MUD FILTRATION

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Abstract

The main application of filtration in the raw sugar industry is for the treatment of clarifier mud. This unit operation has seen many developments, particularly in terms of equipment in other industries. This has, however, not been the case in the South African cane industry, mainly because of the relatively low levels of sucrose losses during this process and because of the availability of filters as diffusion replaced milling. These points and other relevant aspects of this process are considered in this review.

Keywords: Filters, Review

Historical background

A brief review of the literature shows that the continuous rotary vacuum filter was introduced to the sugar industry in 1935. The Proceedings of the 1934 Hawaiian Sugar Planters' Association note that an Oliver rotary filter had just been installed in one factory. One unit was bought in Trinidad (8 x 12 feet) and one in Formosa, in 1935. In 1936, Fiji reported that this filter was so satisfactory that two more (made in Australia) were being ordered. In 1939, 90% of the mills in Hawaii had rotary vacuum filters.

Filtration has been investigated in what could be called an on/off fashion over the period 1960 to 1990. A brief review of the literature shows the patterns given in Table 1, where each letter stands for one publication. Most of the readily available work seems to have been done in Australia (1970-71, 1982-86) and in South Africa (1974-75, 1984-85).

Table 1

Investigations into the filtration of cane muds with rotary vacuum filters

Period	0	1	2	3	4	5	6	7	8	9
Decade 1960-1969	P				U	AII		H		
Decade 1970-1979	AA	AAR	A		RR	R		A		A
Decade 1980-1989			A	A	AARR	R	A			R

A: Australia
I: India
P: Phillipines
U: USA
R: RSA
H: Hawaii

Typical installation

A typical rotary vacuum filter is shown in Figure 1, and a South African filter station is shown schematically in Figure 2. Apart from the use of newer flocculants, there is very little that can be considered as new technology.

Installed filtration area per ton of cane per hour, in southern Africa is shown in Table 2. The reduced filter requirement with cane diffusion is clearly evident in South Africa. It would appear that the installed capacity is somewhat higher than in neighbouring countries. This could possibly be due to two factors. Factories converting from milling to diffusion could have kept extra filters and secondly, many filters could be fairly old, thus requiring stand-by units. Some basic recommended operational parameters are shown in Table 3.

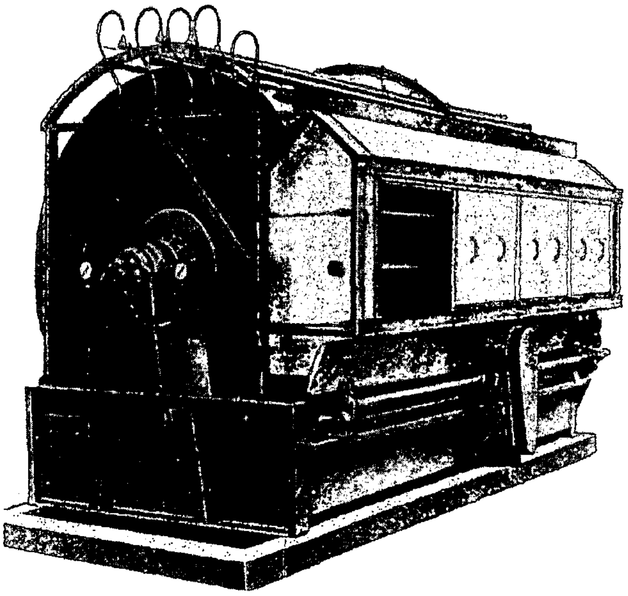

FIGURE 1: Typical rotary vacuum filter.

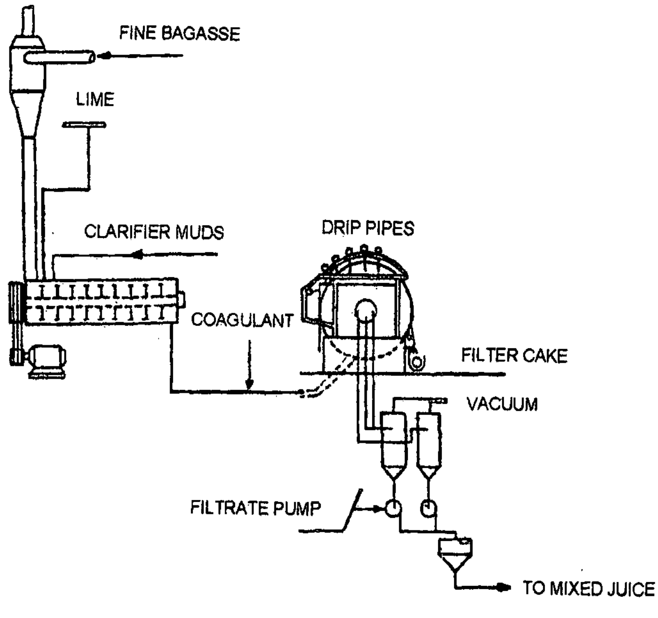

FIGURE 2: Schematic arrangement of a typical filter station.

Table 2

Installed filtration area (m²/TCH) for rotary vacuum filters

Industry	m²/TCH	Milling (M)/Diffusion (D)
South Africa	0,50	D
	0,66	M
Swaziland	0,46	M & D
Zimbabwe	0,26	D
Malawi	0,36	D
Reunion	0,54	M & D
Mauritius	0,39	M

Table 3
Recommended operational parameters

Pickup vacuum	20 kPa
High vacuum	60 kPa
Wash water temperature	>75°C
Brix of filtrate	8 – 9
pH of feed	7,3 – 7,5

Optimisation work

Investigations were done in the mid-eighties in South Africa to optimise filter operation. Two concepts, based on general filtration theory, were shown to apply to cane mud filtration. The specific cake resistance (α) which applies to rate of filtration and the filtration efficiency (e) which deals with filtrate quality were used to measure and improve the performance of filters. It was found that α and e are related, as shown by Equation 1:

$$e = a - b \times \alpha \qquad (1)$$

where a and b are positive constants. Decreasing the specific cake resistance thus improves the efficiency. Experimental work with South African muds showed that it is possible to condition the mud, as shown in Table 4. Generally the addition of the correct quantity of bagacillo is the most important single factor with respect to mud conditioning. A bagacillo ratio (mass dry bagacillo/mass dry mud solids) of above 80% is usually required with South African muds. The quality of bagacillo, in terms of its particle size, has an effect on the efficiency of the filtration in terms of the retention of suspended particles. Higher efficiencies and thus lower levels of suspended solids in the filtrate are obtained with the finer bagacillo. Good mud conditioning would decrease α to about $0,4*10^{11}$ mkg^{-1} and the efficiency would be about 90%. This approach has been found to work well industrially.

Table 4
Mud conditioning

Mud %	Mud solids %	Bagacillo	pH	Flocculant ppm	α	Suspended solids % filtrate
Untreated	5,3	0	6,9	0	$6,0*10^{11}$	1,3
Conditioned mud	3,3	3	7,4	4	$0,4*10^{11}$	0,1

Results from the South African industry

The performance of South African filter stations can be gauged through a number of parameters. The sucrose lost in the filtercake, expressed as a percentage of the sucrose in the cane, has always been seen as an important indicator of performance. Results for the past 25 seasons are shown in Figure 3. It is evident that there has been a marked decrease, starting in the late nineteen-sixties. The loss has been halved over the period 1970 to 1995 to just above 0,2%. Both the quantity and the quality of the cake can influence the results seen in Figure 3. The trends in the quantity of cake are shown in Figure 4.

It is evident that the quantity of cake has decreased over the past 15 seasons. There is no doubt that the use of diffusion has an effect on the quantity of cake produced. The data also show the effect of drought on the quantity of cake, with marked increases in the 1983/84 season and over the past drought seasons.

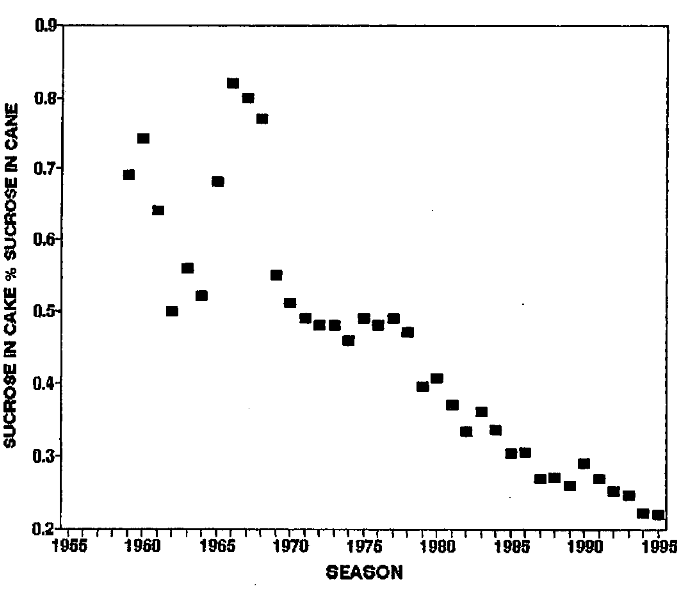

FIGURE 3: Sucrose lost in cake % sucrose in cane, South African industry.

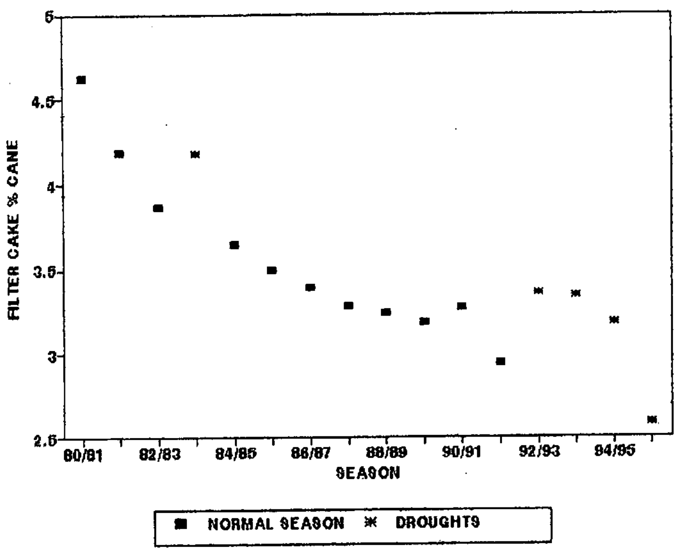

FIGURE 4: Filtercake % cane for the South African industry.

The trends in pol % cake are shown in Figure 5. Although there is some evidence of a decreasing trend, it would appear that the drop in quantity has been more significant with respect to the lower sucrose losses.

Table 5
Lactic acid (ppm on brix) in the clarification/filter stations

Surveys	Mixed juice	Limed juice	Clear juice	Mud	Filter feed	Filtrate
1	400	–	600	–	–	700
2	–	295	370	405	365	585
3	510	520	560	500	650	1200
4	445	435	460	455	935	1250
5	410	570	460	–	1190	27500

Filtrate quality does not usually receive the attention that it deserves. It has been shown that severe sucrose losses can take place in filter stations, particularly through microbiological activity. This can be measured by analysing for lactic acid. The results of a number of surveys done by the Sugar Milling Research Institute are given in Table 5.

Generally, the mixed and limed juices contain about 500 ppm of lactic acid on brix. Large increases can take place in the filter station, as seen in Surveys 3, 4 and 5. It is accepted that 1 ppm of lactic acid represents a loss of about 4 ppm of sucrose which indicates high sucrose losses in the last three surveys. It should also be noted that lactates are highly melassigenic.

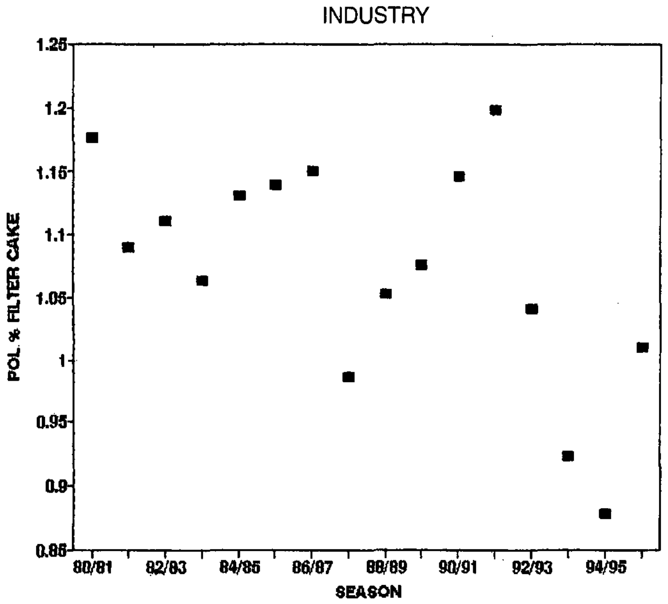

FIGURE 5: Pol % cake for the South African industry.

The difference in purity between clear juice and filtrate gives an indication of filtrate quality. This parameter is shown in Figure 6. Although there has been an improvement, it is believed that this difference should be less than 1 unit. Filtrate quality, in terms of sucrose losses and in terms of suspended solids, would be areas for improvement.

Future developments

Horizontal vacuum belt filters

This type of filter has been investigated for cane mud filtration and is successful for the dewatering of smuts. These filters could well replace ageing rotary filters.

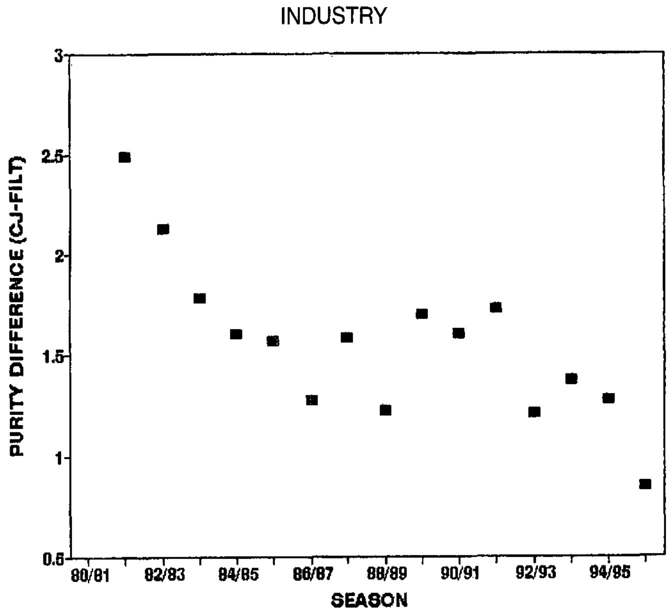

FIGURE 6: Apparent purity difference between clear juice and filtrate, South African industry.

Filtrate quality

As mentioned above, this is an area where improvements are necessary. The final aim here should be to produce filtrate that could be routed to clear juice.

Control and automation

Recent work done at Noodsberg shows that it is possible to improve the performance of existing filter stations through equipment design, control of the operation and a degree of automation. This approach should be encouraged.

Solid bowl centrifuges

This type of equipment has been investigated extensively in Australia and recently in India. This recent work has produced interesting results.

New technologies

Membrane based processes are becoming more of a reality in the sugar industry. It could be that a completely new clarification process, based on membrane technology, would eliminate filtration as it is now done.