PACKAGING AND QUALITY IMPROVEMENTS AT UMZIMKULU

C CREBO, L BACHAN AND V PILLAY

CG Smith Sugar Limited, Umzimkulu

Abstract

Umzimkulu is a raw sugar factory producing 65 000 tons of sugar per annum for the prepack and bagging plants in a range of pack sizes. As these raw sugars are produced for direct consumption, hygiene and quality control have always been an integral part of the sugar production. The steps taken over the years to improve the image and quality of the products produced at Umzimkulu are outlined. These aspects are presented in three parts, *viz*; operations and control, in which plant modifications, new and improved equipment design and packaging changes have helped to improve the quality of raw and packed sugar; a review of the methods of sampling, analysis, materials control and record keeping in compliance with CG Smith standards; and management of quality control in the market place.

Introduction

Umzimkulu packs three types of sugars, viz. Golden Brown (1 000 g and 500 g), Dark Brown (DB) (12,5 kg and 25 kg) and Light Brown (LB) (25 kg). Given the current changes in the industry due to deregulation, Umzimkulu embarked on a quality improvement programme, which not only satisfied customer demands but also focused on low cost of production.

The past two seasons created tremendous challenges in coping with quality of the packed product as sugar received from Sezela was adversely affected by poor cane quality as a result of the drought. In order to achieve both higher quality standards and improved production rates, it was necessary to implement various machine and equipment modifications.

Operations and control

Pans

Sugar quality control starts at the pan floor where the pan boilers have become conditioned over the years to produce a sugar of acceptable quality for the packing station. The specifications aimed for are shown in Table 1.

Table 1

Sugar specifications

Grain size (mm)	0,65 - 0,70
Colour (ICUMSA)	1 500 - 2 500
Fines (%)	25 - 30
Moisture (%)	0,08 - 0,10

While the aim is to maximize crystallisation exhaustion, it is often necessary to cure ahead from the A-crystallisers in order to supply sugar to the packing station and as a result A-exhaustions at Umzimkulu are compromised.

Fines are also detrimental to the packaging operation and therefore great care is taken to prevent false grain from forming in the pans. To prevent the occurrence of false grain, pan boilers tend to wash excessively in the pan thereby impacting on pan performance.

Centrifugals

The centrifugal station is also an integral part of sugar preparation for the packing station, the most important aspect being the control of moisture and molasses coating on the sugar crystal. A consequence of having high moisture and molasses coating on the sugar crystal is that the wash water has to be increased to compensate for the stickiness of the sugar but to the detriment of A-exhaustion.

The formation of lumps and uncured sugar caused by molasses drips into the basket are also unacceptable for packing. This became a real problem with sugar received from Sezela and drip trays had to be installed hastily into their A-centrifugals. At Umzimkulu, use was made of the Programmable Logic Control (PLC) control and strategically positioned wash sprays to overcome the dripping of massecuite and molasses into the basket.

Syrup washing has been tried at Umzimkulu but due to the syrup coating left on the crystals, this project was abandoned.

Table 2 illustrates Umzimkulu's five year average of A-exhaustions compared to similar raw sugar factories. The results show that Mount Edgecombe, who have a similar operation to Umzimkulu, also have to sacrifice exhaustion for packing production.

Table 2

A-Massecuite exhaustion

	1987	1988	1989	1990	1991	Five year average
AK	64,85	66,60	68,16	68,92	68,59	67,42
DL	66,19	67,46	67,74	66,88	68,80	67,25
UC	67,66	66,73	67,54	68,21	67,55	67,54
IL	66,99	67,46	67,56	64,67	64,08	66,15
MS	64,70	62,37	63,16	65,67	68,02	64,78
SZ	65,66	63,63	63,52	67,10	68,70	65,72
AVE	66,01	66,38	66,28	66,91	67,49	66,48
UK	64,48	66,03	65,75	65,90	66,95	65,82
ME	66,17	65,93	60,74	60,86	59,59	62,66

Sugar drier and dust extraction

Sugar drying and dust extraction are probably the most important aspects of sugar preparation for the packing station. Numerous problems with leaking radiators led to the

replacement of the elements which now incorporate a three bank system that gives much flexibility on heat control by using different combinations. When using the flap adjustment on the drier, care should be taken to ensure correct air flows to avoid excessive dust carry-over.

Magnets

Magnets are an essential part of operations and shall remain so as long as mild steel tanks are used in the sugar process. This lesson was learnt in 1986 at Umzimkulu, where a large consignment of Bakers biscuits was contaminated with rust and 1400 tons of Light Brown sugar were rejected. Umzimkulu consciously embarked on a programme of replacing all metal parts in the process, where possible, with 3CR12 steel for the purpose of benefitting the packing station. This programme is starting to pay handsome dividends especially at season start-up where rust contamination has been greatly reduced. During the season an average of 30-40 kg of rust per week are removed from the magnets. These are placed in two tier sets in strategic positions, i.e. after the rotary screen, before the storage bins and at the packing machines.

Sugar screening

Sugar screening is a vital aspect of the packing operation which removes lumps and foreign material from the sugar thereby ensuring a clean and free-flowing product. At Umzimkulu a 2,7 mm aperture stainless steel rotary screen is used to separate the lumps from the sugar. This was changed from a 6 mm screen to improve grain consistency. Ideally a screen system separating both lumps and dust, or fine sugar, should be used.

This screening system is employed by Umfolozi sugar mill to good effect, with the dust extracted being used to "bombay seed" their refined pans. Alternatively, Pongola sugar mill designed and installed a lump breaker which enables them to use only the one tiered screen system. Both these mills also have a packing station attached to their refineries. It is highly recommended that either one of these ideas be implemented as grain uniformity and dust elimination are likely to aid the seam sealing operation.

Temperature control

Temperature control is another vital aspect of quality control as sugar packed at a high temperature is likely to lead to sugar caking due to moisture migration in the packet (Mellet, 1993). Alternatively sugar packed at a low temperature prevents free flow at the packing machines. The ideal temperature range is between 35 and 40°C.

To monitor sugar temperature, two thermo-probes were installed, one at the outlet of the sugar drier and the other just before the sugar is packed. With this added information, the temperature of the sugar can now be controlled by adjusting louvre settings on the forced draught and induced draught fans of the sugar drier.

Prepack operations

Numerous modifications have taken place at the packing station (Denny and Pillay,1990) the emphasis being placed on improving plant capabilities from a quality control point of view. These can best be described as follows:

- A complete change from hydraulic to pneumatic sealing operation. This move enabled a more consistent jaw pressure to improve the sealing operation. Air pressure has since become a problem throughout the factory due to increased instrumentation. The packing machines require a minimum of 500 kPa air pressure. A warning alarm has been installed on the main manifold to stop machines if air pressure drops below 500 kPa. In addition, the air line was re-routed to facilitate better air distribution to the packing machines.
- Recent modifications to the seam seal allows for uniform heat distribution, even cooling, and consistent air pressure distribution for the seam seal and cross seal. The improved seal quality will reduce the number of complaints, thereby reducing claims.
- The installation of an automatic gluing/folding machine not only improved productivity but produced a stable baler which improved the palletising and stacking operation. This in turn reduced, if not eliminated, customer complaints over the 1 kg pack.
- A quality drive programme was introduced by implementing check controls and additional staff from the factory were employed (temporarily) as quality checkers to provide on the job training to the packing staff.
- Quality awareness posters were designed and displayed at strategic points throughout the pre-pack building.
- Quality control on packaging, especially the plastic supplies, also received attention. New specifications for plastic quality were drawn up with the co-operation of the plastic suppliers and Umzimkulu, and documented for future reference. These criteria were implemented by the packing staff to test plastic suitability. A compliance certificate stating exact measurements was also introduced with every batch received from the suppliers. These slips are filed for future reference.

Strategic planning for improvements to aid quality control at Umzimkulu

It can be said that quality control is a continuous process and various improvements are still necessary at Umzimkulu. The following options are being considered.

Grain size

To improve grain size at the pan boiling stage it would be necessary to install new equipment to improve control on the A-pans:

- Automate A-pans with personal computer logic control. This would enhance A-massecuite exhaustions.
- Install an automatic pan cut-over system.
- Install more pan capacity, possibly a continuous B-pan to release boiling time for A-pans.

Conveyor modifications for molasses mingling

The colour of very high pol (VHP) sugar varies with seasonal variations in cane quality. The housewife brand Golden Brown sometimes varies in colour from "light" to "dark" and this creates perceptions of poor quality. This equipment allows for the mingling of molasses onto "light" coloured sugars so as to ensure consistent sugar colours in the range 1500-2000 ICUMSA colour units.

Dust extraction

Sugar dust contributes to poor quality seals and needs to be eliminated from the packing machines. The proposal is twofold:

- Upgrade existing dust extraction system using a Rotoclone system as installed at various factories.
- Install extraction units at the packing machine interface to divert the dust into a 1 ton bag or return it to remelt. This will ensure a "clean" seal.

Sugar dust in the environment also creates a health hazard to workers and may also affect moving machinery parts which contributes to breakdowns.

Bag flatteners

Presently the bags leaving the production line are manually flattened by pallet loaders. This results in low productivity and poor bonding of bags, e.g. collapsed pallets and damages.

The bag flattener will produce flat bags which can be easily stacked thereby reducing damages. The labour time saved will help to increase production. This will save additional handling costs incurred by CGS Warehouse.

Anti-slip application

This applicator ensures an even distribution of anti-slip on bags to prevent collapsing of bags. The damage caused by the existing "hand application" method is on the increase and results in bags tearing when de-stacking from pallets, thus creating a poor image of the manufacturer.

Dedicated compressor

The change from hydraulics to pneumatics in prepacking has increased the air demand. The existing compressors cannot maintain a constant air supply. A dedicated compressor will ensure constant air supply, thus eliminating the main cause of poor quality seals.

Secondary screening

A secondary screening system will produce a uniform, consistent quality product, leading to improved throughput at the packing machines.

Checkweigher on 25 kg Dark Brown line

Due to the nature of product (sticky) and volumes being handled in a manual operation, instances of excessive over-massing and under-massing have been reported. To ensure customer satisfaction and zero loss, an on-line checkweigher is essential.

Vehicle loading

Numerous complaints of dirty bags are received when sugar trucks are loaded during wet weather. A large under cover shed is necessary to alleviate this problem.

Sampling and record-keeping

Sampling equipment

To ensure representative sampling of packed sugar, it was necessary to install a pneumatically operated auto-sampler in the Light Brown packaging line at a point just prior to the sugar being packed. The sampler was installed in-house, the objective being to replace manual catch-sampling. The samplers are adjusted by timers which control the duration that the "hatch" remains open to accept a sugar sample. The timers are set to accept approximately one kg of sugar, which is collected in a plastic bucket, every two hours. The frequency of sampling and analysis is shown in Table 3.

Sugar quality and packaging inspections

The samples collected by the auto-sampler are visually inspected for foreign material, grain size, fines, dust, moisture and colour. Inspections for the presence of rust are also carried out by stirring the sugar in the sample bucket with a bar magnet. Where large quantities of foreign material are observed, actions such as cleaning the magnets and rotary screens are undertaken. This is over and above the normal routine cleaning that is always done.

Table 3

Frequency of sampling and analysis

Sugar pack size	Sampling method	Analysis frequency (h)		Bag/baler identification	Ref. sample
500 g 1000 g	Continuously 2 hourly	Visual inspection Moisture Colour Dirt test Grain size pol Temperature	2 8 8 24 24 8 cont	Pack: preprinted weekly codes Baler: code marker	Yes
12,5 kg 25 kg	Catch 2 hourly	Visual inspection Moisture Colour pol	2 8 8 8	Code marker	Yes

In addition to this a random packet of sugar is sent to the laboratory every hour. This packet is inspected by the laboratory tester for any defects such as poor sealing, foreign material in the sugar and poor quality of packet. This information is entered onto a checklist for reference. A list of all the check items undertaken by the prepack shift supervisor are shown in Table 4. A tick indicates an item to be in order while a cross indicates a defect which is immediately rectified.

Table 4

Prepack and bagging checklist

DATE: SHIFT: TIME: SUPERVISER:

Check the following	500 g	1 000 g	12,5	25 kg
Top seal	√	√	√	√
Bottom seal	√	×	√	√
Seam seal	√	√	×	√
Pin pricks	√	√	√	√
Lumps in sugar?	×	√	√	√
Foreign material present?	√	√	√	√
Code marker working?	√	√	×	√
Anti-slip being used?	√	√	√	√
Rotary screen cleaned?	√	√	√	√
Baler seals okay?	√	√	√	√
Picture centralised?	×	√	√	√
Pallet condition okay?	√	√	√	√
Stacking okay?	√	√	√	√
Checkweighing done?	√	√	√	√
Pkts per baler checked?	√	√	√	√
Sugar temperature taken?	√	√	√	√
Magnets checked?	√	√	√	√

Sub-sampling and record-keeping

The sugar samples are fetched by the laboratory staff once per shift, riffled and sub-sampled for analysis. The samples are analysed on a shift basis for colour, pol, moisture, grain size and dirt. The results are entered on a sheet and may be cross-referenced by the date and production code. The dirt test is similar to the one for refined sugars except that instead of using 1 kg of 50° brix solution, only 100 g of solution is used to facilitate filtration due to the presence of large amounts of foreign material in brown sugar.

In addition to the samples used for analysis, approximately 500 g of sample are sealed in a sachet and stored. The intention is to use those samples as a reference, in case of complaints, and to keep them for two years. The samples and analytical results are cross-referenced by the shift number and date of packaging. In addition, composite weekly samples of Light Brown and Dark Brown sugars are sent to the SMRI for analysis.

Plastic and baler coding

As opposed to installing expensive ink-jet markers the suppliers of plastic were asked to pre-print the plastic with codes to identify the week, month and year. Based on this coding, if a complaint is received on prepack sugar, the sample can be cross-referenced to within a week of the production date. This proved to be a cost effective alternative. The balers, on the other hand, are individually marked using a rotary code marker, as they leave the production line.

Plastic quality

Plastic quality is monitored daily. Each day a sample length of plastic is randomly taken and inspected for the following:

- Quality of print
- Gauge thickness

Gauge thickness is indirectly measured by the mass of a fixed length of plastic. A low mass indicates that the plastic is thin which could result in poor sealing, whilst a very high mass would reduce yields and push up plastic costs.

The pitch and width of the plastic

The information is recorded in a book and the plastic samples are kept for future reference. A list of the checks together with specifications are shown in Table 5.

Dirty balers and bags

In the past, many complaints of dirty balers and bags were received from the warehouse. Most of the problems were due to dirty tarps and footprints during the tarping operation. The problem has been partially overcome by making use of a plastic sheet which is placed over the load of sugar. Truck beds are also washed whenever necessary. In addition, single pallets are covered with plastic shrouds during wet weather.

Check-weighing

In-line, electronic, check-weighers have been in use for many years in the 500 g and 1000 g lines. In addition frequent random samples are taken and manually weighed by the Machine Operators. If deviations beyond the specifications are noticed, adjustments are made to the machines by the Operator.

Each shift, a pallet of each type of sugar is randomly sampled by the supervisor and set aside for check-weighing. From these, 10 balers (or bags) are sub-sampled during the day and weighed on a platform scale and the average mass per unit is calculated.

Table 5

Plastic quality checklist

	Specifications	
Item	500 g	1000 g
Mass of 10 packets (g)	23 - 27	44 - 51
Film thickness (mic)	43 - 50	52 - 61
Width of plastic (mm)	296 - 299	347 - 350
Pitch of plastic (mm)	196 - 199	257 - 260
Core ID (mm)	73 - 80	73 - 80
Core OD (mm)	87 - 96	87 - 96
Reel diameter (mm)	340 - 350	340 - 350
Batch number	of the plastic inspected	
Print quality	as per proof sample	
Colours	tone and colour as per proof sample	

Table 6 shows acceptable limits together with the legal requirements for packed sugar at Umzimkulu. The control tolerance limits are more stringent than those set by the Department of Weights and Measures.

Table 6

Masses used for quality control

Sugar type	UK tolerance	Legal tolerance
500 g	−7 g to + 8 g	−7 g to + 14 g
1 000 g	−7 g to + 10 g	−10 g to + 20 g
12,5 kg	−10 g to + 20 g	−80 g to + 80 g
25 kg	−20 g to + 60 g	−125 g to + 250 g

Over the past year the actual overmass obtained for the different pack sizes are shown in Table 7 which shows that the over-masses obtained were well within the tolerances set by the mill.

Table 7

Overmass during 1993 season

Sugar type	Overmass per pack (g)	99% confidence interval
500 g	1 g	± 1 g
1 000 g	1 g	± 5 g
12,5 kg	6 g	± 6 g
25 kg	13 g	± 8 g

Market complaints

Whilst there was an appreciable number of complaints this season, the value of the claims is declining as seen in Table 8. The main complaints over the past three years have been leaking seals on 1 kg packs, hard sugar and foreign material in the sugar. The difficulty of producing a quality product under the adverse drought conditions, led to an increase in the number of complaints during the 1993 season as seen in Table 9.

Table 8

Value of claims over past four seasons

Year	Production (tons)	Value of claims	Claim % production
1990	78 395	R52 088	0,66
1991	69 104	R43 182	0,62
1992	70 446	R42 191	0,60
1993	72 277	R30 307	0,42

Table 9

Number of complaints

Pack Sizes	1992	1993
500 g	3	6
1000 g	8	13
25 kg (DB & LB)	7	11
12,5 kg (DB)	1	3

Approximately 70% of the claims during the 1992 and 1993 seasons were due to hard sugar complaints at Germiston Warehouse. This confirms the findings on caking of Golden Brown sugar (Mellet, 1993) that if prepacks are stored for long periods under high relative humidity conditions, the sugar gets damp and cakes under dry ambient conditions.

The policy at Umzimkulu is that every single complaint is resolved as soon as possible to the customers satisfaction, be it in the form of replacement, a personal visit or an acknowledgment. This aspect of complaints has now been streamlined with the introduction of the complaints/response handling procedure.

Damages that occur during transport and at warehousing are resolved timeously through meetings with the parties concerned.

Conclusions

Quality control and limitations of packing machines have impacted on performance efficiencies at Umzimkulu as shown by the example of reduced A-massecuite exhaustions in comparison with other raw sugar producing factories.

Quality control is an attitude that needs to be nurtured and is an on-going process. While costs might be attributed to a quality drive programme in the short term, the advantages of producing a consistently acceptable product to the customer has long term benefits. This can be measured by a reduced number of customer complaints and an increase in sugar sales.

Efforts put into the quality drive paid off during the past season as shown by the favourable reports from South African Sugar Distributors. Modifications to machinery not only reduced costs, but also improved product image and packaging. These improvements are an extension of the objective to achieve an ISO 9000 accreditation.

The focus on quality control and producing a product that is acceptable to the customer has been entrenched in every employee. The sampling and analytical procedures contributed to reliable information which is easily accessible and will help resolve customer complaints timeously.

REFERENCES

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