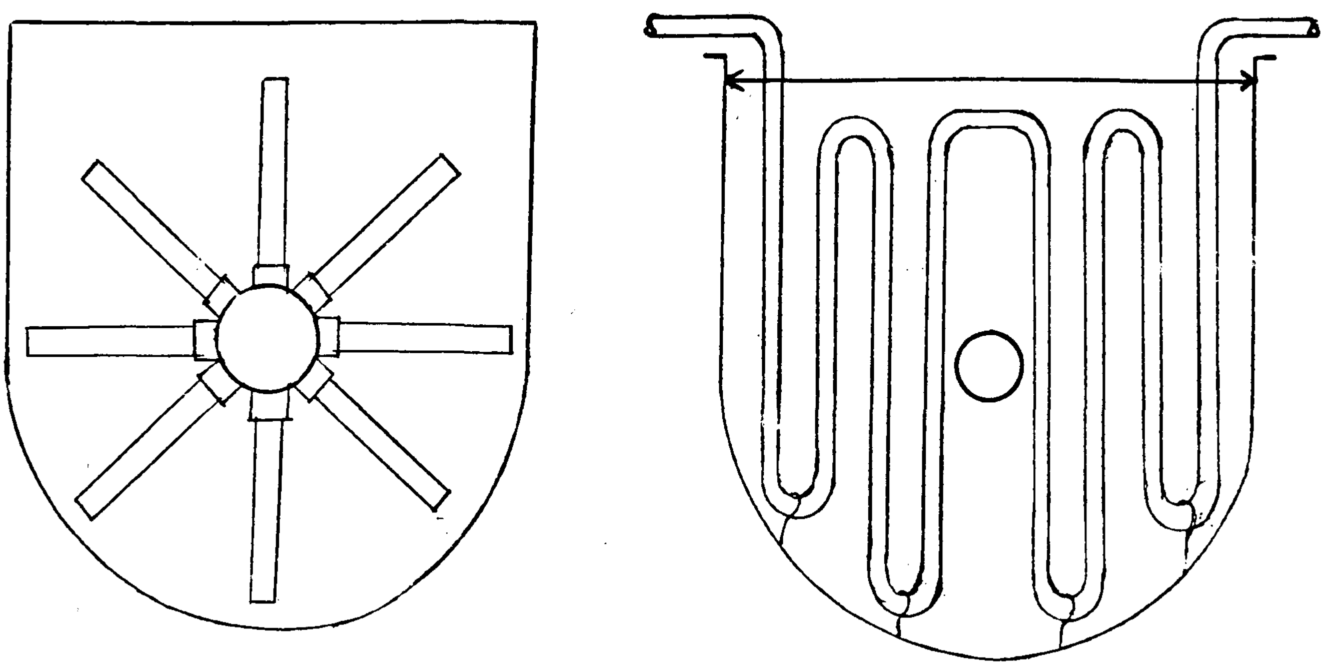


FIGURE 3 Typical boiling graphs for strike A-massecuite.



Modified rotating cooling elements comprising 66 x 100 mm dia. pipe sections radially mounted on a hollow centre tube.

Cooling surface = 32 m²
Surface/Volume = 0.76

Modified fixed cooling elements comprising 8 x 75 mm dia. pipe sections.

Cooling surface = 42 m²
Surface/Volume = 1

FIGURE 4 Cooling elements in A-crystallisers.

Results

Table 1 shows some measurements made on massecuite and nutsch molasses, which indicate the effect which steamings can have. The good work done by brixing up can be completely undone if hot pan steamings are drained onto the massecuite.

Table 1
Effect of hot steamings on massecuite nutsch purity

Run		Hot steamings		No steamings	
		Brix	*Pty*	*Brix*	*Pty*
1	Massecuite	91,3	89,8	90,8	90,1
	Mol. Nutsch	78,9	74,0	81,3	72,7
2	Massecuite	90,6	86,8	91,9	86,3
	Mol. Nutsch	78,0	71,7	79,6	66,0

The way in which A-massecuite exhausion has varied over the last 9 years is shown in Figure 5. From this figure, it can be seen that commissioning of the Refinery in 1982 started a downward trend in A-massecuite exhaustion. This reached its lowest value in 1985 when A-massecuite exhaustion dropped to 62,0.

During the 1986 season, a programme to improve A-massecuite brixes was implemented. This involved maintaining a 15 minute striking time as an operating standard, and further ensuring that pan steamings were kept to an absolute minimum. This required judicious operation of the steamings flap door and completing pan steaming-out via the pan cutover line. From table 2 it can be seen that A-massecuite brixes increased from 91,9 to 92,6. This improved A-exhaustion to 67,0.

Table 2
5-year comparison A-massecuite brix, purity, molasses, purity drop, crystal content, colour and exhaustion

	1984	1985	1986	1987	1988
A M/c brix	92,2	91,9	92,6	92,4	92,2
A M/c purity	85,1	85,5	87,1	85,5	87,4
(A M/c pty - A mol pty)	18,7	16,4	18,0	19,1	19,1
Crystal content	51,2	48,7	48,2	52,5	55,5
A sugar colour	879	956	1039	989	787
Exhaustion (ave.)	65,4	62,0	67,0	66,4	68,9
Exhaustion (Apr-Sept)	—	—	67,2	68,8	69,9

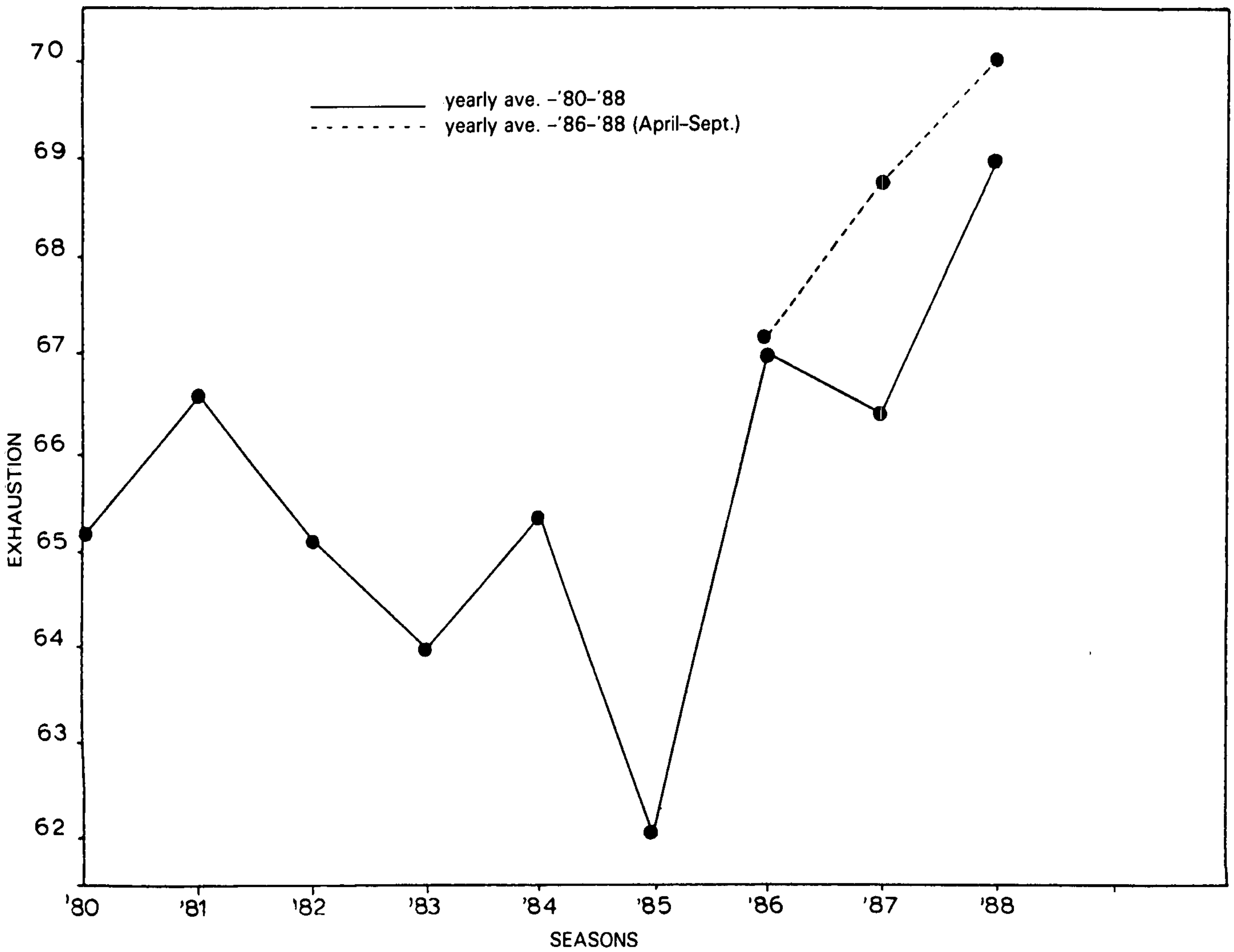


FIGURE 5 A-massecuite exhaustion at Noodsberg.

During the 1987 season, the first phases of A-massecuite cooling and pan control were implemented. A-massecuites were cooled down from 64°C at strike, to 56 - 57°C. Pan strike brixes were maintained at about 92 brix. The 1987 results were affected by serious floods at the end of September. For this reason, A-exhaustion over the period April - September is given for the period 1986 - 1988. Over this period an improvement in A-exhaustion from 67,2 to 68,8 was noticed. This was achieved in spite of a decline in massecuite purity of 1,7 units.

During the 1988 season, the second phases of A-massecuite cooling and pan control were implemented. A-massecuites were now cooled down to 52°C, as shown in Table 3. The A-massecuite exhaustion averaged 68,9 for the full 1988 season. A-massecuite exhaustion is affected by massecuite purity. However, comparison between the 1986 and the 1988 figures show that massecuite purity was 0,3 units higher in 1988, but the increase in exhaustion was 1,9 units. For the period of May - September, the 1988 figure was 1,1 units higher than the corresponding period in 1987.

Table 3

Temperature drop across water-cooled A-crystalliser station (average of 6 runs)

Crystalliser bank	Crystalliser bank	Temperature (°C)
North	No. 1 (inlet)	60,3
	No. 2	57,0
	No. 3	54,5
	No. 4 (exit)	51,7
South	No. 4 (inlet)	60,7
	No. 3	56,7
	No. 2	54,5
	No. 1 (exit)	51,5

This A-massecuite exhaustion improvement in 1988 was achieved in spite of the fact that Noodsberg crushed 1,585 million tons of cane, which is 21% more than the previous record, and processed 248 000 tons of sugar, which is 34,5 % more than the previous record.

It is generally accepted that the achievement of higher brixes and higher crystallisation rates promotes increased colour inclusion in the sugar crystal. It is believed that the good pan work in producing clean massecuites resulting from pan automation more than offset this effect. The raw sugar colour for the 1988 season was 787 ICUMSA colour units, as shown in Table 2. This represents a decrease of 26% over the 1987 season.

Measurements were taken of heat transfer coefficients on the new cooling elements. Rotating cooling elements appear to be more efficient than the fixed cooling elements, yielding higher overall average heat transfer coefficients of 42 $W/m^{2}{}^{\circ}K$, compared with 26,7 $W/m^{2}{}^{\circ}K$ for the fixed elements. This is assumed to be due to the higher relative velocity of massecuite in the rotating cooling element crystalliser. Results are given in Table 4.

Table 4

Overall heat transfer coefficients (W/m^2K) (Average of 6 runs)

Crystalliser bank	Static cooling elements	Rotating cooling elements	Ave.
North	18,4	34,5	26,4
South	35,1	49,9	42,5
			34,5

From Table 4 it can be seen that the heat transfer coefficient on the south bank of crystallisers is significantly higher. This is possibly due to the south bank crystalliser level frequently dropping below the top of the paddles, because there is no strike receiver on that side, allowing for increased air cooling.

From Table 5 it can be seen that the major portion of A-massecuite exhaustion occurs in the vacuum pan where a 17 unit purity drop is achieved. A further 3,9 units drop in purity occurs in the water-cooled crystallisers. This means that approximately 80% of the crystallisation work is done in the pan. This emphasises the importance of equipping the pan boiler with adequate equipment to achieve good quality boilings.

Table 5

Purity drop across A-crystallisers (average of 12 runs)

	Brix	Purity
Massecuite at strike	92,1	86,2
Mol. nutsch inlet	80,6	69,3
Mol. nutsch intermediate	79,9	66,4
Mol. nutsch outlet	79,3	65,4
Units purity drop in pan		17,1
Units purity drop across crystallisers		3,9
Units total purity drop		21,0

Conclusions

Improved A-massecuite has resulted from control of A-massecuite brix by maintaining a striking time of 15 minutes as an operating standard. Tighter boiling of A-massecuite and consistent and reproducible boilings have resulted from pan automation. This has allowed the raw sugar colour to be maintained below 800 ICUMSA colour units.

The benefits derived from improved A-massecuite exhaustion are:

- Reduced volumes of B- and C-massecuite
- Reduced recirculation losses and hence reduction in undetermined losses
- Steam saving based on 1 unit exhaustion = 0,14 tons coal per 100 tons pol in sugar are estimated to be equivalent to 840 tons coal or R42 000 per year.
- Increased refined sugar throughput resulting from improved raw sugar colour.

The potential for even higher A-massecuite exhaustion still exists at Noodsberg. Future efforts will be concentrated on:

- Substituting radio frequency for conductivity sensing to optimise pan automation.
- Substituting syrup washing for water washing in the A-centrifugal.
- Pan discharge door modifications that will allow reduced steaming out of pans.

Acknowledgements

The assistance and advice received from Noodsberg management and staff are acknowledged. Particular thanks are due to W Richards and Dicky Gordon.

REFERENCES

1. JULLIENNE, LMSA (1984). Exhaustion and colour investigations in A-massecuite. *Proc. S Afr Sug Technol. Ass 58*, 42–46.