CLARIFIER MUD RECYCLING TO THE EXTRACTION PLANT

B ST C MOOR AND WH YEO

7 Alida Place, Cowies Hill 3610, South Africa
Tongaat Hulett Sugar, 1001 Umhlanga Rocks Dr., La Lucia 4051, South Africa

Abstract

Following construction of the Komati Mill, Bosch Projects engineers in 1996 reviewed their design of that factory to create an even lower capital and maintenance cost design without sacrificing performance. One of the concepts was to recycle the mud from the clarifiers directly to an appropriate stage along a fixed or moving bed diffuser. Although the concept was not entirely novel, no past attempts had proven commercially successful.

The paper traces past attempts at mud recycling, most of which failed. The recent successes are then outlined.

In 1997, Tongaat-Hulett's Maidstone Mill conducted successful trials on the process and applied for cane payment concessions to implement it on a commercial basis. During 1998, the Maidstone and Malelane mills both adopted the process permanently and by the 1999 season four other South African diffuser mills had followed.

The process does away with the entire filter station, including bagacillo plant, mud mingler, filters, vacuum system, condenser water system and filterpress disposal plant.

Two milling tandem factories, Darnall and Noodsberg, have recently conducted trials with the more problematic process of returning the mud to a milling tandem. Preliminary information is given on Darnall's experience. It seems probable that they will overcome the difficulties and also switch permanently to the process, either partially or totally.

Some ideas are proposed for mitigating the disadvantages in both diffuser and milling factories.

Keywords: clarification, diffusers, filters, filter losses, mud

Introduction

Returning clarification muds to the extraction plant for de-sweetening by imbibition holds many obvious attractions. If successful, it eliminates the entire filter station, including bagacillo plant, mud mingler, filters, vacuum system, condenser water system and filterpress disposal plant. It has the potential to reduce sucrose losses, to reduce the evaporation load and to increase available fuel (bagacillo).

The obvious disadvantages are that more abrasive sand and ash is recycled through the extraction plant and thereafter sent to the boilers. Filter cake is not available for (low value) field fertilisation. In many industries, special cane payment arrangements are needed to adjust for the sucrose returned from mixed juice to the extraction plant.

Early history and failures

The concept of recycling mud to the extraction plant is not novel. During the 1920s and 1930s, compound clarification was widely used. One such process was patented by Petree (1927), whose process featured dilution of the secondary mud by mixture with mill imbibition water. However, Jenkins (1966) states that this was not successful "due to its detrimental effect on feeding at the final mill".

Tromp (1946) also comments that secondary mud was returned to the "carriers of the last mill". It must be presumed that this was to rapidly clear the mud out of the system, but it was not the appropriate position in terms of the brix curve along the tandem. It was also the worst position to apply the heavily limed, slippery product to mills that relied for traction only on the surface roughness open-grained cast iron roll castings. Without Donnelly chutes, pressure feeders or welded roll roughening, the practice was abandoned because of its effects on extraction and bagasse moistures.

Van Hengel and van der Waal (1999) reported on the practice of mud recycling on milling tandems in Java during the 1940s and 1950s. This was more successful, although there was conflict between the desire to return the mud to a stream of similar brix or to a point far along the tandem to minimise mud return to mixed juice.

Weng and Bruniche-Olsen (1965) reported on the recycling of defecation mud to a 1500 tcd DDS diffuser at Nosbi in Tanzania. The stated purpose there was to increase the pH in the hope of producing a better purity juice from the diffuser, not the more obvious benefits listed in the Introduction above.

Subsequently, DDS experimented with mud recycling on a 6 tch sliced cane pilot plant (Barfoed *et al*., 1980). Although clarification in the diffuser was again the primary purpose, the filter plant savings were recognised. This work was presumably abandoned because the extraction process did not prove commercially viable.

Payne (1968) and Lamusse (1980) also focussed on the possibility of carrying out the juice clarification entirely within the diffuser. This would have eliminated the clarifiers and would have obviated the cane payment need for mud measurement, but all attempts to achieve such clarification have failed, for a number of reasons.

Recent successful initiatives

Following construction of the Komati Mill, Bosch Projects engineers in 1996 reviewed their design of that factory to create an even lower capital and maintenance cost design without sacrificing performance. One of the concepts proposed was to recycle the mud from the clarifiers directly to an appropriate stage along the diffuser. This would do away with the entire filter station, including bagacillo plant, mud mingler, filters, vacuum system, condenser water system and filterpress disposal plant. They took out a patent on the process, which they named Filtrafusion™ (Bosch Projects, 1996).

The concept was mentioned in discussions with Tongaat-Hulett in planning a joint venture for the construction of a new mill in Zimbabwe. That project was aborted due to Zimbabwean political issues, but Tongaat-Hulett's Maidstone Mill decided to undertake trials of the system.

Maidstone conducted two factory scale trials during the 1997 season. In the first two-week trial, mud from one of the factory's two clarifiers (i.e. approximately 50% of total mud) was returned to one of the two diffusers that processed 60% of the total cane. In the second one-week trial, all the mud from both clarifiers (100%) was returned to the 60% diffuser.

The process proved immediately successful, as reported by Meadows *et al.* (1998). There was no statistically significant effect on extraction, while filter cake losses were obviously eliminated. Lactic acid measurements gave no indication of sucrose destruction; and corrected ash % bagasse increased by only about 10% (from 2.4 to 2.65%) from normal levels. Full details of the various factors measured are given in the above paper, but they confirmed the expected benefits (see below).

The process returns sucrose from after the mixed juice scales to the extraction plant. This impacts on the factory mass balance, which is fundamental to the South African cane payment system. Before mud recycling could be introduced as a permanent process, industry approval had to be obtained for new cane payment arrangements.

Industry cane payments approval was achieved by the start of the following (1998/99) season and both the Maidstone and Malelane factories immediately adopted the process. Neither factory has operated its filter station at all since then. By the 2000/01 season, four other factories (Felixton, Amatikulu, Eston and Umzimkulu) had also adopted the process as their standard mode of operation.

Benefits of the process

The main benefits from the process are:

- elimination of the entire filter station - filters, bagacillo plant, mud mingler, vacuum system, condenser water system and filterpress disposal plant
- 60 to 85% reduction in the normal sucrose losses in filter cake
- reduced evaporation requirements (no filter wash water)
- increased boiler fuel (no bagacillo off-take)
- reduced cooling requirements (no condenser)
- reduced solids disposal costs at factories where growers do not take all the filter press
- reduced sucrose losses (chemical and bacteriological) in the mud system
- reduced maintenance costs
- reduced operating costs.

Jensen and Govender (2000), in their SASTA Jubilee Award paper, quantified most of the 1999 season's savings for Maidstone Mill, although they did not cover the value of savings in bagacillo fuel and condenser injection water. Including these, the value is of the order of R3 million to R3.5 million p.a. for this 2 million tcpa factory. For a new plant, the capital savings should also be added.

Disadvantages of the process

The disadvantages of the system have perhaps received less attention. The main disadvantages are:

The return of sand to the boiler bagasse: Cane diffusers already retain approximately 60% of the sand in mixed juice from a milling train, and mud recycling returns the remaining 40%. This sand has the potential to increase boiler tube wear and, in extreme cases (e.g. wet weather harvesting), to extinguish boiler fires. None of the factories practising recycling has yet reported increased boiler tube erosion, but this will need to be monitored.

A solution could be screening the presswater, with fibre returned to the diffuser, followed by either centrifuge or settling separation of the heavy fraction. Although not practising mud recycling, Illovo's Nchalo mill in Malawi has recently re-introduced presswater clarification to reduce the quantity of sand going to their boilers and management reports a noticeable improvement in bagasse quality. The sand separated from low-brix presswater would contain little sucrose and could possibly be dumped without further 'desweetening'.

The loss of filter cake as fertiliser for the fields: The main filter cake constituents of value to the cane have traditionally been accepted as its phosphorous (P) and nitrogen (N) (Moberly and Meyer, 1978). With mud recycling, most of the P and N are lost in combustion of the bagasse. However, Meyer and Keeping (2000) state that another constituent, available (soluble) silicon (Si) is an essential element for cane growth. Field trials had produced significant responses (9 to 14 tc/ha) to silicate applications. Si is present in much higher concentrations in the boiler ash from mud recycling factories than in filter cake. As a result, field trials are currently being conducted to assess the effects of the application of boiler ash from two mud recycling factories (Maidstone and Amatikulu).

Complicated measurement of extraction: Since the sucrose contained in the mud is recycled to before the mixed juice scales, it is 'measured twice'. This needs to be corrected for in the mass balance and in many countries has implications for cane payment.

Extension to milling plants

In principle, the advantages to a milling factory should be greater than to a diffusion factory, because of the greater filtercake losses with milling.

During the 2000 season, two milling plants - Darnall and Noodsberg mills – undertook trials on the recycling of mud to their milling trains. Darnall was first and Nyembe and Maharaj (2000) reported on the results of their initial three-week trial. Subsequent progress has been made in ongoing trials at Darnall in determining and controlling the operational effects mud recycling has on the milling tandem.

Critical factors monitored in the Darnall trials were pol loss in bagasse (extraction) and suspended solids % mixed juice ('filtering efficiency' of the milling tandem).

The effects on extraction depended mainly on the position along the 7-mill tandem to which the clarifier mud was returned. Darnall draws off the first and second mill juice as 'mixed juice' to process. When the mud was returned near the front of the tandem (into third mill juice), effects on bagasse pol were negligible. When returned further back along the tandem (into fifth mill juice), extraction dropped by 0.06% from the previous 97.2%. This was still far less than the saving in filtercake losses, which averaged about 0.8% at Darnall.

The slippage problems encountered at imbibition temperature above 74^{O}C were common to crushing both with or without recycling. Previous recycling trials on other mills may not have had the benefit of Donnelly chutes or rough welded rolls to help overcome slippage.

In terms of its brix relative to that along the milling train, the mud should be returned as far forward as possible. However, the filtering efficiency of mill bagasse is less than that of a diffuser bed, and the further forward the mud is returned, the greater the proportion of solids recycled. Even into third mill juice, the recycle proportion did stabilise, but at a high level. Management was concerned that these recycled solids included abrasive particles such as mill roller welding slag as well as the expected sand.

However, the most serious problem from the solids recycling to the front was that the mud raised the specific gravity of the third mill juice to such an extent that the bagasse particles were floated on the surface of the swirl tank instead of being drawn into the pump suction. They built up till causing chokes and spillage mess. For this reason, most of the 2000 trials involved returning mud to the fifth mill.

Darnall mill management developed plans to address these and other more minor problems for the 2001 season.

One such plan (being tested at the time of writing) is to classify the return stream using a cyclone. The heavier underflow is then returned to the back end of the tandem, reducing the soil recycled in the mixed juice, while the bulk of the mud stream is returned to the optimal extraction point where its brix matches that of the mill juice.

Noodsberg curtailed their recycling trial because of other management priorities. Their plans for 2001 are not yet known.

Simunye (Swaziland) and St. Aubin (Mauritius) also have since conducted limited trials of mud recycling on their milling tandems.

As with diffuser factories, if the additional sand burden to the boilers is considered unacceptable, a significant reduction could probably be achieved by sand removal from screened final mill juice. If necessary, sand could also be removed from the juice from the penultimate mill.

Conclusions

The benefits of mud recycling have already been satisfactorily proven for diffuser factories. Some issues remain to be resolved for entirely satisfactory recycling at milling factories.

Some ideas have been proposed for mitigating the problems of additional sand into boilers, for the problems caused by mud return to milling trains and for the loss of filtercake for fields fertilisation.

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