ASPECTS OF THE LOUISIANA SUGAR INDUSTRY OF INTEREST TO SOUTH AFRICAN TECHNOLOGISTS

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Abstract

A broad overview of the Louisiana cane sugar industry is presented, and significant differences by comparison with the South African industry are highlighted. Cane quality and harvesting systems are different and their consequences are described in terms of the effect on recovery of sugar and sugar quality. Challenges to the Louisiana industry to reduce costs of production are identified. The effects of different approaches to some aspects of factory processing are also identified. Some details of interest to millers are presented which could be considered for use in the South African industry.

Keywords: sugar, Louisiana, industry, quality, processing, payment

Introduction

There are considerable differences between the cane sugar industries of South Africa and Louisiana. It has been interesting being involved in both industries and assessing the differences and the reasons why these differences exist. There is always something that can be learnt in the process.

The purpose of this paper is not to compare the two industries, but to report to South African technologists on some of the interesting differences between them.

Production information

The Louisiana industry has shown significant growth in the past two decades, as the data in Table 1 show.

Table 1. Louisiana sugar cane production, 1980 and 2000.

Year	Area harvested ('000 ha)	Yield (tons/ha)	Cane production (M tons/year)	% of US Production
1980	103	47.1	4.857	19.4
2000	176	74.0	13.020	42.7

Over the same period, Hawaii production has fallen to a quarter of what it was in 1980, and the Florida industry has expanded, but not as much as Louisiana's.

The number of sugar mills has been reduced substantially. In 1982, there were 24 mills in Louisiana; this declined to 20 in 1994 and to 15 for the 2002 season. The remaining mills have increased in size, and there is a general belief that in the future a minimum size mill should crush at least 1 million tons cane/year. In 2002, about six of the mills will process around ½ to ¾ million tons cane, and the others are all close to or above 1 million tons cane. The largest mill crushed 2 million tons in 2001.

Over the last 10 years, the cane/sugar ratio has averaged about 10. The largest crop processed in 1999 yielded 1.51 million tons sugar (96 pol basis). Raw sugar prices remain around 20 c /lb, but there is a general belief that these will drop, particularly as Mexico becomes able to export sugar into the US.

The most significant development in the industry has been the release of the new variety LCP85-384. It has resulted in substantial increases in cane yields, with estimates of the yield increase varying between 25 and 45%, an incredible quantum leap when some other cane industries are talking of yield plateaus. Apart from the yield increase, it has also shown good ratooning ability. Previous varieties achieved at most 1 or 2 ratoons, but 384 has shown itself able to last for at least 4 ratoons. The new variety has certainly given the industry a boost. Current yields of LCP85-384 are averaging around 37 tons/acre, or 92 tons/ha. This is particularly amazing when one considers that the cane only starts growing in March and is harvested between September and early January.

Cane harvesting and payment

A consequence of LCP85-384 has been the considerable lodging experienced with the new high yield cane. This forced a change from whole stalk to chopper harvesters, which are better able to handle lodged cane.

Because of the short three-month crushing season, the mills try to crush continuously, even in wet weather. Cane harvesting continues, and the result is significant quantities of mud entering the mill with the cane. This is the reason for cane washing plants at all Louisiana mills. However, the change to billeted cane resulted in considerably higher losses of sugar in the wash water. Measurements of pol in wash water entering and leaving the washing plants have given estimates of sugar losses between 4% and 10%. This is considered to be an underestimate, because it does not include losses caused by fermentation of sugar. In dry weather, the soil content in the cane is probably less than that at South African mills. Some of the mills have begun to turn off the wash water in dry weather, and they have clearly seen the improvement in recovery as a result.

At some mills, highly acidic condensates were experienced in the evaporators. These were identified as formic and acetic acids, which had formed in the cane wash water systems. Stopping cane washing cured the problem of acidic condensates (Day, 2002).

Cane payment

Cane is sampled by a core sampler, entering the top of the load of cane at an angle. The corer does not work as well on chopper-harvested cane as on whole stalk cane, and the corer teeth need to be kept sharp to get a reasonable sample. Cane analysis is calculated from the core/press method, by putting a shredded sample in a hydraulic press, analyzing the expressed juice, and determining the moisture on the pressed cane (Birkett and Kessler, 1994).

The industry has for a number of years based its payment on a Theoretical Recoverable Sugar (TRS) formula. It is based on a lost absolute juice % cane figure of 56.67 and uses the Winter-Carp formula and a 96% Boiling House Efficiency to predict recovery. The formula is as follows:

$$\text{TRS (lb 96 pol sugar/short ton cane)} = [100 - 56.67\, F/(100-F)]\,[0.28S - 0.08B]$$

where F, S and B are fibre, pol and brix % cane respectively. This can be expressed differently as:

$$TRS\ \%\ cane = E/100 \times [S - 0.4(B-S)]$$

where E = % extraction. This is similar to the South African ERC formula:

$$ERC\ \%\ cane = 0.98S - 0.5(B-S) - 0.02F$$

The TRS equation has served the industry well, but it still does not provide sufficient incentive to the growers to send clean cane to the mills. Discussion in the Louisiana industry is ongoing, in regard to how the system can be revised to give the right incentives to growers. Options are penalties and bonuses, or a formula of the Australian CCS type, which allocates part of the TRS to the miller as a processing fee.

The Louisiana industry cane payment system is based on 'vertical slicing', i.e. each mill and its growers agree on the split of proceeds for that mill. This makes it easier for one mill on its own to agree to changes to the cane payment system with its own growers, instead of getting the whole industry to agree to changes. On average, the growers at present get slightly more than 60% of the proceeds from the mill.

The core/press method of cane analysis is used to arrive at the distribution of growers' proceeds. The absolute values of cane analysis are therefore not used. The method of analysis is subject to a number of errors. A recent study has shown direct analysis of cane to be more reliable and has shown that NIR analysis of shredded core samples should be able to give accurate and rapid absolute measurements of cane composition, which can be directly used for cane payment purposes (Madsen *et al*., 2002).

Cane quality

Whenever delays caused by rain or long mill stops occur, problems with high dextran levels are experienced. It is interesting to note that cane delays in South Africa result in the formation of ethanol as the major degradation product, whereas in Louisiana dextran is the most common fermentation product.
A consequence of the rapid formation of dextran is the imperative to crush fresh cane. The dextran formation may affect processing in the low-grade massecuite, but the generally low average cane delays mean that the cane is fresh.

Quality of cane is good by South African standards, being generally low in trash and extraneous material. Rocks do not occur in Louisiana cane fields.

Cane tends to be immature, particularly at the beginning of the season, and so extensive use is made of ripeners. Juice purity increases during the season and is generally highest at the end of the season. The fibre content of the cane is low, with the average fibre % cane reported as just over 13%. The reported average mixed juice purity for the season is about 84. However, measurements of pol/sucrose ratios in the mixed juice from some of the factories have shown an interesting result – pol/sucrose ratios are found to be about 0.95, rather than 0.98 to 0.99 found in South Africa. This means that the true purity is actually much higher than commonly accepted, a true purity of about 89 on average! It also means that the losses are higher than those currently reported. It will be interesting to try to establish why there is such a large discrepancy in the pol/sucrose ratios between South Africa and Louisiana.

Factors affecting cost of production

By comparison with other sugar industries, the major factors adversely affecting the cost of production are the short season and high labour costs. Over the period 1994/95 to 1998/99, LMC International reported Louisiana field costs to be 123% of world average and factory costs 143% of world average (Haley 2001). Since that time the more widespread use of LCP85-384 has helped reduce field costs per unit of production. LMC International reports that the Louisiana field sector is more competitive internationally than the factory sector.

The need to crush the cane before the freeze has tended to inspire in the factories an attitude of throughput above all else. There is now a growing acceptance that recoveries need to be improved as one of the strategies to reduce factory production costs. These are currently estimated at about 7.5c/lb sugar. It should be possible to improve cane/sugar ratios from the present value of 10 to about 8.5 without substantial capital investments, but with a focus on identifying and reducing losses in processing.

Target purity differences are high, averaging over 10 units, and regular reporting of these over the last two seasons is beginning to generate interest in improving molasses purities (Rein *et al*., 2002).

The industry has been slow to adopt modern technology. However, continuous pans have proved themselves in the industry but are sometimes still reported to be more expensive in capital costs than batch pans. The level of automation is low, and progressive implementation of automation is expected to improve efficiencies. The Louisiana industry has neglected the education and training of people to work in the sugar industry. As a result there is less technical depth in the factories than there should be. Efforts are being made to rectify this through courses introduced at LSU through the Audubon Sugar Institute (Rein, 2001). By contrast, efforts made by the South African industry to train engineers have borne fruit, and the depth of knowledge now represents a significant strength of the South African industry.

Factory boiling scheme and sugar quality

All but two of the mills use a three-boiling system, bagging A and B sugars. Average sugar pol is 98.5 although some of the mills produce sugar over 99 pol with little difficulty. As a consequence of fresh cane of good quality, clear juice quality is generally excellent, and good quality sugar follows as a consequence. Syrup colour in Louisiana is around 12000 ICUMSA units (Eggleston et al., 2002). This is about half the average levels of colour in South African syrup (Smith, 1990). A sugar colour of 1000 ICUMSA units can be achieved in Louisiana on average if required, even without going to very high polarization.

The three-boiling system requires about 23% less pan capacity than the South African system, and steam usage is reduced accordingly. Two of the mills use a double Einwurf system, using C sugar as a footing for B massecuite and B sugar as a footing for A's. This requires slightly more pan capacity, but it is still less than the South African system, still produces high quality sugar, and enables B sugar to be cured on continuous machines. It is particularly well suited to the use of continuous pans.

Of interest is the fact that no vapour or steam is used on any centrifugals, and no sugar dryers are used. Transporting the product sugar on conveyors and flinging the sugar into large warehouses seems to provide enough drying and cooling.

Interesting factory technology details

There are a number of things done in Louisiana mills, which could profitably be adopted in South Africa.

- Rubber belt intercarriers with ribs or cleats about 150mm high are finding increasing use. The local supplier, Tricon, reports that more than 70 intercarriers have been supplied. Dropping of riddlings is prevented by the return belt running in a steel trough and the conveyor incline is anything up to 60°. The whole unit is self-contained and can be removed as a unit by the crane. The disadvantages are that cane cannot be discharged into the boot of the conveyor, and imbibition has to be added not on the conveyor, but at the discharge of the conveyor into the following mill chute. Neither of these has serious implications. Later intercarriers have used air belt systems. Belts usually last more than 10 years.
- A condensate monitor supplied by Nalco using fluorescence as an indicator of contaminants in condensate has been applied with success. Sucrose itself does not fluoresce, but some compounds associated with sucrose do. While not fully understood yet, it shows great promise of providing a reliable lost-cost condensate monitor on boiler feed (Herrara, 2001).
- Vane type entrainment separators confirm the trend seen in South African mills towards the use of chevron plate entrainment separators. The units are efficient and self-cleaning on evaporator duties, although they are often supplied with spray nozzles above them for periodic chemical cleaning.
- Load cells are commonly used to control the loading of cane from feed tables onto the main cane carrier. This ensures that the main cane carrier is always evenly loaded, eliminating chokes caused by uneven loading and the labour otherwise required to operate the feed tables. The system is simple and highly effective and is used in nearly all Louisiana mills.
- Hard metal inserts on cane knives and shredders (trade name Domite) are highly successful in minimizing wear. This material is a lamination of chrome moly white iron metallurgically bonded to a mild steel backing plate, enabling the inserts to be welded to knife blades. Blocks for shredder hammers in the same material are used and indexed when the cutting edge wears. Domite has a hardness of 65Rc; fortunately, the absence of rocks and stones makes these hard materials less susceptible to brittle fracture.
- Rising film plate evaporators are evoking interest as add-on surface area to existing evaporator vessels. One unit of 1208 m^2 ran well during the 2001 season in second effect duty, and another is being installed for the 2002 season. These units are supplied by Alfa-Laval, with a re-designed juice inlet system to obviate unequal flows and differential scaling on the plates. Advantages are the compact installation, low installation costs, and the ability to add plates to increase heating area.
- An old pan at Lula Factory is getting a new calandria, and at the same time being changed from a flared to a straight-sided pan by increasing the calandria diameter. The pan capacity increases by 27% and the heating surface by 54%. The circulation ratio is affected adversely, but the circulator and the absence of the flared body are expected to lead to a significant net improvement in pan performance.
- A peristaltic pump is used at the Cora Texas mill to pump filter cake to a disposal bin, from which it is conveyed to the fields. The cake has to be wetted slightly to give a moisture content slightly higher than as produced for the pump to function efficiently. The cake is pumped at a rate of 900 ton/day through a plastic pipe a distance of several hundred metres, and the hose in the pump needs to be replaced four times during the season.

Conclusions

Both the South African and Louisiana industries have been focused on reducing the costs of production. Rationalization and modernization of mills is a trend seen in both industries. South Africa has invested more resources into research and development and into education and training of people, and the level of innovation has been higher. It is expected that the level of innovation and change will accelerate in the Louisiana industry over the next decade and that the industry will become more competitive internationally.

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