THE APPLICATION OF A LINEAR BELT FILTER FOR CUSH-CUSH REMOVAL FROM MILL MIXED JUICE AT MAIDSTONE

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Abstract

A Linear Belt Filter was installed to replace the existing cush-cush removal equipment on the milling tandem at Maidstone. The Linear Belt Filter consists of a feed box under which runs a continuous filter cloth and the screen frame. The filtered juice falls by gravity into a juice collecting box and is pumped to the juice scales. The cush-cush is carried on the screen to the discharge end of the filter and is squeezed by a spring-loaded small diameter roller before falling into a screw conveyor leading to the discharge of the first mill. Results of performance tests as well as operating procedures and problems are discussed.

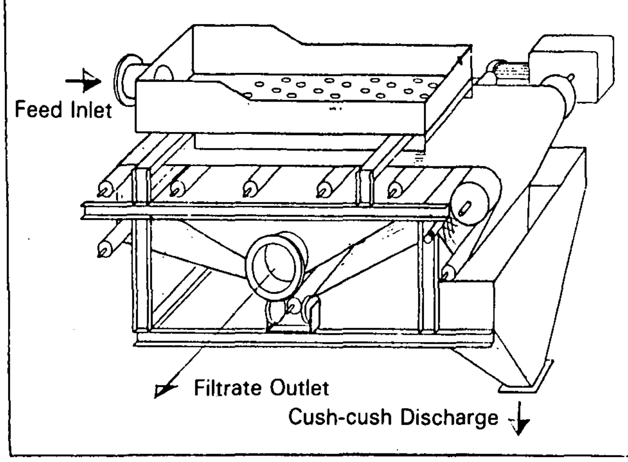
Introduction

Cush-cush separation from the juice of the milling tandem at Maidstone was previously effected in two stages: by a perforated deck cush-cush slat conveyor for coarse removal, followed by vibrating woven wire screens for removal of the finer particles. This combination was costly to maintain, poor in mechanical reliability and unhygienic, with high lactic acid levels resulting from micro-organism growth in various parts of the system. In seeking a simple alternative, the equipment most commonly used in South Africa (DSM screens) was rejected due to limited headroom and an alternative was sought.

General Description

A schematic drawing of the unit is shown in Figure 1.

FIGURE 1 LINEAR BELT FILTER



The Delkor Linear Belt Filter (LBF) had proved itself in the gold industry for filtering wood fibre from cyanide solution, as described by Minson.[4] This application is similar to that of cush-cush separation, and pilot plant trials were therefore conducted at Maidstone. Trial results were extremely encouraging and a full-scale plant was ordered for the start of the 1988/89 season. Various modifications were required to suit the sugar mill juice screening duty. These included:

- a small diameter roller was fitted to further dewater the cush-cush
- a scraper was installed to assist the removal of cush-cush from the cloth
- the distributor plate design required modification to reduce the possibility of bagasse buildup and blockages
- the drip tray was modified to ensure that cloth washings were separate from the cush-cush discharge.

The LBF comprises a coarse monofilament cloth, supported on rollers, and is driven by a head pulley coupled via a variable speed gearbox to a fixed speed drive unit. Mill mixed juice is pumped into the feed box and passes through tear-drop shaped holes in the distributor plates and onto the moving cloth. The cloth speed is manually controlled from 0,25 - 1,0 m/s depending upon the load and filtering characteristics of the juice being processed. Pilot plant results indicated that the screen would cope with ± 40 tons of mixed juice per hour per m^2 of cloth but in practice this figure was ± 25 t/h/m^2.

The juice filters through the cloth by gravity and is collected in the juice tray with the cush-cush being trapped on the top surface of the cloth. The cush-cush is dewatered to about 80% moisture by the sprung roller and is then scraped from the belt at the drive pulley into a screw conveyor which returns it to the first mill discharge. The belt returns via an automatic tracking system and a dynamic tensioner to the cloth wash zone and then to the feed area. Cloth wash water is returned to the final mill feed as imbibition. The integration of the LBF into the process is shown in Figure 2.

Distributor plate design

The distributor plate was designed to minimise the buildup of bagasse in the openings. The number of openings in the centre of the plate was reduced to ensure the spread of feed across the full width of screen cloth. Details of the distributor plate are shown in Figure 3. The feed box consists of three of these plates bolted to the filter frame adjacent to each other. Feed to each of the three sections is controlled by adjustable weirs.

Cloth Type

A simple weave monofilament polyropylene cloth is used as the filtering medium. Two cloths of different apertures, 400 μm and 350 μm, were used during the 1988 season. Tests on the pilot plant during the previous season showed the 350 μm cloth to give very good results, although the capacity of the plant was reduced. This proved to be the case of full scale plant and the filter overflowed frequently with the smaller aperture cloth, especially when very sandy cane was crushed.

Unit Evaluation

Performance tests were carried out during the 1988 season to evaluate the screen and compare the results with those of the old equipment taken during the previous season.

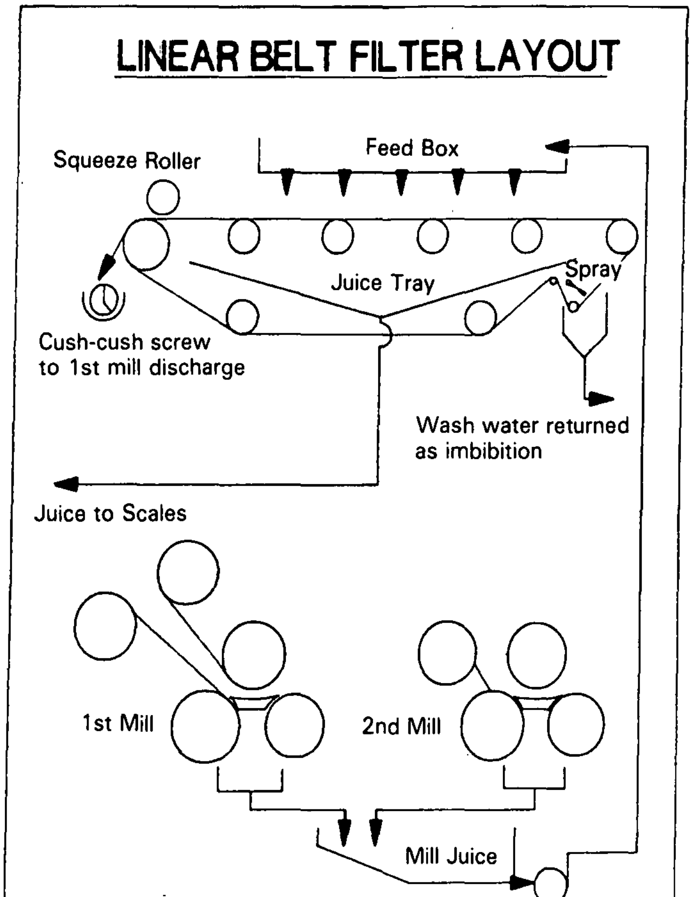


FIGURE 2

Test procedure

Four catch samples of feed to the screen, filtrate and cush-cush were taken and composited over a one hour period. Feed and filtrate were analysed for total insoluble solids, bagacillo % and mud solids %. Cush-cush was analysed for moisture %. All analyses were carried out in accordance with the procedures prescribed in the Laboratory Manual for South African Sugar Factories.

Results and Discussion

A summary of results is shown in Tables 1-4. Removal efficiency % is calculated as follows:—

Removal efficiency %

$$= \frac{(\text{bagacillo \% feed} - \text{bagacillo \% filtrate}) \times 100}{\text{bagacillo \% feed}}$$

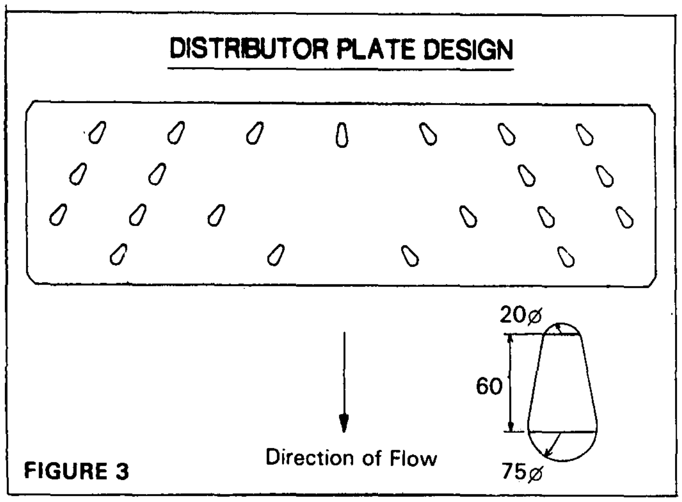


FIGURE 3

Table 1

LBF cloth type: 0,35 mm screen TEST NO. 1 Date: (23/06/88)

	% Bagacillo			% Total Insol.	
	Feed	Filtrate	Removal efficiency %	Feed	Filtrate
No of Runs	6	6	6	6	6
Maximum	0,61	0,10	88,89	0,99	0,38
Minimum	0,51	0,06	82,35	0,78	0,29
Average	0,57	0,08	86,18	0,89	0,35

Table 2

LBF cloth type: 0,4 mm screen TEST NO. 2 Date: (11/07/88-15/07/88)

	% Bagacillo			% Total Insol.	
	Feed	Filtrate	Removal efficiency %	Feed	Filtrate
No of Runs	6	6	6	6	6
Maximum	0,51	0,19	82,98	0,99	0,74
Minimum	0,28	0,08	53,66	0,81	0,48
Average	0,40	0,12	69,83	0,89	0,57

Table 3

LBF cloth type: 0,4 mm screen TEST NO. 3 Date: (15/07/88-22/07/08)

	% Bagacillo			% Total Insol.	
	Feed	Filtrate	Removal efficiency %	Feed	Filtrate
No of Runs	6	6	6	6	6
Maximum	0,69	0,12	92,31	1,31	0,60
Minimum	0,39	0,03	74,47	0,81	0,45
Average	0,52	0,08	85,73	0,92	0,52

Table 4

LBF cloth type: 0,4 mm screen TEST NO. 4 Date: (25/07/88-28/07/88)

	% Bagacillo			% Total Insol.	
	Feed	Filtrate	Removal efficiency %	Feed	Filtrate
No of Runs	6	6	6	6	6
Maximum	0,56	0,09	92,86	0,90	0,54
Minimum	0,31	0,04	80,00	0,71	0,32
Average	0,44	0,07	84,45	0,81	0,45

Tests done on the old equipment at Maidstone during the previous season showed the removal efficiency to be 76%. Lionnet[3] quoted figures of between 80% and 91% for DSM screens at Darnall in 1979, and Bachan[1] reported a figure of 73,9% for Gledhow rotary juice screens in 1984. In 1981 Bickle and Webster[2] quoted figures of between 77% and 86% removal efficiency for the rotary screens at the Pioneer Mill in Australia which had screen apertures of 0,8 mm and 0,5 mm.

As can be seen from Table 2 a low removal efficiency was obtained in the second series of tests. There was no apparent reason for this although the size distribution of the fine bagacillo seems to be the most likely cause. During this series of tests the full area of the distribution plate was being used which may have resulted in poorer filtering, as no mat of bagacillo was built up on the cloth to assist the separation. After modifications to the distributor plate area the figures improved to between 80 and 86%, which compare favourably with the figures quoted above.

Problems experienced in the operation of the Linear Belt Filter

Installation and commissioning of the Linear Belt Filter was relatively trouble-free. However, after two weeks the screen began overflowing back from the squeeze roller and caused cush-cush to be washed into the filtrate collection box. This caused blockages in the juice scale and juice heaters. At first it was thought that this problem was caused by high levels of sand in the juice which blinded the screen. The juice feed arrangement was changed to try to eliminate this binding, but did not solve the problem.

It was noticed that the screen performance deteriorated as the weeks progressed and close examination of the screen revealed a waxy/slimy build-up on the under-surface. Steam sprays were installed and biocide dosage was investigated. The steam sprays were opened twice per shift for about 5 minutes, but biocide dosage was ruled out because of the high cost. There was little noticeable improvement with steam spraying. Rubber skirts were then fitted to the sides of the screen to try to prevent the overflows, but the pressure of the juice lifted them whenever the screen choked and intermittent blockages of the juice scale and heaters continued. A section of the skirting was then removed and an overflow gutter was welded on the side of the screen to direct any overflows back to the mixed juice collection tank. This arrangement is shown in Figure 4.

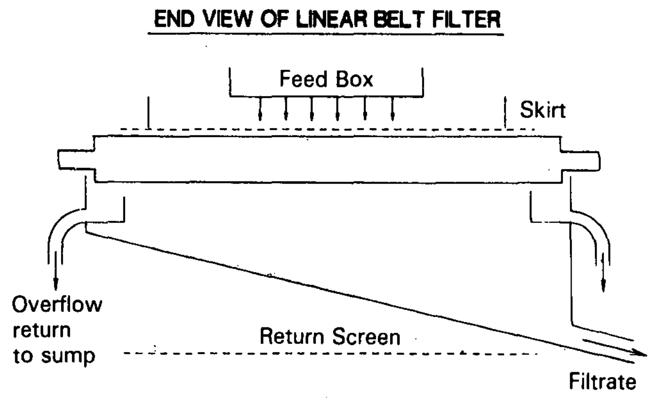


FIGURE 4

This solved the juice scale and heater blockage problem but not the cause of the problem.

Finally it was decided to change the cloth every two weeks to dry out, and to wash the spare on a regular basis. The changing of the cloth is a simple task and takes less than thirty minutes. Since this procedure has been adopted, very few overflows have occurred and the operation of the screen has been trouble-free.

Comparison of Maintenance Costs

Maintenance costs for the LBF proved to be far lower than those of the old equipment used the previous season as shown in Table 5.

Maintenance labour requirements were also much improved, with an estimated saving of 3 × B5 Maintenance Worker days per week which is equivalent to about R500 per week.

Table 5

Comparison of annual maintenance costs of cush-cush screens vs linear belt filter

Cush-cush and vibrating screen maintenance costs: 1987/88 season	
Cush-cush chain	4 200
Cush-cush slats	1 700
Cush-cush screens	3 500
Cush-cush drive (belts, bearings, etc.)	700
Vibrating screens (57 off)	11 115
Vibrator frames (2 off per year)	1 500
Vibrator motors (rewind 1 off yearly)	300
	R23 015
Linear Belt Filter maintenance costs: 1988/89 season	
Filter cloth (replace damaged spare)	6 800
Bearings and seals	400
Off-crop maintenance (full set bearings & seals)	800
	R8 000

Comparison of installation costs

A 9m² LBF equivalent to the one installed at Maidstone to handle 200 tons of juice per hour would cost approximately R115 000. To do the same duty four 2m² DSM screens would be needed at roughly R24 800 each. Both the above prices are for 3Cr12 frames.

Advantages of the Linear Belt Filter

Compared with the previously used vibrating screens, the linear belt filter provides:

- Lower power consumption
- Better screening efficiency, with up to 92% removal of bagacillo from mill juice
- No vibration and hence lower maintenance costs
- Quick change of filter cloth
- Continuous operation and high plant availability
- Low noise levels
- Reduced space requirement.

Conclusions

The Delkor Linear Belt has proved itself to be reliable and efficient for cush-cush removal from juice. Its simple trouble-free operation makes it an attractive alternative to the more traditional gravity screens, vibrating screens and rotary screens.

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