MODIFICATIONS TO AND EXPERIENCES WITH RAPIDORR CLARIFIERS INCLUDING SACCHARATE LIMING AT AMATIKULU

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Abstract

Brief descriptions of these modifications are given. Benefits from improved juice handling capabilities include halving the number of clarifiers in service, using 1,38 cu m/TCH instead of 2,75 cu m/TCH settling volume, reducing juice retention to one hour and improving filter station performance, resulting in clear juice/filtrate purity differences of less than 1,5 units.

Saccharate liming has proven benefits for visual clarity of clear juice through significant turbidity reduction. Extensive plant trials at Amatikulu confirmed these observations but, in the main, found that these improvements were not carried through to syrup and final product sugar. The marginal benefit and the process difficulties involved, particularly from voluminuous, slow settling muds resulted in the discontinuation of this procedure at Amatikulu.

Introduction

The Amatikulu Mill commenced operations at its present site in 1965 designed for 225 tons cane per hour. Over the years technology developments and expansion projects have allowed the rated milling and process plant capacity to be increased to 385 tons cane per hour. In general, this increased capability has come about through the injection of capital equipment. The installation of a cane diffuser, increased vacuum pan capacity and continuous centrifugals spring readily to mind as examples.

One area that has not undergone any expansion of installed plant is that of the clarification and filter station. Although the solids loading on this station was reduced substantially by the conversion from milling to diffusion and by improvements in flocculant technology, these benefits were only realised initially at Amatikulu in relation to the filter station. Prior to 1983, all four Rapidorr clarifiers of 7,3 metre diameter and 265 cubic metre capacity each had to be in continuous use in order to handle approximately 480 cu m mixed juice per hour or 120 cu m/hr per clarifier.

This gave rise to some serious concerns particularly in the area of juice and mud retention time, purity drops and boiling house recovery.

Table 1

Process Results 1979–1982

Year	Tons cane /hour	Clarifier capacity cu m/TCH	Juice retention (hours)	Purity Difference CJ – MJ	Purity Difference CJ – Filtrate	Clarifiers in use
1979	368	2,88	2,17	−0,51	2,76	4
1980	347	3,05	2,30	−0,60	2,59	4
1981	354	2,99	2,25	−0,73	3,94	4
1982	342	3,10	2,44	−0,74	5,31	4

Modifications to Equipment

Many improvements[1] have been suggested over the years to enhance the juice handling capabilities of Rapidorr clarifiers and a number of these concepts were incorporated into the Amatikulu Rapidorrs. These are briefly outlined below.

Clarifier Juice Off-takes

The clear juice internal off-takes were modified to form two semi-circular 100 mm N.B. rings in each compartment with 28 equally spaced nozzles of 25 mm diameter. The nozzles consisted of stainless steel washers, welded alternately to top and bottom of the pipe. Not only did this allow uniform juice withdrawal from each compartment but it also eliminated blocking from solids build up in the pipe and nozzles.

Juice Inlet Baffle

The "penny whistle" juice inlets to the clarifier were modified by incorporating a horizontal baffle plate to prevent disturbance of the descending mud by the incoming juice.

Air/Incondensible Gas Venting

The above modifications allowed the number of clarifiers in use to be reduced at times from four to three. It was not

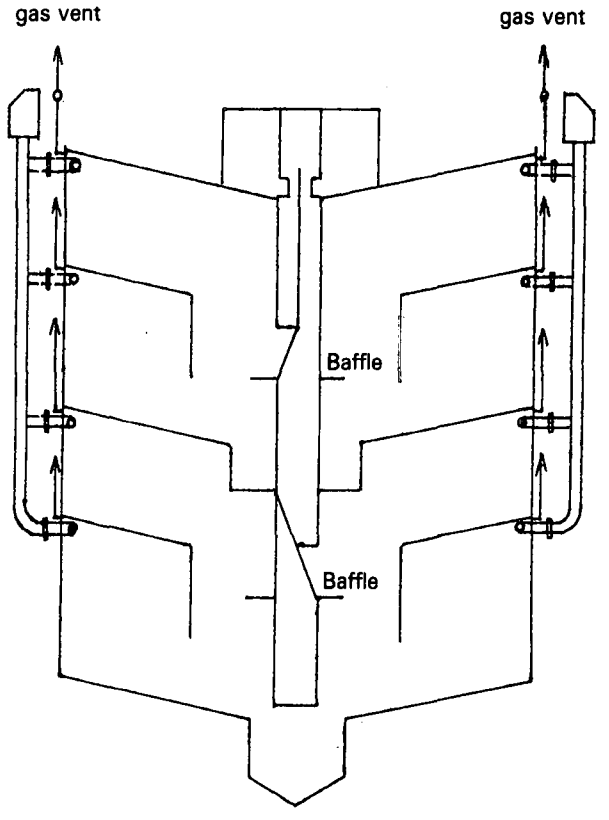

FIGURE 1 Amatikulu Rapidorr Modifications.

until the single vent per tray of 25 mm was removed and three vents of 50 mm spaced at 120° to the clarifier periphery were installed in each of the four compartments, that the major breakthrough was made.

Mud Withdrawal

The Oliver Filter station, in common with many South African factories, had been automated by 1980 with mud trough level control on the individual filters and level control of the mud mixer linked to the clarifier mud pumps.

The removal of the maintenance intensive diaphragm mud pumps did not occur until the 1986/87 campaign as a result of the unfavourable height position of the filters relative to the clarifiers.

This drawback was overcome eventually by installing a semi-pressurised mud withdrawal piping system to the mud mixer (Figure 2). Despite initial misgivings as to the control scheme, it has been totally successful, easy to control and inexpensive as only one mud withdrawal control valve was installed. Essential to the system are temperature indicators and mud compartment level sample points on each compartment, withdrawal pipes which can be individually throttled and mud consistency sample points on the same pipes.

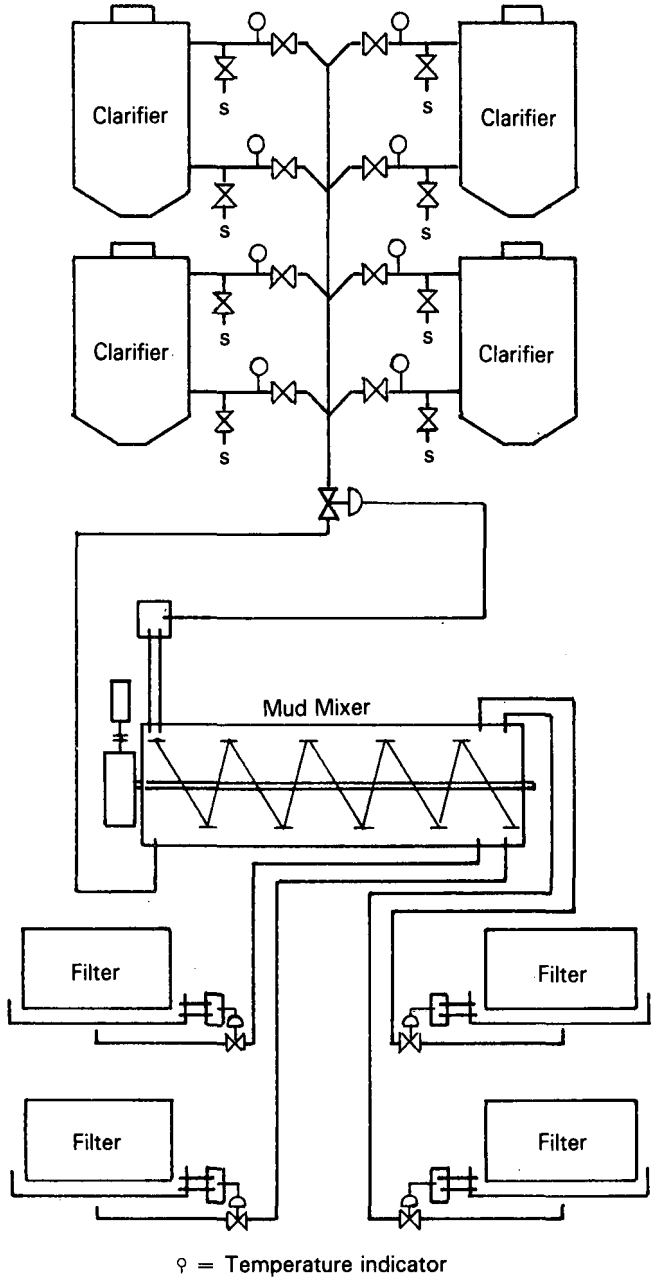

FIGURE 2 Schematic Representation of Clarifier and Filter Station.

Process Benefits

Table 2

Process Results 1982-1987

Year	Tons cane /hour	Clarifier capacity cu m/TCH	Juice retention (hours)	Purity Difference CJ – MJ	Purity Difference CJ – Filtrate	Clarifiers in use
1982	342	3,10	2,44	−0,74	5,31	4
1983	310	2,56	1,95	−0,53	1,36	3
1984	373	1,42	1,08	−0,63	1,48	2
1985	364	1,46	1,08	0,26	1,32	2
1986	331	1,60	1,15	0,00	0,41	2
1987	352	1,50	1,09	−0,50	1,28	2

The spin off from these alterations has been substantial to the process although not always directly quantifiable. The results show that juice retention time has been reduced from well over two hours to average 1,1 hours since 1984. Utilised clarifier capacity at 1,5 cu m/TCH compares favourably with the design yardstick for conventional clarifiers of ± 2,0 cu m/TCH and trayless "rapid" clarifiers where ± 1,0 cu m/TCH is utilised. The benefits in terms of purity differences between mixed juice, clear juice and filtrate are evident. There are also hidden benefits as it is well accepted that juice and mud retention times should be as short as possible for good process performance.

Hygiene and high mud and wash water temperatures in the filter station play their part in order to prevent microbiological degradation of sucrose. To this end, extensive use of lagging has been made on mud piping and filter troughs. Mud level in the clarifier is kept to an absolute minimum. Furthermore, it has been possible to maintain two clarifiers in service at high tonnages (410 TCH and 550 TJH) for prolonged periods with flocculant dosage at acceptable levels of 2,5–4 ppm on mixed juice. Juices were well clarified and without particle carry-over.

Saccharate Liming Trials

Not withstanding these improvements, Amatikulu still suffers from periodic occurrences of sugar outside VHP colour specification. Although this is not an uncommon occurrence in diffuser factories, process management must endeavour at all times to produce the highest possible grade sugar commensurate with equipment limitations and sucrose recovery demands. A fully automated saccharate liming system was installed in late 1982 with the object of determining its effect on final product sugar at Amatikulu. North-Coombes *et al*[2] had shown that saccharate liming offered improvements in visual appearance of clear juice which was borne out by significant reductions in turbidity. A 7 : 1 ratio of evaporator syrup to milk of lime was advocated.

The Pongola trials[2] advised that the addition point for the saccharate should be at intermediate juice temperature. Amatikulu used the hot defecation milk of lime (M-O-L) process and this was to be compared to saccharate liming with the saccharate introduced into the suction of the pump used to convey the juice from the juice scales to the heaters. This diffuser juice was at ± 65°C and was thought to be comparable to the intermediate stage advocated.

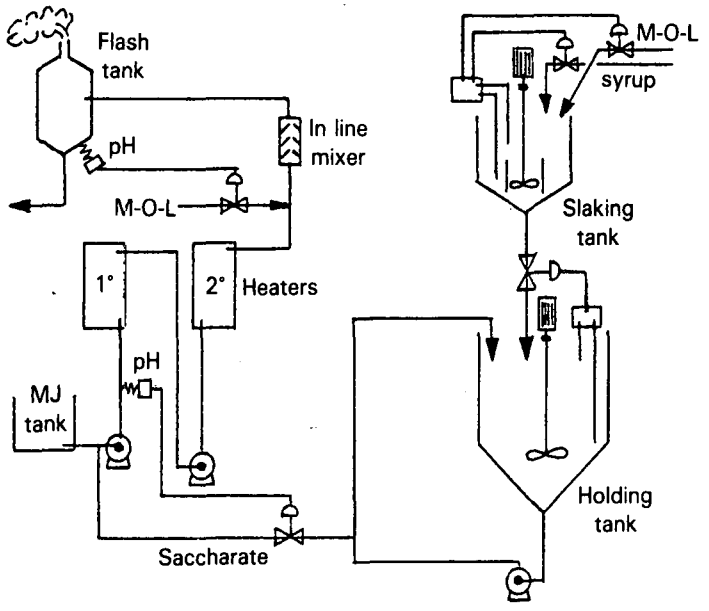

FIGURE 3 Saccharate or Milk of Lime System.

The work[3] done in 1982 at the Mill established that saccharate liming gave a slower settling, more voluminous mud with an increase in mud volume of 100% and a substantial decrease of 44% in clear juice turbidity. This is illustrated in figure 4.

No conclusive results on the effect on syrup or sugar quality could be obtained.

Further experiments[4] in 1983 over a three month period on a week on/week off basis found some clear patterns. Juices were analysed every shift whilst sugars were composited on a daily basis.

On the basis of the 1982 and 1983 work, the conclusions drawn were:

- there is no significant difference in raw sugar quality (pol or colour) with the use of either milk of lime or lime saccharate in clarification.

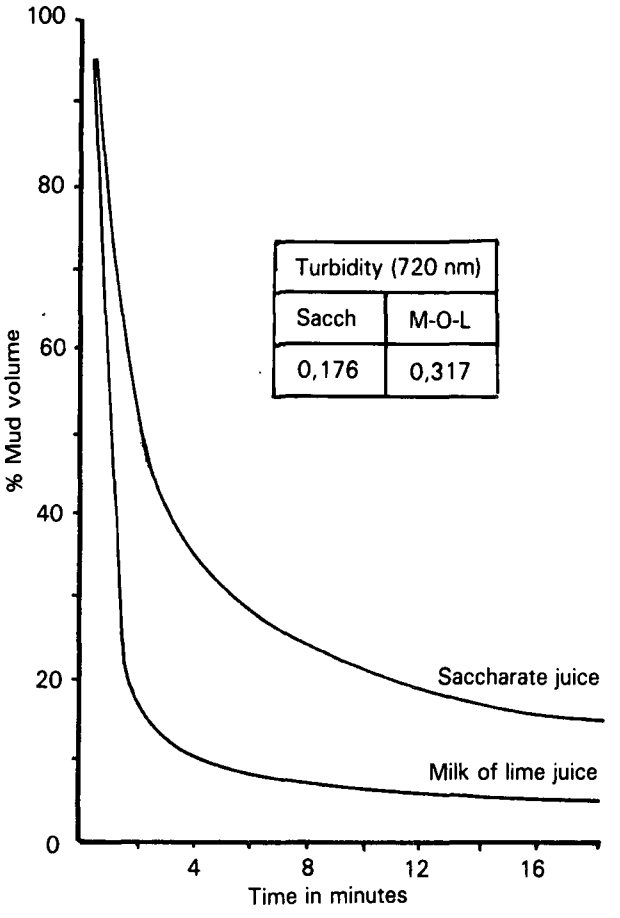

FIGURE 4 SRI KIT settling tests.

- the lower clear juice turbidities obtained by saccharate liming are largely negated by high turbidity increases during evaporation.

Two valid criticisms of this work however, are that the addition of lime saccharate at the centrifugal pump meant that the juice underwent additional pumping and heating,

Table 3

1983 Saccharate Trials

	Saccharate liming				Milk of lime			
	Colour a*c 420 nm	Turbidity 720 nm	% Change		Colour a*c 420 nm	Turbidity 720 nm	% Change	
			Colour	Turbidity			Colour	Turbidity
Mixed juice	45,0	0,80	–	–	51,2	0,72	–	–
Clear juice	38,7	0,28	−14	−65	45,7	0,39	−11	−44
Syrup	38,0	0,54	− 2	+93	43,6	0,65	− 5	+75
Sugar-Raw	2187	–	−94	–	2272	–	−95	–
Affinated	1585	–	−27	–	1740	–	−24	–

Table 4

1984 Saccharate Trials

	Saccharate liming				Milk of lime			
	Colour a*c 420 nm	Turbidity 720 nm	% Change		Colour a*c 420 nm	Turbidity 720 nm	% Change	
			Colour	Turbidity			Colour	Turbidity
Mixed juice	32,6	0,90	–	–	34,2	0,88	–	–
Clear juice	24,9	0,15	−23	−83	26,8	0,16	−22	−82
Syrup	26,4	0,26	+ 6	+84	28,4	0,29	+ 6	+81
Sugar-Raw	930	–	−96,5	–	1060	–	−96,3	–
Affinated	510	–	−45	–	670	–	−37	–

possibly causing floc breakdown, and that the cane quality during the 1983 drought year was highly abnormal.

To overcome these objections the system was redesigned to allow a comparison between the use of lime saccharate on hot juice (ie 104°C) with the established milk of lime method.

The period of the test was from June to August 1984 and covers six sets of two week runs, alternating M-O-L and lime saccharate. Much data was gathered and only averages have been presented.

Cox[5] concluded from these trials:

- the effects of cane quality on performance tend to override to a large extent any differences due to M-O-L or saccharate clarification.
- initial tests at the early part of the season under poor cane quality conditions indicated that saccharate lime could improve raw sugar colour by about 12% and affinated sugar colour by 20%.
- as the season progressed and cane quality improved the difference between saccharate and M-O-L disappeared, confirming the 1982 and 1983 results.
- increased mud volumes with saccharate liming may necessitate additional clarifiers. Amatikulu was unable to run on two clarifiers when undertaking hot saccharate liming. Three clarifiers were necessary because of mud problems. Flocculant dosage had to be increased to a value in excess of 5 ppm. Problems were also experienced with filtration of this mud.
- turbidity increases occur during processing at the evaporators.
- no differences were found between the two systems when C molasses viscosity, boiling house recovery and target purity difference were compared.
- the benefits of saccharate liming would appear to be far less than the proven advantages of syrup clarification.

Conclusion

Through relatively inexpensive modifications, it is possible to enhance the capabilities of the proven, reliable Rapidorr clarifier to the degree that juice retention times can be reduced to about one hour whilst maintaining flocculant requirement at low levels. Purity profiles have improved considerably as a result.

Extensive testing over three years at Amatikulu with saccharate liming gave no incentive to adopt it permanently because quality improvements beyond clarification were not usually maintained. Sugar quality improvements either were not detectable or occurred at times of poor juice quality and were insufficient to enable VHP specifications to be met under these conditions.

Acknowledgement

The extensive development and experimental work reviewed here has been a team project and many individuals have contributed. The invaluable expertise of Mr R. G. Montocchio and the assistance of the staff of Amatikulu and S.T.D. merit special mention.

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