

Standard Liquor Filtration Using a Putsch Sibomat Filter

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ABSTRACT

Standard liquor filtration is typically accomplished using diatomaceous earth (filter aid) as the filtering medium. The Putsch Sibomat filter offers an alternative that does not require the use of filter aid. Rogers Sugar Ltd (Taber) initiated a test starting in the spring of 2003 with the objective to test the effectiveness of the Sibomat in terms of filtrate quality and filter capacity and to identify whether elimination of filter aid could be achieved. Standard liquor filtration at Taber consumes on average 2 kilograms of filter aid per tonne of sugar produced, at a campaign cost approaching \$100,000 Canadian. Elimination or major reduction in the filter aid consumption can produce an attractive economic payback. The Sibomat filter test unit supplied by Putsch was a full-scale assembly with only one filter basket. Fitted with a 55-micron screen element, it was installed in parallel with the factory's main filter station. Following testing during two juice campaigns and two beet campaigns, results to date indicate suitable beet campaign operation with significant filter aid savings, but unacceptable performance over both juice campaign periods. During the first juice campaign, filter aid contamination of the Sibomat feed contributed significantly to the poor results. Unfortunately, correction of this issue for the second juice campaign did not produce an acceptable improvement in filtrate quality. Very fine suspended matter in the stored thick juice could not be removed even after changing to a 33-micron screen element. After correcting a number of commissioning issues during the first beet campaign, the Sibomat handled up to 75% of the total juice flow (34 m³/hour average) producing suitable quality filtrate with acceptable cycle times (80 to 90 minutes). The consumption of filter aid was reduced by more than 50%. During the second beet campaign, intermittent performance issues were identified. This, plus higher average liquor flow, contributed to reduced filter aid savings. Although there is excellent potential for significant filter aid savings when using the Sibomat for beet campaign, current data suggests that total elimination of the diatomaceous earth filtration station cannot be recommended.

INTRODUCTION & OBJECTIVES

The Rogers Sugar factory in Taber utilizes three filtration steps: 1) first carbonation, 2) second carbonation and 3) standard liquor. Final filtration of the standard liquor is accomplished using Sparkler pressure leaf filters, with diatomaceous earth (filter aid) as the filtering media. These filters typically produce high quality filtrate on a consistent basis, but filter aid cost and operator input can be significant. An automated Sibomat filter system was tested on standard liquor at Taber as a possible replacement for the Sparkler station. These tests commenced during the thick juice campaign of May 2003 and have continued through two juice campaigns and two beet campaigns. This paper summarizes the operating experience during that period.

The operating trial was conducted with the following objectives in mind:

- Assess the Sibomat performance in terms of capacity, cycle time, and filtrate quality
- Determine if the Sibomat filter can replace the existing filters and eliminate filter aid
- Collect sufficient data to justify capital funding for a Sibomat filter station

EQUIPMENT DESCRIPTION

A typical Sibomat filter station consists of a bank of up to four individual filters, a fully automatic backwash system, and PLC instrumentation capable of controlling all four filters. Each filter has an advertised juice flow capacity of 30 to 40 m³/hr (130 - 175 gal/min) with an estimated cycle time between backwashes of 2 to 3 hours, using a 55-micron screen. A fully automatic cleaning cycle requires about 90 seconds and uses less than 0.05 m³ (12 gallons) of wash water. The filtering medium in each Sibomat filtration unit is a replaceable fine wire mesh screen. The cylindrical shaped filter basket is capable of accepting flexible screen liners of 77, 55 and 33-micron openings. The 77 or 55-micron screen is held in place by a cage inserted on the inner side and, on the outer side, by a fixed heavy gauge wire mesh cylinder welded to a frame. Sealing rings fitted top and bottom are designed to prevent bypassing of material from the unfiltered side to the filtered side. A single large O-ring seals the ends of the screen cylinder to the filter pressure vessel housing. Because of the very fine wire components, the 33-micron screen comes with an integrated backing screen that is brazed together for stability. Integrated U-cup elastomer seals on this screen mate with the O-ring to isolate the high and low-pressure side of the filter.

The test unit supplied to Roger Sugar Ltd (Taber) is a full-scale filter consisting of one filter canister, with controls and integral backwash systems capable of handling the full four-filter system. Expansion to a full station would require additional filter canisters and piping modifications. The Size 1 filter supplied to Rogers has a filtering area of 1 m².

Three filter screens were supplied for testing:

- 77-micron screen
- 55-micron screen
- 33-micron screen

A magnetic flow meter measures the liquor flow rate and totalizes flow to the filter station. Pressure switches initiate the backwash cycle based on pressure differential. Once initiated, the self-cleaning system of the Sibomat achieves a rapid cleaning of the screen lasting about 90 seconds. The self-contained washing pump produces pressures of 80 to 120 bar (1160 - 1740 psi) and appears to do an excellent cleaning of the filter mesh. Hot water (60°C minimum) from the factory condensate system was supplied to the high-pressure wash pump. In a multi-filter station, a single differential pressure switch activates a backwash cycle for the station. Each filter backwashes in sequence one at a time.

OVERVIEW OF TEST SET-UP

The Sibomat filter was installed in parallel with the existing Sparkler filter station to assess the Sibomat performance. Filtrate could be recycled to the unfiltered stream for re-filtration on the main filter station, or diverted to the filtrate stream if and when the filtrate quality became acceptable. The initial indicator of filtrate quality would be the suspended solids loading, but later, if suspended solids proved consistently acceptable, further testing of white sugar quality would be pursued.

A spare filter feed liquor pump was utilized as the Sibomat feed pump, while the main pump supplied the Sparkler pressure leaf filters. Suction and discharge piping was modified to supply the

Sibomat filter independently from the Sparkler feed and eliminate filter aid contamination to the Sibomat. A spare frequency drive was connected to the motor to obtain flexibility in flow and pressure output from the Sibomat feed pump. Unlike a multi-filter station, in this single-filter installation, juice flow was interrupted each time the backwash cycle operated. Therefore, each time the filter was returned to operation after a backwash, pressure bumps were noticeable. The variable frequency drive minimized the pressure bumps while maintaining a normal flow control at about 35 to 40 m³/hour.

For convenience, the Sibomat drain was directed to the local juice sump and recycled back to the upstream process. A permanent installation that would allow the drain to flow by gravity would be beneficial.

JUICE CAMPAIGN 2003 TEST RESULTS

The Sibomat filter came fitted with a 77-micron filter so testing commenced with this screen. After addressing some instrumentation issues during commissioning, the performance proved disappointing. The level of suspended solids in the filtrate was not acceptable with the 77-micron screen and the filter cycle time was in the order of only 5 minutes. Given that the neither the filtrate quality nor the filter cycle times achieved were remotely near to expected performance, the decision was made to focus on the improvement of filtration quality by installing a finer mesh screen.

A change to the 55-micron filter required about 30 minutes by two people. The next set of tests was equally disappointing. Two test cycles operated between 7 and 9 minutes, filtering less than 5 cubic meters of juice each. Filtrate quality did not improve.

To determine whether acceptable filtrate quality could be achieved at all, the finest 33-micron screen was installed. After less than a minute of operation, the differential pressure stopped the cycle. Less than one cubic meter of juice had passed through the filter. Filtrate quality remained unacceptable. Further testing was abandoned until some improvement in thick juice quality could be detected.

In all cases, the standard liquor solution filtered through the Sibomat originated from stored juice from the previous beet campaign. The average unfiltered liquor concentration was 70.8 brix. Stored thick juice is typically more difficult to filter than thick juice filtered directly during beet campaign. During the testing period referenced above, filtration was particularly poor as evidenced by Sparkler filter cycle times between 5 and 7 hours (20% of normal) and premature plugging of the upstream thick juice plate heat exchangers. Despite the high precipitate loading in the unfiltered liquor, Sparkler filtrate was acceptable throughout the period.

Following initial commissioning in early May, further Sibomat testing and data collection was conducted on May 21 and May 22, after thick juice quality had appeared to improve marginally. Results of these tests, all conducted with a 55-micron screen, are summarized as follows:

Test Identification	Initial Flow Rate (m ³ /hour)	Cycle Time (minutes)	Total Cycle Flow (m ³)	Average Flow Rate (m ³ /hour)
May 21, Test 1	44	10.0	7.2	43
May 21, Test 2	35	12.8	7.2	35
May 21, Test 3	42	12.0	8.4	42
May 22, Test 1	41	11.3	7.6	40
May 22, Test 2	40	12.0	7.7	39
May 22, Test 3	40	6.7	4.4	40
May 22, Test 4	40	10.2	6.7	40
May 22, Test 5	40	12.0	7.7	38

Filtrate quality continued to be poor with relatively high sediment loading. Filtration on a laboratory sediment pad was difficult and sometimes impossible to complete. Filtrate quality from the Sibomat was unsatisfactory even with the smallest filter mesh opening of 33 microns. All filtrate was recycled back to the Sparkler feed. The Sparkler filter using filter aid generally provided a superior liquor quality with brilliance and clarity absent in the Sibomat filtered samples.

During testing, the expected flow rate was achieved in the early part of the cycle, but the extremely short filtration cycle resulted in a filtration volume of only 4 to 8 cubic meter (1100 – 2200 US gal) before back washing was necessary. Cycle time was clearly unacceptable.

Further testing during beet campaign was deemed beneficial.

BEET CAMPAIGN 2003 RESULTS

The beet campaign experience started similar to where the juice campaign ended, but filter aid contamination was quickly identified as a major source of the performance problems. The Sibomat cannot tolerate filter aid, thus filtrate quality and cycle times were unacceptable during these initial trials.

The small volume of filter aid that accompanies the juice drained from each Sparkler prior to pressure washing the cloths, plus that which is present in the filter vents, was enough to contaminate the unfiltered tank and hence the Sibomat. For the duration of the Sibomat testing it was decided to re-direct all Sparkler drains and vents to the beet end. From that point forward the Sibomat performance improved dramatically, suggesting that filter aid contamination had contributed to the juice campaign problems.

During these initial beet campaign trials, Sibomat filtrate was recycled back to the unfiltered standard liquor stream for filtration at the Sparkler station. On October 13, after all Sparkler vents and drains had been re-piped, Sibomat cycle time improved to more than one hour and filtrate quality had improved to a level that appeared equal to that of the Sparkler filtrate. The Sibomat filtrate was directed to the white pans at this time, operating in parallel with the Sparklers for the remainder of campaign.

On October 15, the flow rate through the Sibomat was increased to about 35 m³/hour and all but one Sparkler filter was shut down. The Sibomat filtered about 65 to 70% of the total liquor flow with only one Sparkler filter in service until November 19th, when a second Sparkler filter was placed back into operation. While the Sibomat flow rate remained about the same at 35m³/hour, higher standard liquor flow rates reduced the Sibomat's contribution to about 50% of total flow. Average standard liquor concentration during the beet campaign was 71.9 brix.

The following table summarizes some of the specific tests conducted.

Test Identification	Initial Flow Rate (m ³ /hour)	Cycle Time (minutes)	Total Cycle Flow (m ³)	Average Flow Rate (m ³ /hour)
Oct 8, Test 1	34	10.0	5.3	32
Oct 8, Test 2	34	10.5	5.7	33
Oct 9, Test 1	34	9.0	5.0	33
Oct 10, Test 1	34	4.0	2.1	31
Oct 10, Test 2	34	3.5	2.0	34
Oct 10, Test 3	23	6.5	2.3	22
Oct 13, Test 1	22	95.0	32.0	20
Oct 13, Test 2	33	45.0	23.4	31
Oct 13, Test 3	42	48.5	32.7	40
Oct 17, Test 1	40	55.0	33.9	37
Oct 22, Test 1	36	72.5	41.4	34
Dec 1, Test 1	33	100.0	53.0	32
Dec 1, Test 2	38	100.0	61.5	37

The data clearly displays the performance improvement achieved immediately after eliminating the filter aid contamination on Oct 13. Filtrate quality remained acceptable throughout the operating period and no quality impacts were identified. No sugar sediment issues were noted while operating the Sibomat and microbiological tests on finished white sugar showed no difference compared with previous years.

A significant reduction in filter aid consumption was achieved once the Sibomat filter started delivering acceptable filtrate to the filtrate stream. By diverting 50 to 70% of the standard liquor through the Sibomat, fewer Sparkler filters were operated and Sparkler cycle time remained high. For the campaign period, filter aid consumption averaged 0.78 kg/tonne of sugar compared with a long-term average consumption of 2.0 kg/tonne.

The advertised 2 to 3 hour cycle times could not be achieved, even with very good juice quality. However, the short wash time and minimal wash water meant that the shorter cycles (1.0 to 1.5 hours) were not a major disadvantage.

JUICE CAMPAIGN 2004

Despite installation improvements that permanently corrected the filter aid contamination issue, juice campaign performance was again unacceptable. The absence of filter aid resulted in improved Sibomat cycle time, but acceptable filtrate quality was rarely achieved.

The Sibomat operated through juice campaign in a recycle mode, with all filtrate returned to the Sparkler filter feed for re-filtering. This allowed continued monitoring of cycle times and filtrate quality. Cycle time was similar to that achieved during beet campaign (1-1.5 hours), but filtrate quality was rarely acceptable. Average standard liquor concentration for the juice campaign was 70.0 brix.

Very fine suspended solids in stored thick juice could not be removed consistently in the Sibomat filter even with the finest 33-micron screen. However, the pre-filtration offered by the Sibomat station allowed longer Sparkler cycle times and slightly lower body feed volume. The combined effect was filter aid savings of approximately 0.6 kg/tonne of sugar (one-half the beet campaign savings).

BEET CAMPAIGN 2004

Similar to the previous beet campaign, the Sibomat performance was generally acceptable, but results were less consistent than the previous year. On a number of occasions, the Sibomat cycle times were dramatically reduced to less than 15 minutes and/or the filtrate quality deteriorated. The former was sometimes related to issues with hot water supply to the high-pressure backwash system (pressure and/or quality). Short cycles often occurred concurrent with filtrate quality issues and in some cases this could be correlated back to juice purification system upsets.

It became more evident this campaign that upsets causing high sediment in first carbonation filtrate had direct impact on the Sibomat performance. Whenever an upset at the first carbonation station was experienced, the filtrate quality and/or cycle time deteriorated. In some instances, consistent second carbonation filtrate did not appear to compensate for problems at first carbonation. First carbonation filtrate suspended solids averaged between 20 and 30 ppm for most campaign weeks, with excursions to more than 100 ppm on some days later in campaign. Second carbonation filtrate averaged 10 to 12 ppm most campaign days, with the worst day still less than 25 ppm. In some cases a specific first carbonation upset could be identified while in other cases correlation was more difficult. In each case, the Sparkler filter station operated without incident during these periods.

When filtrate quality became an issue, the filter was immediately switched to recycle mode and an extra Sparkler was placed into service. Routine filtrate quality monitoring determined when the filter could be returned to service.

Interestingly, we also experienced periods when Sparkler cycle time became extremely poor, while the Sibomat continued to operate without problem handling up to 70% of the total standard liquor flow. It was immediately obvious that juice quality could not be the cause of poor Sparkler

performance. In each case, equipment malfunctions were quickly identified and corrected. The Sibomat was able to maintain factory throughput during these times.

Due to the higher syrup flows during the 2004 beet campaign, a minimum of two Sparkler filters were necessary. At a flow rate of about 35 to 38 m³/hr, the Sibomat handled 50% or more of the standard liquor flow. However, one Sparkler alone could not handle the other 50%. Intermittent issues with the Sibomat operation required that a third Sparkler be added occasionally. Filter aid consumption was higher this campaign due to the need to operate two or three Sparklers. A second Sibomat filter canister would have lowered filter aid consumption further by reducing the number of Sparklers to one. Standard liquor concentration averaged 72.0 brix for the beet campaign.

FILTRATE QUALITY

Except during periods of purification system upsets, the Sibomat was capable of delivering acceptable filtrate quality. No difference in sugar quality could be identified when comparing the periods of time when the Sibomat was in operation and when it was bypassed. Upsets at the purification station could be linked to both Sibomat operating problems and higher white sugar turbidity. During normal operation no difference in turbidity was identified.

Superior microbiological results were achieved from the Sparkler station as compared with the Sibomat. However, all but two samples of filtrate from the Sibomat had a total microbial count less than the specification for white sugar quality. The two higher values both occurred during periods when upstream process upsets caused higher filtrate sediment and performance issues at the Sibomat. All white sugar microbiological levels were well within specification throughout campaign whether or not the Sibomat was in operation. No difference in the white sugar micro results were identified when comparing the past two beet campaigns with years prior to the Sibomat testing.

During juice campaign, the microbiological counts were considerably higher in the thick juice returned from storage. Again the microbial levels were higher from the Sibomat, compared with the Sparkler filtrate, but very little data is available for these periods. Also, because no Sibomat filtrate could be directed to the white pans, white sugar comparison data is not available for the juice campaign scenario.

OBSERVATIONS

Rogers Sugar experience with the Sibomat filter on standard liquor can be summarized in the following observations:

Juice Campaign

- Juice campaign conditions at Rogers Sugar were unsuitable for Sibomat use because the thick juice contains a higher volume of very fine suspended matter that could not be removed.
- Limited microbiological data for Sibomat filtrate is available.
- No white sugar data related to the Sibomat operation is available for juice campaign because filtrate quality was generally unsuitable for direct crystallization.

Beet Campaign

- The Sibomat provided excellent savings in filter aid cost by removing load from the Sparkler station when consistent high quality thin juice is available from the beet end of the factory.
- Low quality first carbonation filtrate can impact the Sibomat filter's ability to supply suitable quality standard liquor filtrate.
- During beet campaign, the Sibomat displayed total microbial plate counts in filtrate well within the limits for white sugar quality under normal operating conditions.

General Observations

- The Sibomat filter is a well-built unit capable of filtering high-density syrups up to 72 brix.
- The Sibomat filter cannot tolerate any amount of filter aid; any installation operating both types of filtration equipment must be designed to ensure no filter aid contamination of the Sibomat inlet stream.
- Sibomat flow rates matched the manufacturer's specifications with the 55-micron screen.
- Cycle time is lower than the manufacturer's specification, but the achieved 100-minute cycle was acceptable given the short backwash time and low backwash volume.
- The effectiveness of particulate removal is determined by the screen opening specification and thus is typically not as effective as filter aid filtration.
- The finer 33-micron screen could not provide acceptable cycle times at the flow rate desired nor acceptable filtrate quality under all operating conditions.
- The Sparkler filters provided superior filtrate quality under a wider range of input juice conditions.
- The Sparkler filters provide superior microbiological performance.

CONCLUSIONS

The Sibomat station could not replace the existing filter aid based filter station due its inability to handle an acceptable variety of thick juice qualities. In particular, thick juice from storage can vary considerably from one year to the next. It is critical that the standard liquor filter station be capable of adapting to the variety of juice conditions.

The Sibomat station can provide excellent savings in filter aid cost during beet campaign when thin juice quality is normal and consistent. Under these conditions, the filter aid system could be shutdown if a full-capacity Sibomat station were available.

The Sibomat filter was tested only for standard liquor filtration in Taber, but it can be suitable for a variety of syrup filtration applications within the factory. In some factories the Sibomat is used to filter thick juice, melt liquors, or other syrups in various process configurations. Such schemes could provide quality improvement or cost reduction in the right application.