RAW SUGAR FILTERABILITY IMPROVEMENTS WITH SYRUP CLARIFICATION

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Abstract

A study has been initiated to review syrup clarification technology, with the objective of finding methods of improving syrup clarification, including chemical addition, and with special reference to aeration and flocculation problems. Preliminary results suggest that significant improvements to raw sugar quality are possible, particularly filterability. The review to-date is presented, with recommendations on future work.

Keywords: sugar, filterability, syrup, clarification

Introduction

Raw sugar quality continues to be an important matter given the increasingly competitive nature of the open market. Save for the right price, consistently superior quality sugar is vital to securing a long-term advantage for the southern African sugar industry. The Sugar Milling Research Institute (SMRI) has over the years been looking at various technologies aimed at improving the quality of raw sugar, evaporator syrup clarification being one of them. A research project was initiated to investigate the benefits and methods of improving syrup clarification, including chemical addition, and with special reference to aeration and flocculation problems. Several researchers (Rein *et al.*, 1987; Smith *et al.*, 2000) have investigated syrup clarification, from laboratory studies to factory trials. They have established that syrup clarification benefits sugar quality and also sugar yields. It has been found, however, that in commercial applications the performance of syrup clarification is inconsistent. This paper looks at the results thus far in the review of syrup clarification as a possible technology for better sugar quality, specifically sugar filterability.

Background

The purpose of syrup clarification is to remove residual suspended solids found in evaporator syrup. It has an additional advantage in that, because of its position in the process, it can remove residual scale particles from preceding evaporator bodies. Since the syrup liquor is very viscous, at about 65ºBrix, clarification is done by flotation. Air is used to aerate the flocculated particles so that they float and are removed at the top of the clarifier as scum. The treated syrup is drawn from the bottom of the clarifier and sent to vacuum boiling pans to crystallise out the sugar.

Investigation, methods and results

Weekly samples of raw sugar, raw syrup and treated syrup from Maidstone mill were regularly analysed for filterability. Raw and treated syrup turbidity data were provided by Maidstone mill. The filterability test for sugar was that recommended by Lionnet and Ramsumer (2002), in which a 30°Brix sugar solution is filtered under 20 kPa pressure through a 3.0 µm Millipore membrane. The filterability test for syrup samples is the same as that for sugar except that the syrup Brix was 5°Brix. Higher Brix did not work, as filtration rates were too low.

The relationship between syrup turbidity removal and syrup filterability improvement is shown in Figure 1. It shows that high turbidity removal results in a significant improvement in filterability, which in turn would imply correspondingly better sugar filterability. These results are encouraging, but they are not consistent; hence the reason for this study.

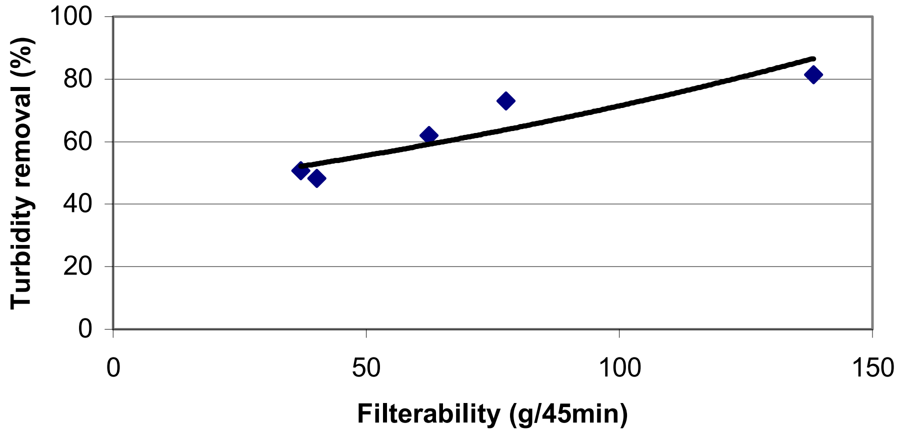

Figure 1. Syrup filterability with syrup turbidity removal across syrup clarifier.

A set of poorly filtering sugars was analysed for filterability as well as suspended solids as this was suspected to be the probable cause for poor filtration. The results (shown in Figure 2) showed filterability decreasing with increasing level of suspended solids in the sugar solution. The results confirm that suspended solids are the primary cause of poor filtration and syrup clarification is a suitable technology for improving sugar quality since it can effectively remove suspended solids.

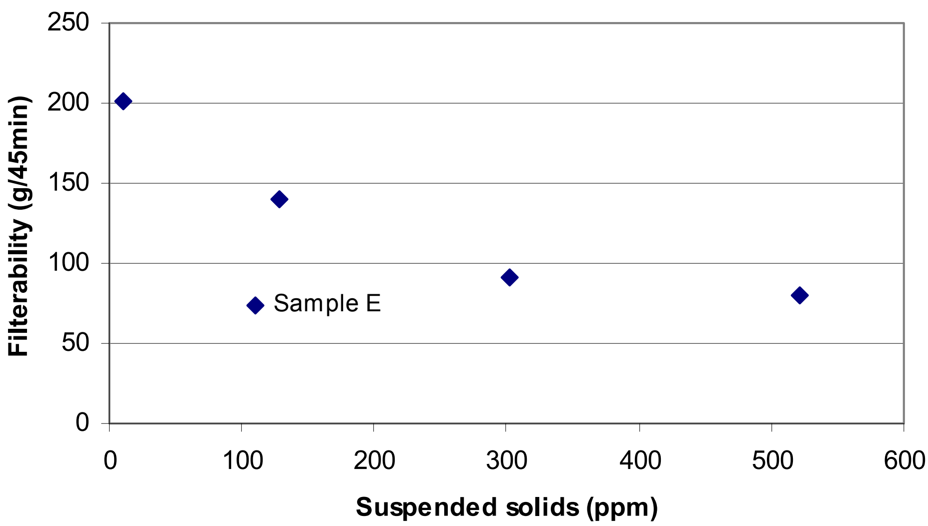

Figure 2. Relationship of sugar filterability with its suspended solids level.

The poor filterability of the outlier in Figure 2 labelled Sample E is believed to be due to excessive quantities of bacteria. Comparative tests for the bacteria population level were done against a known good filtering sugar, using a standard test done with a 3.0 µm membrane.

Sample E had a bacteria count greater than 100 compared to the good sugar which showed no bacteria presence.

Chemical optimisation

Several tests were done with anionic polymers to evaluate their effectiveness in syrup flotation. Raw evaporator syrup was obtained from Maidstone factory and was clarified in a pressurised flotation cell at the SMRI.

The test procedure followed was as follows:

- Two litres of syrup was heated to a temperature of 85°C with constant stirring.
- Air was bubbled in to a pressure of 5 kPa.
- Polymeric flocculants were then added at specific dosages and the mixtures were stirred for five minutes. The flocculants were prepared overnight to 0.1% solutions.
- At the end of five minutes, the mixtures were allowed to stand for 20 minutes for separation to occur. Twenty minutes is the typical average residence time for syrup clarification, based on data collected from SMRI consulting work on various syrup clarifiers.
- Samples were then taken and analysed for turbidity. Turbidity improvement is determined by comparing the turbidity of the treated sample with that of the untreated sample.

The performance of the flocculants is shown in Figure 3 below.

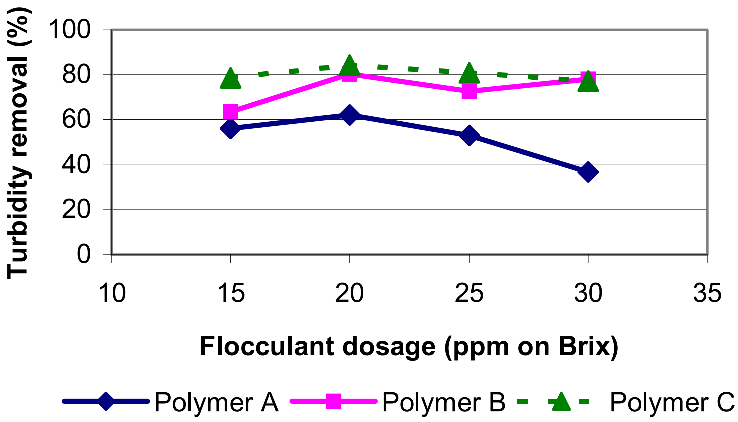

Figure 3. Turbidity removal with flocculant dosage for different type of flocculants.

The results show that Polymer C gives a superior turbidity removal over the other two flocculants. The results also show that turbidity steadily improves to the optimum dosage level of around 20 ppm on Brix, for all three flocculants, but falls sharply for Polymer A. The drop in efficiency is believed to be due to the liquor solution charge reversal as a result of an overdose of the anionic polymer. When the solution charge is reversed, air bubbles can no longer find sufficient sites to attach themselves on the floc, with the result that the floc cannot rise to the surface of the liquor where it could be removed as scum. The drop in efficiency is worst for Polymer A, which corresponds with a high degree of hydrolysis (charge) of 49% for this polymer, compared to the other two flocculants, both of which have a degree of hydrolysis of 20% (unpublished data[1]). These results show that if flocculant dosage can be maintained at an optimum level, turbidity removal of about 80% can be achieved and, as has been shown, this would imply a significant improvement in filterability.

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[1] Supplier Material Specification Data Sheets.

Clarifier design

In practice, it has been found that it is difficult to maintain high turbidity removal rates and it is believed that, among other aspects, poor aeration could be the leading cause of poor performance. Pilot plant studies with different types of nozzle designs are necessary and this is part of the future work plan. Simulation studies using technology such as computational fluid dynamics (CFD) modelling may also provide meaningful answers that would lead to improved clarifier designs.

Conclusions

The benefits of syrup clarification to sugar quality filterability are large and worthy of further consideration. Studies with various anionic polymers showed very large benefits for optimised flocculant dosage rates.

Suggested further work

- The study with optimisation of flocculants should be continued to confirm benefits. This should be followed by plant trials. Plant tests might produce a seasonal profile which will aid future polymer addition rate control.
- Clarifier design should be reviewed against latest technology advancements for better designs. A pilot clarifier could be designed based upon ideal principles.
- Further data needs to be collected to confirm that the improvement in syrup quality is reflected in an improvement in sugar filterability.

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