FEEDING BAGASSE TO MULTIPLE BOILERS WITH A 'SMART-FEED™' BAGASSE FUEL CONVEYANCE AND DISTRIBUTION SYSTEM, INCORPORATING 'RENTON PLOUGHS'

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Abstract

Sugar mills conventionally use either chain-slat conveyors or belt-plough installations to feed their boilers.

Chain-slat conveyors predominate, but are expensive and their mechanical components are constantly subjected to the abrasive action of bagasse and sand and are therefore costly to maintain. Slat conveyors also have a tendency to choke. Trapped foreign materials often cause the slats to break and the chains to stretch non-uniformly, resulting in conveyor breakdown. Consequently, chain-slat conveyor systems often contribute to poor plant availability.

Previous belt and plough installations, on the other hand, have experienced operational problems, which has limited their use as an alternative to slat-chain systems.

The performance and merits of the 'Smart-feed™' system, installed at the Hippo Valley Estate Sugar Mill (HVE) in Zimbabwe are evaluated. This installation has successfully demonstrated that the problems experienced with previous designs are eliminated by the "Smart-feed™" system, which uniquely integrates 'Renton Ploughs', innovative conveyor and chute designs and state-of-the-art automation and control.

Now entering its third season of operation, the HVE 'Smart-feed™' installation, which includes a 2.1m wide and 80m long slider bed conveyor feeding six adjacent boilers via 23 ploughs, has achieved the anticipated savings in capital and operating costs and has resulted in improved availability and reliability. Improved boiler control has also resulted from the ability to control the fuel flow to individual feeders.

Keywords: bagasse, fuel, conveyor, plough

Introduction

HVE's old and complex chain-slat bagasse conveyors were identified by its management as a prime contributor to plant down time and PGBI Engineers and Constructors (Pty) Ltd / PMS (PGBI) was commissioned in October 1999 to design and install its 'Smart-feed™' Bagasse Fuel Conveyance and Distribution System.

Although conflicting opinions exist on the respective merits of belt and slat conveyors for feeding bagasse fuel to boilers (Moor, 2000) a plough and belt-based fuel feed system was selected. The decision was based on a concept originally installed for Felixton Mill and subsequently refined for Malelane Mill. The expectation of reduced capital, operating and maintenance costs and a high local content element, were important factors in an environment where foreign currency was scarce.

The new system would accommodate a future increase from HVE's current crush rate to an ultimate capacity of 800 tch. Site work started at the end of December 1999 with the removal of the existing chain-slat conveyors and the modification to the Power Plant building to accommodate the new system, which was commissioned in April 2000.

The 'Smart-feed™' System is now in its third season of successful operations, making a robust case for adopting belt-plough systems in boiler fuel feeding applications.

The configuration of the 'Smart-feed™' system at HVE

Six John Thompson boilers are currently installed in line at HVE. The plant comprises three 45 t/h dual-fired boilers, two 68 t/h and one 100 t/h bagasse-fired boilers. The plant is capable of generating 371 t/h steam at MCR on bagasse.

An 80 m long, 2.1m wide, slider bed conveyor traverses the full length of the boiler plant. Twenty-three diverging section bagasse-feed chutes connect the bagasse feeders to apertures on alternate sides of the slider deck.

Trailing, forward curved ploughs, are staggered about the centre-line of the belt, upstream of each of the chutes and set a few millimetres off the slider conveyor belt surface.

The ploughs are retractable by means of remotely activated pneumatic cylinders. Each plough itself is linked to a second air cylinder, which acts as a pneumatic spring. The air pressure on the second cylinder can be adjusted from the control room to suit flow requirements and any variation in bagasse properties.

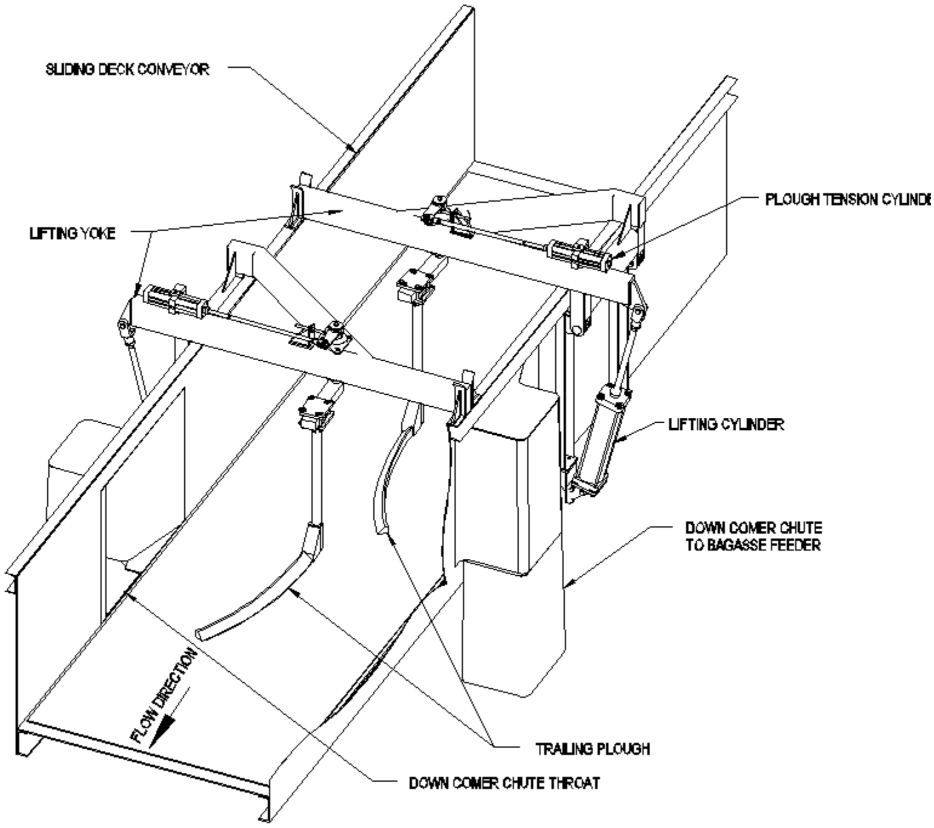

Figure 1. Typical 'Smart-feed™' plough and chute configuration.

Operation of the 'Renton Ploughs'

The pneumatic spring holds the plough across the bagasse flow, diverting a layer of bagasse from the belt surface into the chute aperture. When the chute is full, bagasse is no longer diverted and builds up against the plough. The bagasse then either spills over the top of the plough, or builds up until it overcomes the pneumatic spring's resistance, thereby forcing the plough parallel to the bagasse flow. The plough's unique shape and section allows un-diverted bagasse to spill over and be conveyed to the next plough. The sudden release of the bagasse build-up causes the pneumatic spring to again position the plough across the bagasse stream, diverting bagasse to replenish any shortfall in the chute. The chute is therefore always full and the conveyor is choke free.

A single low-level chute sensor is fitted to each chute and interlocked to the bagasse feeder to prevent the chutes running empty thereby avoiding boiler furnace pressure fluctuations and blowback. A CCTV camera mounted at each boiler allows the operator to see each plough's operation.

Problems encountered with previous installations

Bagasse build-up and belt tracking
A problem encountered in previous plough and slider bed installations was the build-up of bagasse between the underside of the belt and the slider bed, causing belt troughing. This troughing prevents the ploughs from functioning correctly and, in extreme cases, the belt snagged on the plough and resulted in belt damage.

It was also found at the Felixton Mill that if all the ploughs only feed off one side of the conveyor, the imbalance of the frictional forces on the belt can cause the belt to ride up the side wall resulting in bagasse build up and wear of the belt edge.

The 'Smart-feed™' System eliminated the above problems by:

- selecting suitable belt material and carcass/cover configuration
- designing and installing the slider deck correctly
- arranging and designing both head and tail pulleys appropriately
- installing the feed chutes on alternating sides of the conveyor thereby equalizing the transferred friction forces on the belt.

Choking at the feeder chute throat
Choking at the feeder chute throat is a problem encountered on some belt systems. Various solutions have been attempted, including manual and automated clearing (mechanical plungers).

This problem was eliminated on the large boilers at HVE by the application of previous experience, extensive research and testing in the design and configuration of chute throat and plough combination.

The choking problem was, however, encountered at HVE on the three smaller, 45-ton boiler feed chutes due to the feeder chute aperture configuration.

The feeder chute aperture size is generally dictated by the combined effect of:

- the need to design chutes so that the cross sectional area diverges
- catering for adequate bagasse retention capacity
- bagasse feeder flange inlet size
- the need to accommodate the variance in height of the individual boilers' bagasse feeder inlet flanges.

Complying with the above requirements for the 45-ton boilers at HVE, in view of their smaller feeder inlet flanges and lower feeder heights, resulted in abnormally small apertures in the conveyor deck, causing chokes as well as limiting steaming capacity.

This problem was resolved by modifying the chute and sidewall apertures of one boiler during the season. The modification increased the effective throat cross sectional area by 30%. The remaining smaller boiler chutes were similarly modified during the off-crop.

Other problems
Fuel starvation of the last boiler in line was identified as a potential problem in the design at HVE. The Power Plant layout is such that the conveyor supplying the slider bed conveyor from the mills, discharges prior to the three smallest boilers. Ideally the mill conveyor should discharge prior to the larger boilers. This problem manifested itself in the commissioning phase, but was overcome by increasing the bagasse-recycling component. A level controller on the slider deck automatically controls the reclaim conveyor's speed. Elements of the bagasse recycle system were recently upgraded during the 2001/02 off-crop to increase the recycle capacities, which were scheduled for upgrading in the second phase of the programme.

Over the past two seasons, problems were experienced with some of the locally supplied and designed pulleys. These problems, unrelated to the design, function and performance of the plough system, have nonetheless contributed to system down time. All pulleys were redesigned and replaced during the 2001 season and in the 2001/02 off-crop.

Advantages of the 'Smart-feed™' System

Some of the advantages of the HVE plough feed system are:

- The initial capital outlay for the installation of a slider bed conveyor and plough system was approximately two thirds of that of a new chain-slat installation.
- The HVE slider bed conveyor is in excess of 80m long, replacing the complex multiple stacked arrangement of chain-slat conveyors, thereby simplifying operations. (Chain-slat conveyors are typically limited to 55m in length.)
- Maintenance costs of the system installed at Hippo Valley have been virtually nil over the past two seasons.
- Poor boiler availability and a fluctuating steam supply was previously caused by:
  - frequent chokes due to broken slats & stretched chains, which are time consuming to clear
  - bridging between slats which resulted in fuel starvation.

  These problems have been eliminated by the new system.
- Regionally supplied belting and other system components have replaced expensive chains and conveyor components, some of which were imported from abroad.
- The HVE slider bed conveyor absorbs less power per meter of conveyor than that of a chain-slat equivalent.
- Reduced conveyor size and costs, as a result of substantially higher belt speeds than those traditionally accepted, have been made possible by the 'Smart-feed™' System.
- The weight per meter of slider bed conveyor is less (±350 kg/m), therefore requiring a far lighter support structure.
- The system, particularly the single conveyor, facilitates the installation of longer feed chutes, thereby increasing their retention capacity.
- The 'Smart-feed™' System is flexible and responds rapidly to sudden changes in:
  - bagasse supply (rapidly balancing fuel from the mills with reclaimed bagasse component)
  - individual boiler fuel demands.
- The 'Smart-feed™' System controls are compatible with, and easily integrated into, centralised PLC and SCADA boiler control and monitoring systems.

"Renton Ploughs" in their retracted position

The *"Smart-feed*™*"* System in operation **Bagasse being diverted into a feed chute**

Figure 2. The 'Smart-feed™' System Installation at HVE.

Risks and their mitigation

Some risks are associated with the installation and operation of a plough and slider belt system. These are detailed below, together with some possible mitigating strategies.

- Belt damage can occur from rocks, tramp iron and wood, which can wedge between the plough and the moving belt. This risk is especially relevant when bagasse is reclaimed from sources where contamination is possible. Tramp iron can be removed by installing electromagnets.
- Where a single conveyor feeds all the boilers without redundancy (as is the case at HVE), a conveyor stoppage will have an immediate effect on the steam supply. In order to mitigate this risk a complete spare belt and drive unit are positioned conveniently, ready for immediate and rapid installation.

Conclusion

The plough and slider bed system installed at HVE and at TSB Malelane have met, and in many cases exceeded, the benefits anticipated.

The application of knowledge and experience now available from previous installations has culminated in a successful installation and system design, rendering it state-of-art and proven technology.

Mills considering installing a plough and belt system should do so after proper conceptual designing and planning, and understanding the technology. Success of the system is fundamentally dependent on paying proper attention to the details and adopting the correct design parameters and applying all the experience and know-how that has now been accumulated.

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