CLARIFICATION DEVELOPMENTS AT BOIS-ROUGE MILL, REUNION ISLAND

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Bois-Rouge, Reunion Island

Abstract

Progressive changes in the clarifier station at Bois-Rouge are described. Three reasons are behind the modifications: a factory expansion, from 250 to 350 TCH, the use of cane diffusion to replace the mills in 1992, and the effect of clarification on sugar quality which was clearly evident at Bois-Rouge. The flash-tank and one clarifier have been modified and the benefits thereof are detailed. Juice quality must be maintained at all times to guarantee the quality of special sugars. The use of flocculants, saccharate liming, process control and automation are discussed. During the 1996 season two short residence time, trayless clarifiers will be used. Optimisation of the filters and loss reductions are further priorities in 1996.

Keywords: clarification, sugar quality, Reunion Island

The Bois-Rouge mill and the sugar cane industry in Reunion Island

Over the past ten years, the sugar industry of Reunion has undergone many changes, eg the number of factories dropped from five in 1985 (2 million tons of cane) to two in 1996 (estimated cane tonnage 1,9 million). In the agricultural sector, the growers, although generally assisted by the government, lack the labour needed to maintain the cane quality. The changes at Bois-Rouge are associated with the restructuring of the industry. This mill crushed 225 tons cane/hour in 1985 (0,5 million tons of cane) but will reach 350 TCH in 1996 (0,96 million tons of cane). Major changes took place mainly at the beginning of the 1990s:

- Quintuple effect evaporators in 1990.
- Shredder and diffuser in 1992.
- Small refinery plant and production of special raw sugar in 1993.
- Power plant for cogeneration using bagasse and coal in 1992.

The process has also seen many changes. The clarifiers were modified in 1980 (Lincoln, 1982), but needed to be improved to cope with the increased cane tonnage. In 1995, the bigger clarifier (24 x 3 compartments) was modified to become a trayless, Whayman and Associates (W&A), clarifier to reach 300 TCH.

Since 1992, Bois-Rouge has been producing more and more high quality raw sugar and some refined sugar, to the detriment of bulk raw sugar for the French refineries. Changes have therefore been necessary, including flow control, saccharate liming and modifications to the flash-tank.

The Bois-Rouge process in 1993

Juice extraction is by cane diffusion followed by two dewatering mills. Lime (available CaO <72%) is added to the press juice and at one other point in the body of the diffuser to a pH of 6,0. The temperature is maintained at 75°C. The mixed juice is limed, after heating to 103°C, using an in-line mixer close to the flash-tank. Flocculant is dosed in the feed pipes immediately before entry to the clarifiers. Flocculant is made at a concentration of 0,1% and dosed without dilution.

The modified multifeed clarifiers are insulated. The flash-tank is undersized (diameter = 3,5 m) for the peaks in juice flow.

The quality of the clear juice is far from good (average optical density = 0,45 at 900 nm). At Bois-Rouge, clear juice quality is checked by the measurement, on an hourly basis, of the optical density (OD) at 900 nm against a distilled water blank in a 1 cm cell. Turbidity of clear juice is gauged by this absorbance:

OD > 0,30	Bad quality of clear juice
0,20 < OD < 0,30	Fair quality of juice
0,10 < OD < 0,20	Good quality of juice
OD < 0,10	Excellent quality of juice.

At the filtration stage, the mud is pumped twice before it reaches the filters (2 x 30 m^2) and the residence time is estimated at 15 minutes. The filters work continuously with a recirculation of mud. No lagging exists and the temperature at the filters is below 75°C. The amount of bagacillo from a hopper on the bagasse conveyor is not sufficient and there is often a shortage which affects the cake pick-up and thickness. The vacuum station is also undersized.

The first objective: guarantee of quality for the production of special raw sugar

The same process at the crystallisation station has been used for the production of special raw sugar in 1993 and

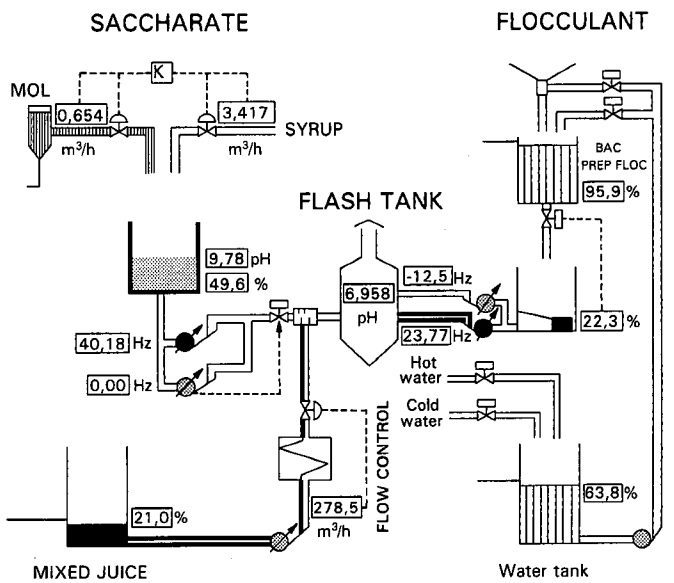

FIGURE 1: Process control for the preparation of saccharate liming and flocculant dosing.

1994. The percentage of special sugar has, however, increased from 45 to 61%. It is the improvement of the process at the clarification station that has allowed this increase. In Reunion, the quantity of phosphate is generally above 400 ppm in the mixed juice and there is therefore no need to add more phosphate. On the other hand, the levels of cane trash, tops and soil brought into the mill have reached record heights.

The combination of high extraneous matter (particularly leaf) and diffusion has resulted in high extractions of colour and other impuritites, and adverse effects on clarification have been seen. Two processes have been made, as illustrated in Figure 1.

Flocculant preparation

A new flocculant with a high molecular weight and a high degree of hydrolysis is used. Preparation and maturation tanks are plastic, and the temperature of the water is controlled (<50°C). The flocculant is prepared at a concentration of 0,1% on a weight basis. The pumps are peristaltic and therefore help to maintain the quality of the polymers.

Saccharate liming system

Calcium saccharate is added just before the flash tank. The turbidity averaged 0,25 instead of 0,45 as shown in Table 1. Many sugar factories, especially in Australia (Leotta *et al.*, 1993) and in Mauritius (Wong and Chung, 1995), use saccharate liming with a net improvement in clarification. Different tests to investigate the preparation of the saccharate were carried out during the 1993 season. These tests resulted in the following procedures for the preparation:

- Temperature of the preparation <50°C
- Seven molecules of saccharose for one of CaO
- Residence time minimum of 2 hours before use.

In 1994, this preparation was instrumented and well controlled. The scheme is given in Figure 2. The time for mixing the milk of lime (available Ca O:75%) with syrup is estimated at three minutes. A K Coefficient fixes the proportion of lime to be used for a known flow of syrup. On average for a lime of 12° Baumé and a syrup of a brix of 68° and apparent purity of 86, a liquor to milk of lime ratio in the order of 4:1 (m:m) is used. Five to 6% of liquor is recycled for saccharate preparation. Input flow is controlled by the level in the preparation tank. The change of level is reduced to a minimum to avoid the production of foam and to maintain the quality of the calcium saccharate. The stability of the limed juice pH at Bois-Rouge is therefore rarely a cause of concern. Leotta *et al.* (1993) recommended a molar ratio of calcium to sucrose of less than two to ensure full reaction. The retention time is short to reduce the destruction of reducing sugars.

Table 1

Clarification development at Bois-Rouge mill

	Estimated filtrate losses % pol in cane	Turbidity at 900 nm		Purity		
		Multifeed	Trayless W&A	CJ	Filtrate	Diff.
Season average 1994	0,25	0,24	–	84,90	80,60	4,30
Season average 1995	0,16	0,18	0,23	85,50	82,70	2,80
Before insulating the trayless W&A clarifier	0,24	0,18	0,42	83,04	78,33	4,71
After insulating the trayless W&A clarifier	0,23	0,20	0,25	85,46	81,72	3,73
Use of diluted flocculant in line	0,06	0,15	0,16	85,93	84,40	1,53

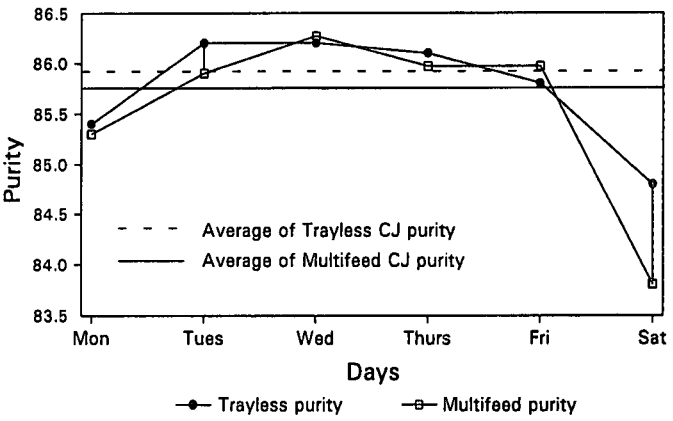

FIGURE 2: Change in clear juice purity during the week.

To ensure a steady flow of mixed juice to the clarifiers, there is a system to control the flow variation of juice from the diffuser. The major problem is the transition during the day when supplies change from chopped cane, mechanically harvested, to whole stalks with a high proportion of extraneous matter. Percolation in the diffuser in this condition is less controllable, causing rapid increases in the flow. To regulate the flow under those conditions, it is necessary to accept a higher level in the mixed juice storage tank, which could cause problems of degradation of sucrose (Antier, 1996).

The main objective in 1994 was to ensure a much better quality of clear juice and syrup to the crystallisation station. In his report, Whayman (1994) recognised that the standard of clarification has improved considerably compared with that of 1993. However, the capacity of the clarifiers needed to be improved to crush 350 TCH and to reduce the losses. In 1994, the clarifiers sometimes overflowed when the flow was above 380 t/h.

Second objective: clarification capacity and reduction of losses

Clarification capacity

As mentioned before, using a diffuser with great variation in the quality of cane causes variations in the flow of mixed juice. In addition, as the cane tonnage progressively reached 350 TCH, the control of the limed juice flow rate needed to be redesigned.

The advantages of short residence time clarifiers have been proved, and the next aim is to reduce losses and to minimise the deterioration of the juice. Thus, the larger multifeed clarifier has been modified to a trayless W&A clarifier type. The capacity of the clarifier has decreased from 212 m^3 to 127 m^3, and the retention time has therefore dropped to an average of 30 minutes instead of 55 minutes. It is obvious when the results of the 1994 and 1995 seasons are examined (Table 1) that there was again a significant improvement in the quality of the clear juice regarding the cloudiness of the juice at the outlet of the clarifiers. This improvement in quality was also obtained at the multifeed clarifier, partly because of the good performance of the flash-tank. The diameter of the flash-tank was increased by 143%. Good insulation, together with a dilution in line of the flocculant, have resulted in a good performance concerning the clarity of the juice (0,15 to 0,16 OD at 900 nm).

Figures 2, 3 and 4 represent a comparative study of performance at the two clarifiers after the improvements indi-

cated in Table 1. It is important to know that 63% of the limed juice is to the trayless and 37% to the multifeed clarifiers. If the main flow varies, the variation is handled by the trayless and a steady flow remains for the other clarifier.

Trends in the OD (Figure 3), in both cases, show that there is a degradation in quality during the week. This can be explained by problems at that time: juice heaters were not cleaned as necessary and scale in the final heaters caused the final temperature to be below 103°C.

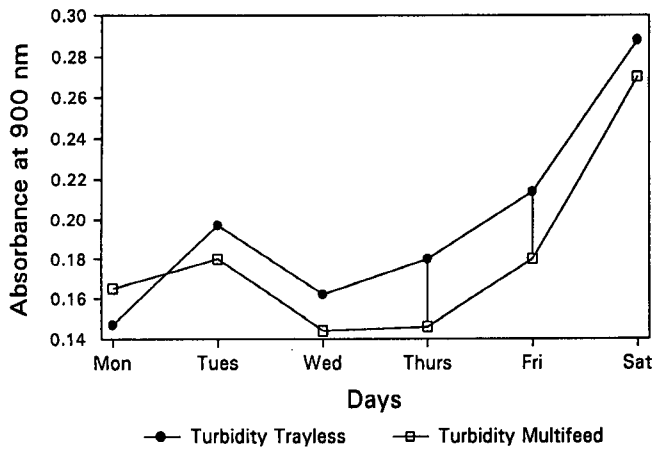

FIGURE 3: Changes in the turbidity of clear juice during the week.

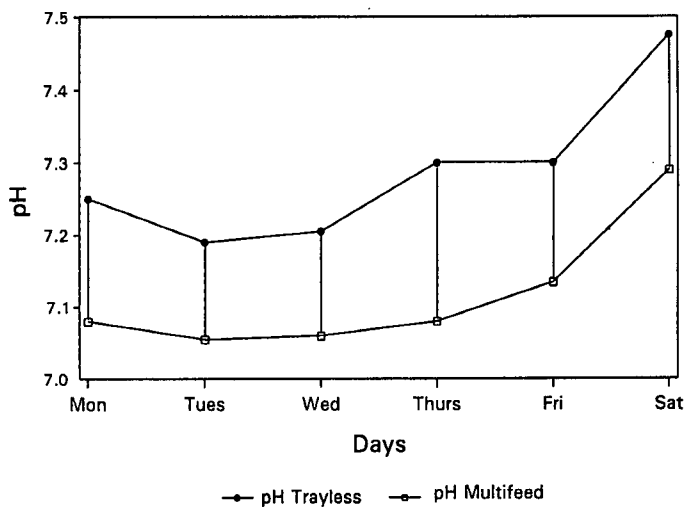

FIGURE 4: Changes in clear juice pH during the week.

There is a significant difference in the purity of the clear juice between the two clarifiers in more than six weeks' comparison. On average, the outlet purity of the trayless W&A is about 0,20 unit lower.

In Reunion, crushing starts on Monday morning at 06h00 and ends on Saturday at 10h00. No cane is stocked in the millyard but it is not rare to have cane on the exterior reception sites (zones) or in the fields already cut during the weekend. This explains the decrease in purity observed on Monday and Saturday. The juice is limed a little more than usual, before the stop of the factory (difficult sedimentation of mud with the liquidation of the diffuser), to recuperate the maximum amount of clear juice at the outlet of the clarifier. The fact that a more pronounced drop in the purity is observed for the multifeed seems to show that the weekly losses on this type of clarifier are underestimated. The disadvantages in this clarifier are way hidden, since no sample taking is possible. A difference in pH is evident, at a value of 0,15 units on average, in favour of the trayless, remaining constant throughout the week. On average, the apparent residence time in this clarifer would be 62 minutes, but it is probable that conditions are far from ideal flow. Some juice passes through in 20-30 minutes, whereas some may remain for much longer, up to two hours.

Losses minimised

As said before, the filtration unit has undergone many changes. Figure 5 shows the trends over the past 10 years for the difference in purity between the clear juice and the filtrate. There is no obvious reason for the sudden change (2 units) in 1990. From 1984 to 1989, the difference was 0,5 units average. The losses reached 4,3 in 1994, after which the following steps were taken:

- Muds from the SRI are sent directly to the mud mixer.
- All the mud pipes and the mud mixer are lagged.
- Retention time in the mud mixer was reduced to a maximum of three minutes.
- A louvre type bagacillo separator was installed.

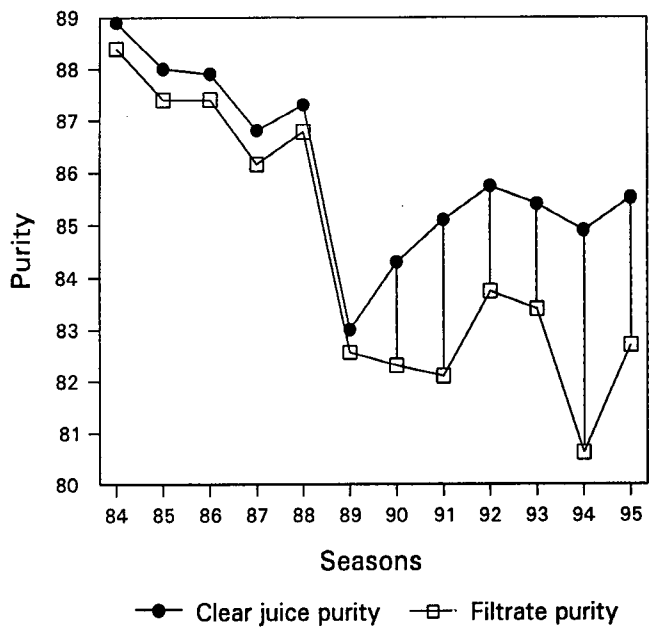

FIGURE 5: Quality of juices over the last 10 seasons.

The results, at the beginning of the season, did not really improve (Table 1). The pol in cake remained high and so did the filtrate losses. Significant changes were obtained with in-line dilution of the flocculant (0,06 estimated filtrate losses % pol in cane and 1,53 purity difference between the clear juice and the filtrate). The average for the 1995 season has decreased to 0,16 compared with 0,25 for the 1994 season. Nevertheless, mud temperature was not maintained at 85°C because there was too much recirculation of the mud in the filters, which work badly. The mud of the 22' clarifier also goes through this tank instead of directly to the mud tray. A study (Antier, 1996) of the microbiological aspects showed that mesophilic bacteria, particularly of the *Leuconostoc* species, were present at high levels in the filtration station.

Perspectives

Clarifier options for 1996 and the future, comprise three steps with respect to capacity and loss reduction.

- Replace the existing clarifiers with one SRI. This is the best option but may be postponed until finances and a new location in the mill are available.
- Retain the existing systems. This is the cheapest option but with the disadvantage of poor juice distribution for the two clarifiers. In addition, reducing the losses of sugar will be difficult.
- Convert the existing 22' multifeed to an SRI type. The advantage here is low capital outlay, easy distribution of flow and the use of the SRI type.

This last option will be retained for the next seasons (Figure 6). The volume of the modified clarifier will be 83 m^3 instead of 130 m^3, and more homogeneous distribution of juice between the two clarifiers could be obtained. With a distribution of 55/45% of the flow for each clarifier, the average residence time in the clarifiers will decrease to 32 minutes for the first and to 28 minutes for the 22' clarifier.

It was found during the 1995 season that the performance of the clarifiers was improved if the temperature of the flash was kept constant at 103°C throughout the week. In 1996 the capacity of the platular juice heaters will be increased. It will be possible to clean a juice heater, during the week, without disturbing the process.

At the filtration station, feeding the mud mixer with adequate variable speed pumps will allow the filtration to stabilise. Investment has been made in a 70 m^2 stainless steel filter which is designed to work together with the best of the other filters of 30 m^2, to treat all the mud with no recirculation. A vacuum pump and new filtrate receivers, better sized, are also installed.

It was also useful at Bois-Rouge to explain to all the staff the changes that can be achieved by attention to small but important steps such as flocculant dilution, the quality of the juice and the losses. In the future, there must be vigilance

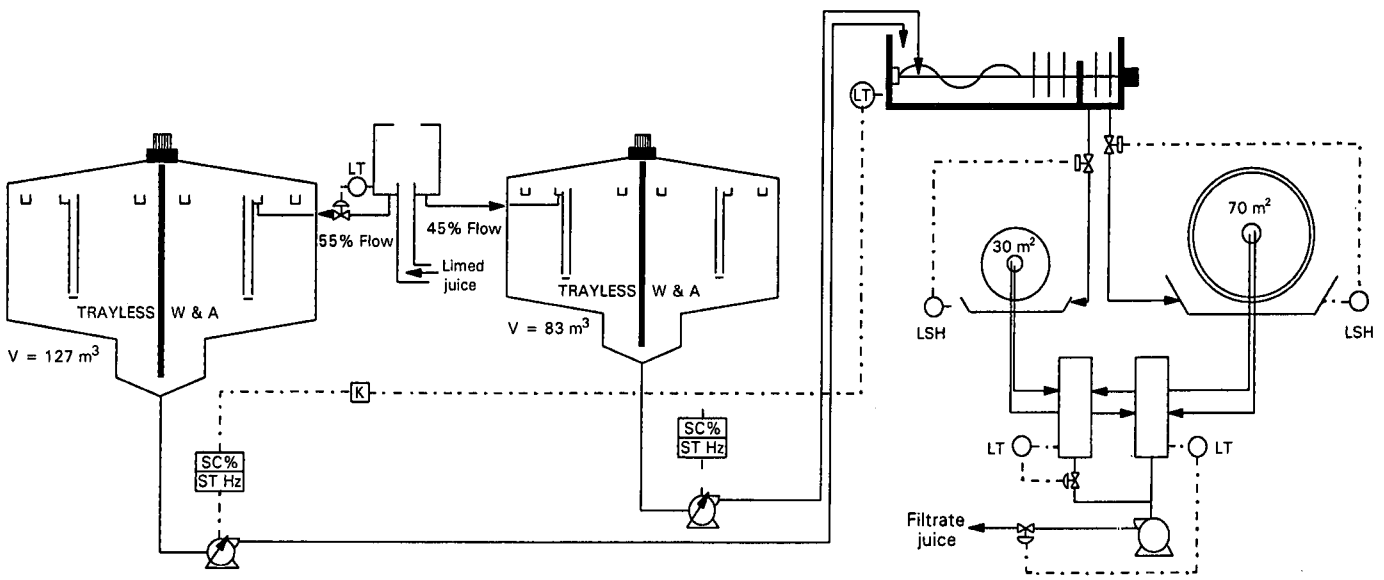

FIGURE 6: Clarification at Bois-Rouge mill for the next season.

with continual attention being paid to the optimisation of such an important station.

Acknowledgements

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