SYRUP SCREENING AT THE MALELANE MILL

STEPHEN MARKHAM AND THENUS VAN STADEN

Transvaal Suikerkorporasie Bpk - Malelane

Abstract

During the 1999-crushing season, the Malelane Mill installed vibratory screens after the quadruple effect evaporator. The purpose of the screens was to separate out any residual scale originating from the chemical cleaning of the evaporator vessels. This strategy was adopted after attempts to improve the flush out of the evaporator vessels after chemical cleaning proved ineffective in removing all the scale. The underlying motivation behind the screening was to remove evaporator scale from the raw sugar that was destined for packaging, and which therefore compromised brown sugar quality.

This short paper covers at the history behind the installation of the screening station, the sizing of the screens and the problems associated with tearing of the screens, carryover of syrup and blinding.

The effectiveness of the screens in removing evaporator scale and methods of cleaning the screens are discussed.

Introduction

Prior to the 1999-crushing season, the Malelane Mill had always practised mechanical cleaning of the evaporators. This involved a total steam shut down of the factory, resulting in loss of cane throughput for up to 18 hours. During the 1998 off-crop, a cleaning -in- place plant was installed to replace the mechanical cleaning with chemical cleaning. This would allow 50% of the evaporator station to carry on with normal juice duty, while the other half could be taken off range to be chemically cleaned, by means of boiling caustic soda. This eliminated the need for a total steam shutdown and therefore crushing could continue, albeit at a reduced rate. One of the major undesirable outcomes of this strategy was that large amounts of the scale removed from the tubes during the cleaning, remained in the saucers of the evaporator vessels. Although a water flush was incorporated in the cleaning program, this proved ineffective in removing all the scale. In addition to the residual scale (released from the caustic boil out), additional scale was dislodged from the tubes and vessel walls with the first passage of juice through the cleaned vessels. The net result was that scale particles were carried forward with the syrup and eventually contaminated brown sugar destined for packaging and therefore compromised quality.

Table 1. Process streams entering syrup tank.

STREAM	FLOWRATE (m^3/hr)
Evaporator Syrup	60
B/C Melt	19
Refinery Returns	6
Total	85

Syrup Quality

Normally some suspended matter occurs in syrup. This can be traced to bagacillo and mud carry over from clarifiers and rust and scale from vessels and pipes. The levels can vary from a normal value of approximately 0.1% (m/m) to a peak of 0.5% (m/m) immediately following an evaporator clean. A substantial portion of the heavy scale particles settle out in downstream tanks. The scale build up in the syrup storage tank was so severe that it was necessary to stop the factory midway into the season in order to clean out the tank to prevent re-entrainment of the settled scale into syrup during periods of low tank level.

Screening Options

In order to reduce the amount of suspended matter in the syrup it was proposed to install a screening station to screen syrup before the syrup tank. Screening, filtration and flotation options were considered. The syrup flotation option was given serious consideration but due to the suspended matter being too heavy to float out, this option was discarded. The filtration option proved to be far too expensive. Syrup screening using in-line self cleaning strainers required a substantial increase in pump pressures and flow rates which made this option uneconomical. Circular vibratory screens were finally settled upon as the most cost effective option.

Screen Sizing

The streams entering the syrup tank (Table 1), are evaporator syrup, return jet from the refinery and B&C melt. It was decided to screen all of these streams prior to entering the syrup tank.

After discussion with the supplier, four 1524mm diameter circular screen separators with 310 micron aperture screens were installed, each with a capacity of 35 m^3/hr (see Figure 1). The screens have an adjustable frequency of up to 1600 cycles per minute and a variable horizontal and vertical stroke. The initial proposal was to use three screens for the combined output and to have one screen on stand-by.

Commisioning

From commissioning it was noted that three screens did not have sufficient capacity to handle the combined syrup stream flow. The screens would flood resulting in syrup and any scale residue on top of the screen being sent back to the mixed juice tank. The stand-by screen was brought into service to try alle-

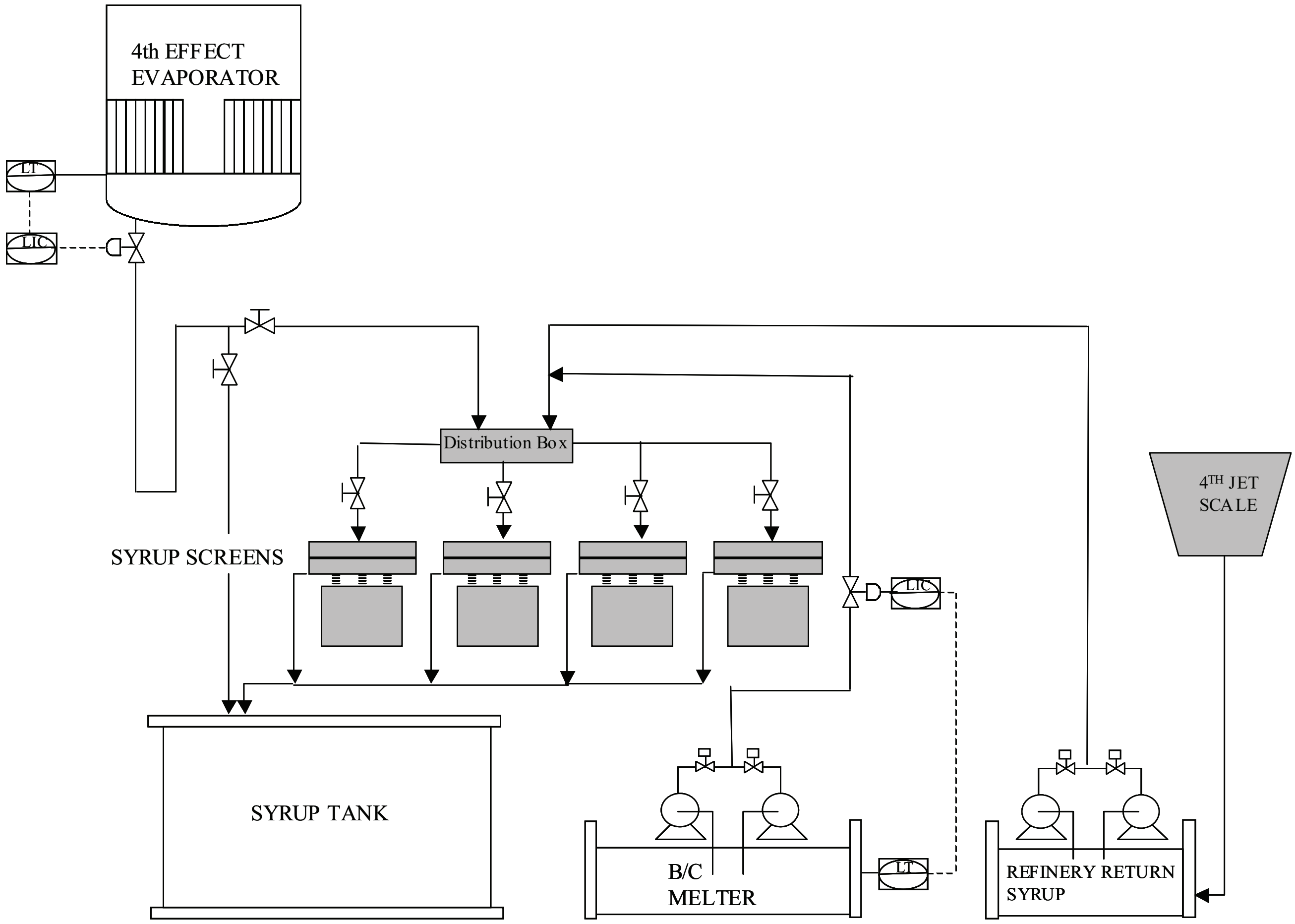

Figure 1. Syrup screening arrangement.

viate the problem. Even with all screens in service, there were still times when screens would overflow. To determine the screen capacity, a Doppler flow meter was clamped onto the discharge pipe from the fourth effect evaporator. Instantaneous flow-rates of up to 140 m^3/hr were measured. The reason for this was traced to erratic juice flow and varying vapour bleed through the evaporator train coupled with a too rapid response from the last effect control valve. Whilst the average mass balance flow rates were correct, they did not take into account instantaneous flow peaks.

Similar flow variations were found with the B/C melt and refinery return streams. Tuning of the level control loops on these streams yielded only a slight improvement. Because there was no surge tank between the evaporator and the screens, these flow variations were transferred directly onto the screens.

Another problem was the tearing off the screens at the centre at the point of syrup loading on the screen. The surging of the syrup stream placed significant pressure at this point and caused the screens to tear.

In order to solve both of these problems it was decided to replace the 310micron / 53 % open area screens with 500micron / 57 % open area screens. The greater open area would increase the capacity while the thicker diameter wire would increase the strength of the screens. The performance of the screens improved dramatically with the greater aperture screens. However some flooding still occurred during peak loading and the condition worsened as the screen fouling increased. After a process of trial and error of evaluating different screen apertures, it was found that 720micron/63 % open area screens had the capacity to handle most flow variations and give an acceptable quality of screened syrup. The Mill plans to experiment with a larger aperture screen in the near future with a view to extend cleaning cycles.

Cleaning of screens

After two weeks of continuous operation it was noticed that the screen capacity declined rapidly. Examination of the screens revealed blinding with a creamish coloured deposit. The cleaning methods used at the Mackay Sugar Co-operative (Doyle and Attard, 1996) were tried. This involved using high-pressure cold water to clean the screens *in situ*. The nature of the scale at Malelane was such that cold, and even hot, high-pressure water did not have any impact on the scale. The method of cleaning the screens *in situ* was abandoned and the screens were removed in order to clean them. Operation was continued by installing a new screen. Based on the Australian experience of using hydrochloric acid solution to soften the scale, Malelane experimented with a 50 % solution of phosphoric acid with inhibitor since this acid was readily available at the mill.

Although the scale was softened by the action of the acid, it still needed to be scrubbed off by wire brushing. Trials were done using caustic soda and it was discovered that this softened the scale to a greater extent than did the acid. It was however still necessary to remove the scale by means of wire brushing. In order to clear the screens of excessive amounts of evaporator scale during operation, spray nozzles were installed above the screens. Clear juice at 98°C is sprayed intermittently to wash the scale off the screen and into a receiving launder from where it is pumped back to mixed juice.

Results and discussion

After initial problems with flooding and carry over of syrup, the screens have been successfully sized to handle any fluctuations in the flow-rate. The current method of cleaning the screens gives satisfactory results although experimentation is ongoing to try to find alternative methods.

To evaluate the effectiveness of the screens, samples of evaporator syrup were taken before and after the screens (Table 2). The syrup was then filtered through membranes and the residual scale could be seen on the membranes. Visual examination of packed raw sugar shows no presence of scale particles. Some minute "pencil point" black specks still occur in the final packed brown sugar.

Insert Table 2

The reduction of filterable residue in syrup after the screens and in the packed brown sugar can be seen in the following photographs (Figure 1).

(Insert Fig. - photos)

Conclusion

After chemical cleaning a substantial amount of scale eventually found it's way into the brown sugar, compromising the final product quality. In order to prevent this, a syrup screening station was installed at a total cost of R350 000. The installation of these vibratory screens for the syrup as well as B/C melt has ensured that the majority of this material is removed before entering the syrup tank, thus improving sugar quality. The 720micron screens proved to have sufficient capacity to cope with the high instantaneous flow-rates, as well as being robust enough to withstand the pressure caused by surges in the syrup flow. With regard to the cleaning of the screens, the best results were obtained using caustic soda.

Acknowledgements

The authors would like to thank TSB management for allowing them permission to publish this paper. Acknowledgements are due to Ben Vermaak for finalising the design and implementation of the project, Ish Singh for his valuable input on the operational aspects and to Eriez Magnetics for their technical support.

Table 2. Typical values after a chemical clean.

	Suspended solids (%m/m)	Suspended solid removal %)
Syrup before screens	0.35	
Syrup after screens	0.03	92
Raw sugar	0.01	98

REFERENCES

Doyle, CD and Attard, RG (1996). Screening of factory liquor using a vibratory unit. *Proc Aust Soc Sugar Cane Technol* 20: 470-476