THE IMPLICATIONS OF POOR CANE QUALITY

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Abstract

In recent years the South African Sugar Industry has implemented a programme of large-scale expansion, in both the factories and agricultural sectors and it is possible that due to this expansion the emphasis has shifted from cane quality to quantity. An attempt is made to highlight some of the detrimental effects of poor cane quality and its effects on both the engineering and process sections of sugar factories. Certain statements and figures quoted are based on general observations, findings and trends in the South African industry and more particularly at Noodsberg Sugar Co. Ltd., and may vary from mill to mill.

Introduction

It is estimated that approximately 12 per cent of cane crushed in South Africa consists of tops, trash, sand and other extraneous materials, i.e. in excess of two million tons of extraneous matter was handled by mills in the 1975 season, the equivalent throughput of two large mills.

There has been a gradual decline in cane quality as can be clearly seen in the photographs below and by comparing the average figures for the South African industry over the past four seasons.

TABLE 1
Average figures for the S.A. Sugar Industry

<table>
<thead>
<tr>
<th>Season</th>
<th>Pol % cane</th>
<th>Fibre % cane</th>
<th>M.J. purity</th>
<th>Ov. rec.</th>
<th>Cane/ sugar ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972/73</td>
<td>13,26</td>
<td>14,82</td>
<td>86,66</td>
<td>85,50</td>
<td>8,77</td>
</tr>
<tr>
<td>1973/74</td>
<td>13,08</td>
<td>15,64</td>
<td>85,66</td>
<td>85,17</td>
<td>8,93</td>
</tr>
<tr>
<td>1974/75</td>
<td>13,08</td>
<td>15,59</td>
<td>85,01</td>
<td>84,76</td>
<td>8,97</td>
</tr>
<tr>
<td>1975/76</td>
<td>12,60</td>
<td>15,67</td>
<td>84,59</td>
<td>84,33</td>
<td>9,33</td>
</tr>
</tbody>
</table>

This downward trend for pol % cane and mixed juice purity has been prevalent from the 1955/56 season.

The quality of cane is dependent on many factors, the most important probably being
(i) delay between burning/cutting and crushing;
(ii) climatic conditions.

The most common excuse for bad cane is the climate, particularly drought (and frost in the Midlands). It could be claimed instead, however, that—
(i) pol % cane has been reduced primarily due to the ever-increasing amount of tops, trash, roots and soil;
(ii) mixed juice purity is reduced due to the gradually increasing delay between burning, cutting and crushing and an increase in the amount of tops;
(iii) Factory overall recoveries—Over the past years, most factories have installed more sophisticated and efficient equipment and technical and process technology is of a higher standard than ever before, yet factory recoveries continue to drop. This is again largely due to the constantly deteriorating quality of cane received.

With the increase in throughputs of most factories this influx of extraneous material is becoming an ever-increasing problem and should not be allowed to continue.

The seriousness of this low cane quality and its effect are separated into two sections:
(a) The effects of sand, soil and rocks on milling.
(b) The effects of cane quality on the boiling house.

The effects of sand, soil and rocks on milling

At this stage the only available measure of sand in cane is by means of the suspended solids in mixed juice expressed as a percentage, but this does not take into consideration the sand remaining in bagasse, or deposited in tanks, under feeder tables, etc. It is commonly accepted that for milling trains, the amount remaining in bagasse is approximately equal to that in mixed juice. However, this is not true for diffuser installations where the bagasse blanket acts as a filter medium.

Excluding diffuser installations, the average suspended solids in mixed juice for South African factories increased from 0.56% in 1974/75 to 0.63% in 1975/76, i.e. an increase of 12.5% under drought conditions!! Converted, this is equivalent to 240 000 tons of sand which, mixed with juice and water, forms a wonderful grinding paste.
(i) Cane preparation

Damage by rocks, tramp-iron, etc., and excessive wear by sand on cane knives and hammers must have a detrimental effect on the cane preparation, which will affect the extraction. Furthermore, the damage and loss of production caused by rocks results in a further loss of sucrose.

(ii) Milling

Apart from mill settings, probably the two most important factors influencing extraction are—

(a) cane preparation;
(b) mill roll conditioning and peripheral speed; both of which are heavily dependent on the amount of sand in cane.

For example—Average figures for the preparation index of cane and mill extraction are given for a 10-week period.

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>Variation in P.I. and extraction at Jaagbaan due to wear</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start of week</td>
</tr>
<tr>
<td>Preparation index</td>
<td>91.2%</td>
</tr>
<tr>
<td>Extraction</td>
<td>96.85%</td>
</tr>
</tbody>
</table>

These figures do not include the periods when, due to high sand content, the knives and hammers had to be changed midway through the week.

Further effects are a reluctance for the top roll to float, no mill lift, and a high moisture % bagasse. It has been repeatedly observed that during periods of high sand content the mills refuse to "lift", Donnelly chutes start filling, crushing rates are reduced or the peripheral speed has to be increased.

It is generally accepted that the volume of bagasse leaving the discharge opening of a mill is always greater than the volume between the two mill rolls. This expansion of bagasse results in "reabsorption" of the expressed juice. Tests carried out in Australia have shown clearly that this "reabsorption" increases with the degree of "squeeze", peripheral speed, and the amount of juice which has to be expressed per unit of time. When weighing up these facts it is easy to see why the effects of sand and soil has become so much more critical in recent years. For example, most factories have had to increase peripheral speed to some extent to cope with increased throughput and mill feeding devices have been improved to allow mills to work harder. Maceration levels have been maintained at a constant level relative to the quantity of cane crushed, which has in many cases resulted in quantities of fluid far greater than those previously handled.

It would therefore not be unreasonable to expect that for a given wear rate in the milling train the sand level should have been considerably reduced over the years: unfortunately the reverse is the case.

The above table shows clearly the decrease in roll wear due to switching from carbon arcing to welding and hardfacing, also a 20 per cent increase in wear for an 11 % increase in suspend solids.

This 20 per cent increase in wear for an 18-roller mill is equivalent to an extra 3-roller reshelbs per season.

Boilers

Numerous mills have installed new boilers. Invariably these boilers are of a modern design with high thermal efficiencies and of the spreader stoker type, having a minimum of refractory and some form of alternative fuel system, usually coal.

Unfortunately these boilers require a well-controlled and very steady supply of fuel, which due to the very small thermal heat storage in the boiler may not be interrupted. Most of these boilers commissioned in the previous season have had serious steaming problems. It is still a debatable point whether this is due only to sand, or a combination of sand, high bagasse moistures and fuel supply to the boilers.

This graph shows clearly how the number of low steam stops increase with increase in sand content.

The effects of poor quality cane on the boiling house

There are two negative factors to consider, viz.:

(i) The effects of sand, soil and foreign matter in cane

These are easily definable, and are primarily limited to excessive wear in mixed juice pumps and piping, blocking of
tubes and bottom passes in vertical juice heaters. Excessive
wear on doors and pass baffles of Juice heaters has necessitated
major rebuilding and modifications.

Heavy deposits of sand in the clarifier have resulted in the
lower scraper arms being wrapped around the central shaft,
requiring additional strengthening of the scraper arms. One
of the most serious effects of sand is the resultant loss of sucrose
in filter cake; at Jaagbaan the filter capacity is on the low side,
and this is further aggravated by the ever-increasing amount
of sand in mixed juice.

**TABLE 4**

<table>
<thead>
<tr>
<th>Season</th>
<th>Suspended solids in mixed juice</th>
<th>Filter cake % cane</th>
<th>Pol in filter cake as a % mixed juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974/75</td>
<td>1,01</td>
<td>4,91</td>
<td>0,61</td>
</tr>
<tr>
<td>1975/76</td>
<td>1,13</td>
<td>5,64</td>
<td>0,72</td>
</tr>
</tbody>
</table>

Furthermore, blockage of filter drums screens and filtrate
piping are not uncommon. It has been estimated that approxi-
mately 15 000 tons of sand were removed from the mixed
juice in the 1975/76 season, an increase of 1 800 tons over
the previous years.

Transportation of milo from the mill back to the farms has
always been a troublesome and expensive undertaking, which
is increasing yearly due to extra sand and soil.

(ii) The effects of low mixed juice purity

The quality of cane received at the mill plays a large part
in maximising the amount of sucrose recovered.

It is commonly accepted that the mixed juice purity is
directly related to the boiling house recovery, as a general rule
a 2 per cent drop in mixed juice purity is equivalent to a 1
per cent drop in boiling house recovery.

The primary causes of low mixed juice purities are:
(i) delays between burning/cutting and milling;
(ii) tops;
(iii) effects of climatic conditions, e.g. drought, frost, etc.

From week 8 to 23 there was a steady decline in mixed juice
purity; the first rains of the season started at week 18, resulting
in transport, burning and cutting difficulties. This condition
deteriorated to such an extent that during week 23 the mill
crushing rate far exceeded the farmers' delivery rate, and
resulted in fresh unburnt cane being supplied to the mill, which
resulted in a 2 per cent increase in mixed juice purity.

However, as the weather conditions improved, farmers again
started burning and cutting areas far in excess of their daily
quotas, and the mixed juice purity plummeted to its previous
low value.

Low mixed juice purity has a detrimental effect on sucrose
crystallization. Distortion of sugar crystals, i.e. elongated and
needle grains, is very common, resulting in poor molasses
exhaustion, and difficulties are frequently experienced with
sugar qualities being below the specifications required for
export sugar.

The large increase in tops supplied with the cane has resulted
in an excessive increase in non-sugars, gums, etc., being pro-
cessed, which (i) causes increased massecuite viscosities,
(ii) have a detrimental effect on the boiling and crystallization
process, (iii) cause more rapid blinding of centrifugal screens,
and (iv) reduce molasses exhaustion.

The estimated expenditure due to extraneous matter in cane
(Jaagbaan 1975/76 season)

(a) Cane preparation

Costs to repair damage caused by rocks, etc.,
to knives .................................. R19 500
Hardfacing and steel costs for knives and
shredder hammers .......................... R16 000
Lost time due to: (at R30/ton sugar):
(i) Changing of knives and hammers mid-
week: 21 hours @ 220 tons cane/hour .... R13 800
(ii) Damages caused by rocks, etc.: 49 hours
@ 220 tons cane/hour ..................... R32 300

(b) Milling

Increase in mill roll wear (+12 % or 3 reshells) R15 000
Trashplate and scrapers ..................... R2 500
Imbibition pumps and piping ............... R13 000
Mill roller hardfacing ...................... R8 000
Intercarriers, chains, etc. ................. R5 000
Loss in extraction due to wear, etc. (0,3 % @
R100 per ton sugar) ....................... R33 120

(c) Boilers

Superheater to be replacement (3 boilers @
R30 000 boiler/6 years) .................. R15 000
ID fans and ducting ....................... R4 000
Ash handling and sluicing ................. R1 000

(d) Labour

Extra labour to clear excess sand from below
 carriers, boilers, etc. ...................... R4 000
(e) Transport costs
12\% tops, trash and sand in cane is equivalent to 126 600 tons/year, @ R0,80 tons/
15 km ........................................ R101 280

(f) Boiling house losses
Two units drop in mixed juice purity resulting in a 1\% drop in boiling house recovery, i.e.
1 300 tons sugar @ R100/ton ........ R130 000

TOTAL ......................................... R413 500

Being very conservative and reducing this by 50\%, the total cost to the South African industry is in the region of R3,3 million per year, or R1,65 per ton sugar. This excludes the cost of running two factories which crush 2 million tons of rubbish.

Conclusion
The cane received by the mill does not have to conform to any specifications or quality. It is therefore rather amazing that from this raw product a sugar is expected to be produced to conform to certain strict specifications, e.g.:

Purity: Colour, Grain size, Starch.
Ash: Reducing Sugars, etc.

Over the past few seasons more and more mills have experienced difficulties meeting these requirements, and paying penalties due to the gradually decreasing quality of cane received at the mills.