LIMING IN DIFFUSERS: CALCIUM SACCHARATE OR MILK OF LIME?

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Abstract

Liming of diffusers with milk of lime is warranted from a corrosion point of view. It can however cause both physical and chemical problems. The use of calcium saccharate, prepared from lime and mixed juice, as an alternative to milk of lime is suggested and the results from preliminary tests are discussed. The main objective is to investigate whether calcium saccharate could overcome some of the problems associated with milk of lime for diffuser liming.

Introduction

Since cane juice is acidic, corrosion of mild steel components in the diffuser is an important consideration. Liming in the diffuser is thus practised to control pH. It is possible to control corrosion by raising the pH to values between 5,5 and 6,0, conventionally with milk of lime. However, high pH values and/or overliming must be avoided for the following reasons:

- pH values above 7 cause percolation problems by affecting the nature of the fibre irreversibly. Percolation velocity is reduced considerably (Love and Rein, 1980).
- Hydrolysis of the acetyl group in the hemicellulose fraction of the cane fibre can occur (Schäffler, 1988). This produces calcium acetate which in turn produces acetic acid. The acid is volatilised in the evaporators causing very severe corrosion in calandrias, and in vapour and condensate piping.
- Laboratory work has shown that extraction of silica, found in relatively high concentrations in tops and trash, from cane is increased as the pH rises (Walthew *et al*, 1988). Silica has been associated with scaling problems in the evaporators.
- Laboratory work has shown that high pH values favour the extraction of colour bodies, particularly from tops and trash (Lionnet, 1985).

Good pH control is essential, but it is not easy. Automatic control for milk of lime addition at a number of points is required. Efficient operation is difficult and maintenance is high mainly due to the milk of lime piping being blocked by lime solidification.

These difficulties could be overcome if calcium saccharate is used instead of milk of lime. Tests were therefore done in the laboratory, and on a factory scale, to investigate the feasibility of using calcium saccharate to control the pH of the juice inside the diffuser.

Experimental

North-Coombes *et al* (1981) give a method to prepare calcium saccharate. The stoichiometry (Equation 1) shows that the ratio of sucrose to CaO should be 6,2 to 1. It is however recommended by the above authors that a slight excess of sucrose be used (7:1) and that the temperature be kept below 58°C, to produce the highly soluble mono-calcium saccharate.

For example, if 10 kg of saccharate is required then approximately 7,5 kg of mixed juice (at 12,5 brix and 85% purity) and 2,4 kg of milk of lime (at 10 Bé) is needed.

Cane payment in South Africa involves the sucrose content of mixed juice, which cannot therefore be interfered with. Mixed juice that has not been weighed is needed to make the saccharate. If weighed mixed juice is used, sucrose will be recycled to a point before the mixed juice scale and will therefore be accounted for twice. On the other hand, the calcium saccharate thus prepared cannot be used elsewhere in the factory.

Mixed juice and milk of lime were obtained from a South African factory. The mixed juice was analysed for its sucrose content by gas chromatography; the CaO content of the milk of lime was estimated from its density.

It was decided to prepare the calcium saccharate at 50°C, as recommended, but also at 80°C to investigate any temperature effects.

The required amounts of mixed juice and milk of lime were mixed and kept at the set temperature for about 5 minutes, after which samples of the clear supernatant and of the settled sludge were taken.

All materials were weighed. The following analyses were done:

Mixed juice - pH, sucrose and potassium.

Supernatant - pH, sucrose, sulphated ash, inorganic phosphate, calcium and potassium.

Dried sludge - Sulphated ash, inorganic phosphate, calcium and potassium.

Results

Sugars

Although it is known that sucrose is stable under alkaline conditions, balances were performed to confirm this. Sucrose balances and sucrose/potassium ratios were used. In the first case the mass of sucrose in the original mixed juice and that in the corresponding saccharate were compared, and sucrose/potassium ratios in mixed juice and in the calcium saccharate were also compared, after it had been established that the milk of lime contained no potassium. The results are in Table 1.

On average, the results agree reasonably well particularly in view of the fact that the sucrose result is quoted to one decimal

place only. There is thus no evidence of sucrose destruction. This is not the case for fructose and glucose. The mixed juice contained 0,1% glucose and 0,2% fructose, but fructose and glucose were not found in the supernatant showing that both monosaccharides had been destroyed.

Calcium content

The total calcium content of the calcium saccharate prepared at 50°C was about 6600 mg (8500mg/kg solution). Of this about 2300 mg was in the supernatant and 4300 mg was in the sludge. Thus, both the supernatant and the sludge must be used as liming agents. There was about 20% less calcium in the supernatant prepared at 80°C, supporting the recommendation about the temperature as made by North-Coombes *et al.* Similar conclusions were reached through sulphated ash balances.

pH

Typical pH values of the milk of lime, at 10 Bé, and calcium saccharate were approximately12,6 and 11,7 respectively.

Cane juice pH control

A 1 kg sample of shredded cane was mixed with approximately 3 litres of water and heated to 70°C. The mixture was stirred, and once the required temperature was reached, the calcium saccharate (made at 50°C) was stirred and added to the cane. The pH was recorded. This procedure was repeated with milk of lime. A typical pH profile, taken from an average of two tests, is shown in Figure 1.

It is clear from the results that there is a much greater danger of overliming with milk of lime than with calcium saccharate.

Saccharate requirements in a factory

The quantity of calcium saccharate needed for a 100 TCH factory can now be estimated. With mixed juice at 12,5 brix approximately 1200 kg/hr of saccharate is needed. This saccharate needs to be made from milk of lime at 10 Bé. The amount of saccharate required is also dependent on cane quality.

Full scale test

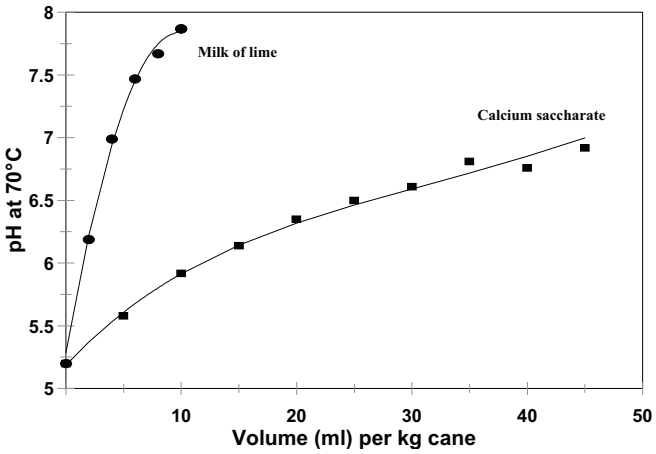
A very brief (2 hour) full scale test was done on the Gledhow diffuser. No practical problems were encountered.

Conclusions

Table 1. Sucrose balances.

Test	Mass of sucrose (g)		Sucrose /potassium ratio	
	Original mixed juice	Calcium saccharate	Original mixed juice	Calcium saccharate
1	111,4	109,9	0,0114	0,0108
2	111,1	111,4	0,0114	0,0118
3	110,9	111,4	0,0114	0,0113
4	111,1	111,5	0,0114	0,0118
5	111,2	109,9	0,0105	0,0113
6	51,5	52,2	-	-
Average	101,2	101,0	0,0112	0,0114

Figure 1. Increasing the pH of cane juice with saccharate and milk of lime.



This preliminary work shows that there is no serious difficulty in using calcium saccharate to lime diffusers, apart from the destruction of fructose and glucose. Reaction kinetics between CaO and sucrose are being investigated at the SMRI and preliminary results indicate that the reaction is very rapid. In this case long retention times for calcium saccharate preparation is not needed and this would reduce the destruction of fructose and glucose.

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