IMPROVED A-MASSECUITE EXHAUSTION AT MAIDSTONE

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Abstract

Over the past five years the Maidstone factory has attempted to raise the A-exhaustion, both to save energy and to reduce sugar losses. As a result of various improvements made, the exhaustion was increased from 62,2 to 68,5 in this time. Steps taken were spread over the years as capital became available. The centrifugal station was the first to be modified, installing two new Broadbent A-centrifugals to replace seven old machines. The pan floor was next; three small pans were replaced with two 52 m3 low-head Hulpans. In 1989 the crystallisers were modified with additional A-capacity being provided and, in addition, cooling was installed on four of the A-crystallisers. The final step was to update the automation on the A-seed pans and the continuous A-pan. Experiments were conducted with the use of syrup washing on the A-centrifugals, but this has been abandoned. A successful drive for improved cane quality has helped A-exhaustion through improved syrup purities.

Introduction

The Maidstone Sugar Mill suffered several bottlenecks and equipment deficiencies in the early eighties. Amongst the most serious were C-massecuite reheating, B-pans, A-centrifugals and C-crystallisers. In fact a great deal of the raw house was not suitable for efficient recovery at the record annual throughputs being achieved (1984), especially with the quality of cane deteriorating every year.

The pan floor, besides having two continuous pans, was severely restricted with its numerous small, high-head pans that had poor circulation. After a new reheater and two new vertical B-crystallisers had been installed it became apparent that the most cost effective route to eliminating the remaining capacity problems was to increase the A-exhaustion.

To achieve this goal, three major improvement areas were identified:

- the seed preparation for the continuous pan had to be improved.
- the purity rise on curing was too high and needed improvement.
- the A-crystalliser capacity needed to be increased to achieve the purity drop desired.

Subsequently also identified were:

- the need to improve cane quality.
- pan automation to round off the overall process improvement.

The histogram shown in Figure 1 highlights the steady improvement achieved over the five seasons under review.

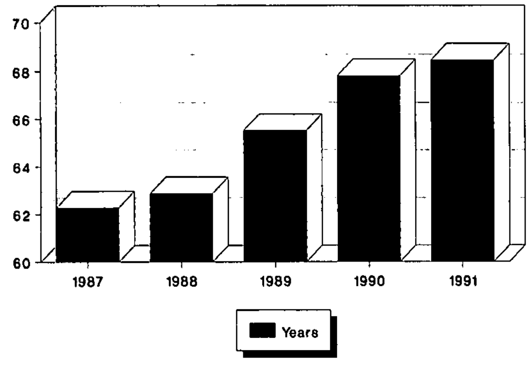

FIGURE 1 A-massecuite exhaustion

Changes introduced

The Maidstone team set about modifying the raw house in such a manner that a 68% A-exhaustion would be achieved consistently. There were four main areas of equipment changes that were planned and executed over a five year period: A-centrifugals, A- and C-seed pans, A-crystallisers and pan floor automation.

A-Centrifugal changes

The A-centrifugal station comprised two 1250 kg BMA Variant and seven old 450 kg Asea machines prior to the changes. In the offcrop of 1988 the seven Asea centrifugals were replaced with two new Broadbent 1380 kg centrifugals (although four of the Aseas were retained on standby). These were chosen after considering a number of performance and cost factors as reported by Moor and Greenfield (1988). A major feature of the Broadbent centrifugal is its ability to scrape the basket clean and so give an advantage with respect to purity rise. It is fitted with a trailing arm configuration plough with a soft tip so the tip can be set safely to touch the screen.

In addition these new centrifugals have a substantially higher G-factor at the spin speed than both the Variants and the Aseas. This feature allows better drainage of A-molasses and so less water is needed on the wash cycle.

In the same year syrup instead of water washing on the A- centrifugals was also tried. These tests have been reported by Lionnet (1989). Although the use of syrup reduced crystal dissolution, there were several problems. Spray nozzles blocked and much larger quantities of wash were required. In addition it proved more difficult to achieve the VHP sugar purity specifications and quality control was generally more difficult. This practice was therefore abandoned.

Figure 2 shows the A-centrifugal station before and after the modifications were made. The additional capacity available in the modified layout should be noted. The Broadbent centrifugals do about 26 cycles/ hour compared to 15 cycles on the Asea machines.

A number of mechanical, electronic and commissioning problems on the two new centrifugals resulted in a season of poor performance and the standby units were in service much of the time. However the following season (1989) all went well and the purity rise at the centrifugals improved markedly (see Table 1).

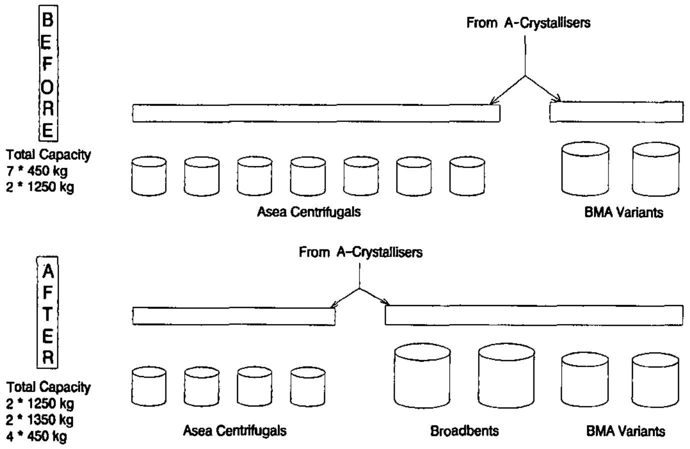

FIGURE 2 A-centrifugal station before and after modifications in 1988

Table 1

Average annual purity rise across A-centrifugals

Year	1987	1988	1989	1990	1991
Purity rise	5,27	5,57	3,21	3,74	3,32

Pan floor changes

The A-seed was prepared using seven old 28 m3 batch pans of poor design. The seed was transferred into a seed receiver under vacuum from where it was pumped by metering pumps into the continuous A-pan. This whole operation was far too cumbersome in that many cuts had to be made, and much false grain had to be washed. The seed finally arriving at the continuous pan was poor in terms of crystal size variation.

Two larger low-head 'Hulpans' (52 m3) were available from the former Empangeni mill. These were installed in the 1989 offcrop after being renovated and chemically cleaned (see Figure 3). One of these pans was allocated to A-seed preparation. This pan replaced three small A-pans which were removed. A larger seed receiver (70 m3) was installed under the A-pans to facilitate pumping seed from an open receiver. This greatly improved the consistent supply of seed to the continuous pan. In addition the old B-magma tank was removed and use was made of an existing larger receiver (60 m3).

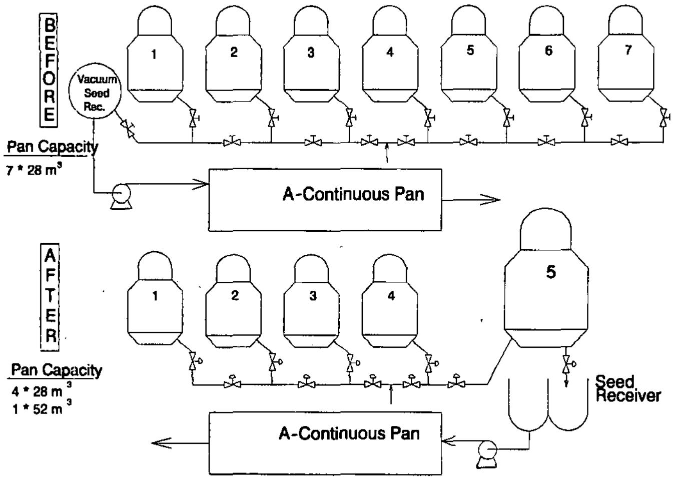

FIGURE 3 The A-pan station before and after modifications in 1989

The path was now set for larger and more consistent seed production due to the good circulation in the low head pan. The pumping of this seed to the continuous pan was more regular and at the same time a renewed interest developed in using the Gilette meter as a means of optimising crystal content throughout all the continuous A-pan compartments. This was needed because the radio frequency (RF) probes on this pan were still being developed and refined and were often out for repair or modification. Even with the reliable RF probes, the Gilette meter provides a quick and useful calibration check for the Pan Boilers.

The improvements achieved are not evident in the measurements of purity drop over the period under review (Table 2), other than for the 1990 season. The performance in the first season with the new pan floor arrangement was disappointing. This was probably due to the pan floor staff still adapting to all the changes. Furthermore, the improvements, although not obvious in purity drop on boiling, were nevertheless there in the form of quality seed with reduced fines from false grain. This gave a payback in the crystallisers and particularly in the centrifugals.

Table 2

Average annual purity drop on boiling

Year	1987	1988	1989	1990	1991
Purity drop	20,95	20,85	18,89	21,11	19,88

It is worth noting that the purity drop achieved at Maidstone across the A-pans for the five years is good compared to the South African sugar industry average. Twenty units of purity drop across the A-pans (annual average) is considered good work and possibly Maidstone will only be able to raise this to around 21 units. Nevertheless, it is felt that the purity drop across the pans can be improved and emphasis will be put in this area in the coming season.

Crystalliser changes

During the 1989 offcrop two large vertical C-crystallisers were installed for a number of reasons. Firstly, the A-station was short of crystalliser capacity. These two C-crystallisers would release eight smaller horizontal crystallisers for A-duty. Secondly, Maidstone needed to move away from horizontal crystallisers for C-duty so that the C-massecuite could be brixed up more (flow restrictions). Thirdly, four of the horizontal C-crystallisers were needed for the new A- and C-seed receivers.

Figure 4 shows the before and after A/C-crystalliser stations. The large increase in A-capacity and a decrease in B-capacity – changes which conform with the philosophy subsequently propounded by Jullienne (1991) should be noted.

The new extended A-crystalliser station was increased by 53 percent and only in the following year (1990) was the additional water cooling installed on four of the eight crystallisers.

Although the retention time of the A-massecuite increased from 7,6 h to 11,7 h, the expected additional purity drop was not realised until the 1991 season. The reason for this was that the physical level of the additional crystallisers was slightly lower than the rest of the A-station. The increased retention time had the effect of increasing the massecuite viscosity to the extent that the lower crystallisers were a hold up and often overflowed. The operators resorted to dilution which negated the benefit of increased retention time.

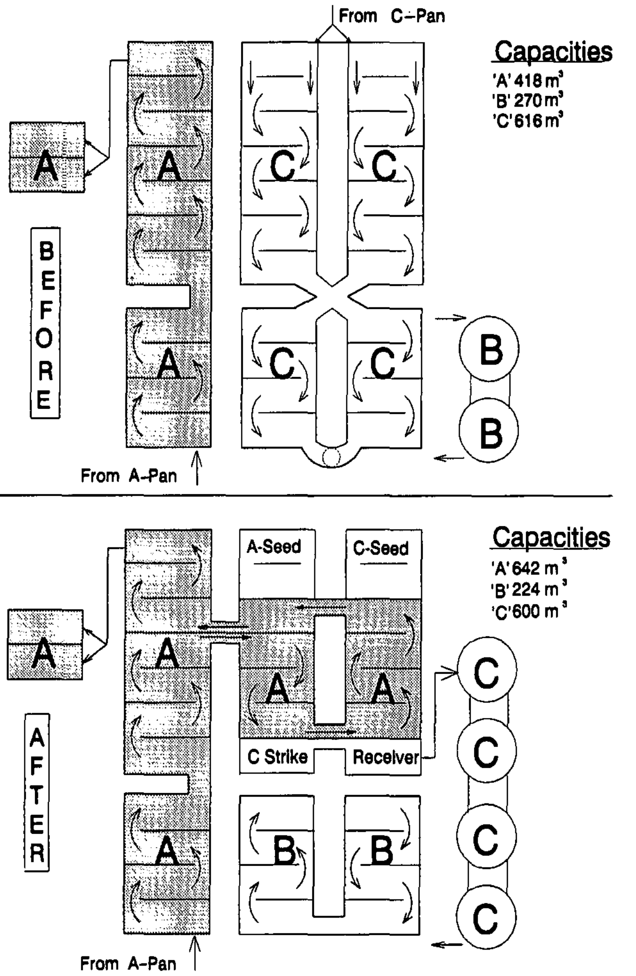

FIGURE 4 A-/C-crystalliser station before and after modifications

The sides of the lower crystallisers were raised for the 1990 season. At the same time, the use of cooling water was started, to give further exhaustion. This again caused higher viscosities and a holdup in the new bank of crystallisers resulting in further dilution.

Raising and sealing the sides, together with the use of a concrete vibrator, finally improved the flow. Massecuite, at relatively high brixes flowed through the new system with very little or no dilution. The concrete vibrator was suspended in the massecuite to promote the flow of massecuite through the crossover gutters where most of the holdup was experienced. The improvement in the 1991 season substantiates the benefit obtained from increased retention and cooling.

Table 3

Average purity drop on crystallisation

Year	1987	1988	1989	1990	1991
Purity drop	2,32	3,04	2,94	2,43	3,53

Pan automation improvement

The three main areas of improvement were:

- Installation of a pan floor supervisory system.
- Modifications and improvements to the Tongaat-Hulett RF probes.
- Refinements made to the software programmes.

Firstly, a PC-based supervisory system was installed in the 1990 offcrop. The aim of the project was to enable the Pan Boilers to follow what was actually happening in the pans in terms of the measured value following the programmed set point. In addition, there is a trending facility which captures and stores data for as much as seven days and these data can be called up in the form of trend lines. These are an excellent control for the Process Management to follow boiling trends from the previous night/day. Not all the computing power has been utilised yet but developments are ongoing as the operating personnel become familiar with the existing features. A spinoff not expected was that the Instrument Technicians are able to tune the controllers far better with the detailed trends that are available.

Since the Technical Management Department of the company launched its first RF pan probe in the early eighties, development of this probe has not stopped. Maidstone initially experienced much probe damage on the continuous pan due to frequent removal of the probes for cleaning. This has largely been overcome by a more sophisticated design.

The effect this improved probe had on the continuous A-pan was to provide control in all compartments all the time (i.e. no downtime). This reduced the possibility of forming false grain and/or over slackening the massecuite, which had happened previously with faulty probes.

On the software front the programmes have been made more user-friendly where parameters such as the graining point, the thinning time and the brix profile can be modified easily. The aim is for the Process Superintendents to be able to make minor adjustments to the programme to compensate for changes in seed quality.

Other improvements

Other minor improvements that have been made in line with the thrust of improving A-exhaustion are:

- C double curing facility was installed in the 1989 offcrop to raise the purity and quality of the remelt. This was stopped after a season's test work showed inconclusive results. This was confirmation of previous theoretical work done by Kruger (1984). It is of interest that others considered the reintroduction of double curing for sugar quality improvement during the same period (Jullienne, 1989).
- Flexible ploughs were installed on the BMA Variant centrifugals in the 1988 season. These provide cleaner ploughing and are still in use.
- The pan floor staff were reorganised with the emphasis of greater responsibility being placed on the Pan Floor Supervisor. A number of positions were upgraded while the number of employees on the pan floor was reduced.
- Extensive automation of the cutover system was done in 1990 which enabled the Pan Boilers to cut from one pan to another more rapidly and with less error or effort.
- A closed circuit cooling system was installed on the vacuum pump sealing water to improve the quality of water and reduce the wear on the pumps. This has been plagued with problems mainly relating to the chemical control of the water.
- Improvements in the B-station to improve the quality of grain going to B-magna were:
  - Large diameter casings installed on the K850 B-machines as reported by Rein and Archibald (1989).

- Improved pan circulation via jigger steam. The B-pans have floating calandrias which give poor circulation.

- Cooler pan temperatures have been made possible merely through policing condenser temperatures and pan vacuums with the help of the supervisory system and temperature trends.
- The rearrangement of the A-seed pumping station and seed receiver has enabled far more regular metering of A-seed to the continuous pan.
- Increased condenser capacity for the A-pan (originally designed for B-duty) was made possible by swopping the A- and the oversized continuous C-pan condensers. This has certainly improved the vacuum control on the A-pan.
- Cane quality improvement has been given a high priority over the last three years because at one stage Maidstone had the worst cane in the industry. This campaign has met with success, particularly from miller-cum-planter estates. This has paid off with record mixed juice purities in the last two seasons being obtained. These higher purities assist in A-exhaustion.

Costs

Apart from the many minor improvements, the costs of that part of major capital works designed to improve A-exhaustion over the period were approximately as follows:

Centrifugal installation	R920 000
A-pan floor modifications	R700 000
A-crystalliser modifications	R400 000
Instrumentation	R120 000

Savings

Accurate quantification of the savings from the improvement of A-exhaustion is difficult. However, the savings are considerable and derive from a variety of benefits, including:

- Undetermined losses reduced from less recirculation and boiling.
- Increased raw house capacity (enabling a shorter season).
- Improved sugar quality - particularly colour.
- Labour savings.
- Steam/fuel savings from less boilings.

Conclusions

The five years of programmed plant changes and operational improvements have achieved the goal of raising the A-exhaustion to 68. However, the implementation of these changes frequently did not turn out as expected.

The expected improvement of purity drop on boiling was disappointing and needs further investigation. The substantial increase in A-crystalliser capacity did not return the hoped for benefits for two seasons but has in the last year. The centrifugal station has shown the largest improvement and it is believed that this can be even better once the pan floor operation has been optimised.

Finally, the cost of implementing these changes has been substantial but the pan floor can now cope efficiently with high throughputs and larger crops. Alternatively, while the cane crops are smaller than desired, the factory gains handsomely by crushing the crop in a shorter period when the sucrose level in cane is at its highest.

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