

A REVIEW OF MODIFIED SHREDDER SYSTEMS

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Abstract

Cane preparation arguably has the most influence on extraction. The capital outlay of cane preparation plant is relatively high because the arduous duty requires a sturdy construction and heavy duty components. Power consumption constitutes about 25% of total factory requirements. The choice of plant, therefore, warrants careful consideration. Modified shredder systems which prepare whole stalk cane as an alternative to conventional heavy duty shredders and cane knives are considered.

Introduction

It is just over 20 years ago that the first Tongaat shredder was commissioned. The design incorporated a number of departures from the traditional one at the time. Perhaps the most important feature of the design was the full coverage of hammers across the shredder width. However, with the passage of time the Tongaat shredder has earned the reputation of a truly heavy duty shredder. The fact that some 80 units have been installed testifies to its success.

A few years before the first Tongaat shredder was commissioned, the old ZSM factory at Empangeni was experimenting with an anvil drum and a washboard mounted above a set of knives rotating against the direction of the cane. This concept of a contra-rotating set of knives is now widely applied in the South African sugar industry.

In the Brazilian industry this concept has also been widely applied but as a shredder, not as a cane knife set. The basic concept is shown in Figure 1. The rotor tip velocity is almost 60 m/sec, and the feed drum peripheral velocity is 15-20% greater than that of the carrier.

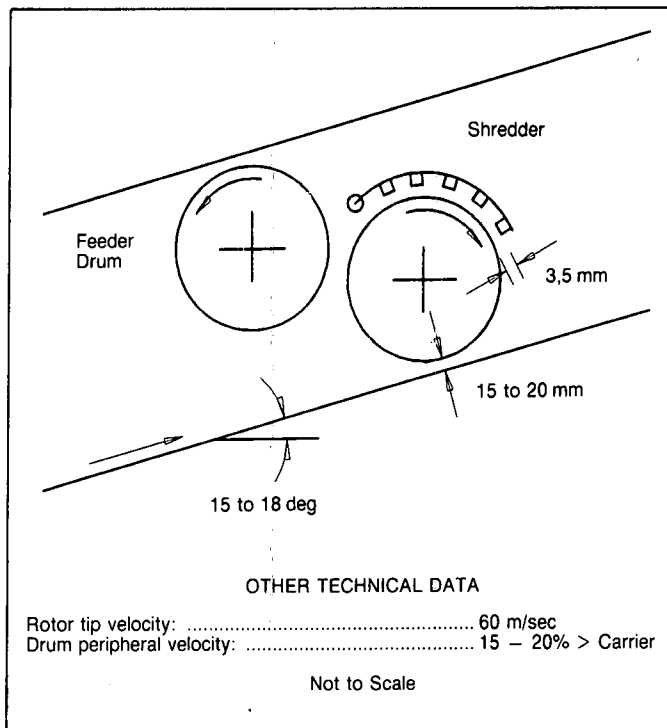


FIGURE 1 Schematic diagram of a Deon Hulett/Copersucar shredder.

There have been some dramatic improvements to this concept over the years to the extent that there are now shredders being marketed which claim to produce, from whole-stalk cane, long fibres with a minimum of fines ideal for the

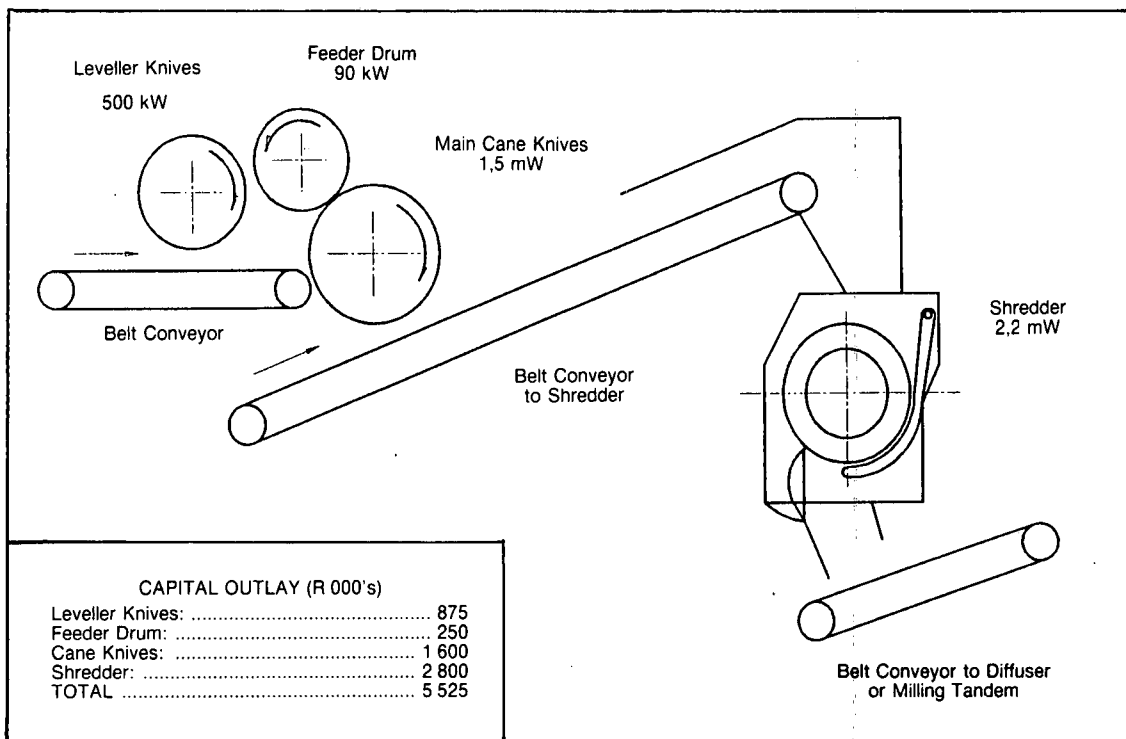


FIGURE 2 Conventional cane preparation system for 300 tons cane/ hour.

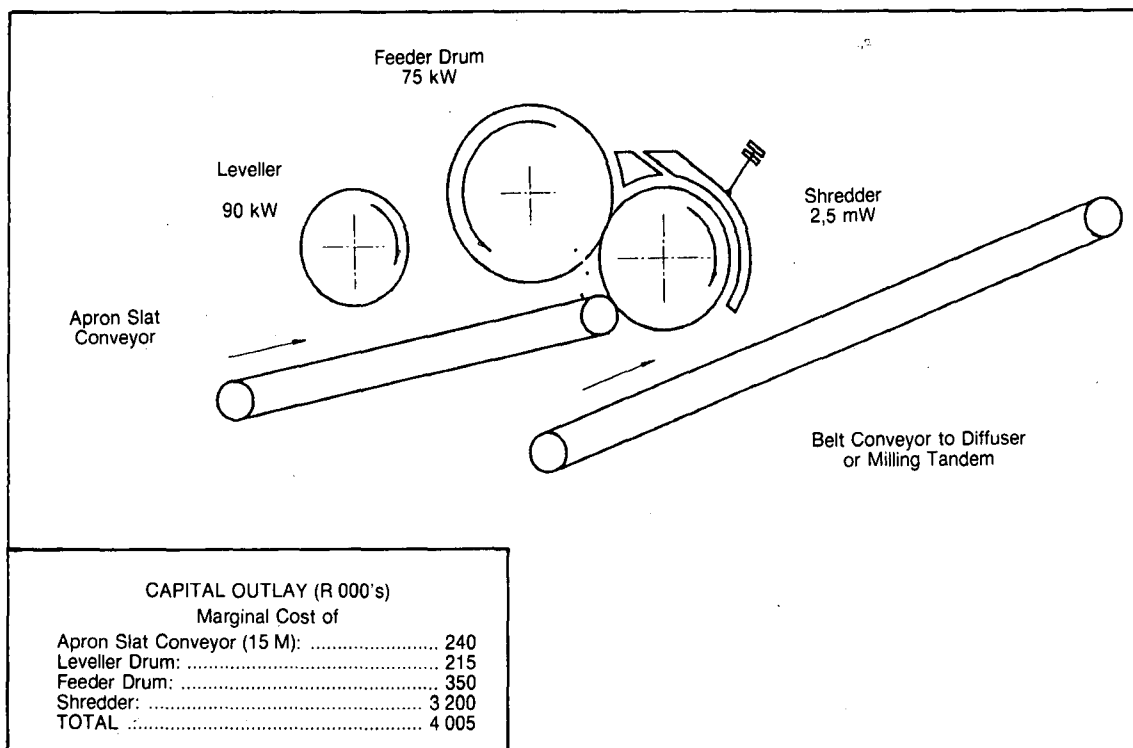


FIGURE 3 Whole stalk cane shredder for 300 tons cane/hour.

extraction process. A radical change is that maintenance intensive cane knives are no longer necessary.

Several of these shredders have been installed in recent years. Distinguishing features of the design are discussed and some of the problems experienced are reviewed.

Distinguishing features of the whole-stalk cane shredder

A typical layout of a conventional cane preparation system is shown in Figure 2. The installed power is about 4,3 MW for a 300 tons cane/hour factory and the capital outlay required is about R5,525m, comprising R875 000 for leveller knives, R250 000 for the feeder drum, R1 600 000 for cane knives and R2 800 000 for the shredder.

The layout of a whole-stalk cane shredder for a 300 tons cane/hour factory is shown in Figure 3. This comprises a leveller approximately 2 m in diameter, rotating at 30 r/min and positioned 750 mm above the carrier. Absorbed power is about 65 kW. The levellers of this design operating in Mauritius and Reunion are extremely effective and it is important that they are so if the speed recover power demand of these heavy duty shredders is to be kept to a minimum.

Also required is a feed drum of about 2,4 m in diameter fitted with a variable speed drive to ensure that the peripheral speed of the drum equals the carrier speed. The feed drum is positioned about 500 mm above the carrier and absorbs about 60 kW. The cane stalks are gripped between the carrier slats and the drum to provide a controlled delivery of cane to the rotor hammers.

Figure 3 shows the shredder positioned at the head shaft of the slat conveyor. The advantage of this arrangement is that it permits a washboard with a 180° angle wrap. However, there are a number of installations in Mauritius and Reunion where the shredder is positioned above the carrier, similar to the layout shown in Figure 1.

The two most recent whole-stalk shredder installations at Bois Rouge in Reunion and at Sucoma in Malawi have drives of 2,5 MW for 325 tons cane/hour and 2,8 MW for 320 tons

cane/hour respectively. However, Fives Cail Babcock have called for a 3,5 MW drive on the proposed Noodsberg shredder which is a 300 tons cane/hour factory. The absorbed powers at Bois Rouge and Sucoma are respectively 1,6 and 1,3 MW so a 3,5 MW drive for the Noodsberg factory appears to be unnecessarily high.

The texture of the prepared cane in Mauritius and Reunion is uniform and the fibres are indeed long. Prior to the installation of the whole-stalk shredder at Bois Rouge, 7% of time lost was attributable to rock damage. Subsequent to its installation, no stoppages have been recorded. None of the other factories could quantify the reduction in lost time due to rock damage but in general they are of the opinion that rock damage is no longer a major problem. However, tramp iron is still a major problem and invariably damages the anvil bars of the washboard. Of course, an advantage of a set of cane knives before the shredder does permit the installation of a magnet to remove tramp iron.

The installed power of the whole-stalk shredder is about 2,7 MW for a 300 tons cane/hour factory and the capital outlay is about R4m, comprising R240 000 for the marginal cost of an extra 15 m of apron carrier, R215 000 for a leveller drum, R350 000 for a feeder drum and R3 200 000 for the shredder itself. The capital outlay advantage relative to a conventional system is thus R1,52m or about 27%, and the installed power advantage is 1,6 MW or about 38%.

Problems experienced with recent installations

The inertia of these shredder rotors need not be greater than the conventional shredder, but the duty they are required to perform is more arduous because there are no cane knives to assist them. One must therefore cater for large load fluctuations. The effective operation of the leveller and an effective control system on the shredder deed conveyor certainly will help to contain these.

Despite this though the method of drive requires careful selection to avoid severe peak loads. An abnormally high

load will pull down the drive unit speed. If this is a steam turbine then it will recover to the set speed by using for acceleration the excess of available power above that required for normal operation. This excess of power can be limited by nozzle block controls or other means.

However, if the drive unit is an electric motor then the solution is not so easy. A motor with a relatively low resistance rotor will have a low running slip, which is desirable, but will draw a high starting current and will have a low starting torque, which are undesirable features, particularly when the motor is trying to recover its speed after a load increase. Conversely, a motor with a relatively high-resistance rotor will have the desirable features of a higher torque and a lower starting current, but will have a high slip at full load.

With a squirrel-cage rotor the choice must be made in the design. Of course, a slip-ring motor offers the possibility of connecting an external resistor into the rotor circuit. In either case, the choice of the drive unit requires very careful consideration.

Mon Desert Alma Sugar Mill in Mauritius and Bois Rouge and Le Gol in Reunion have whole-stalk shredders. Each of these factories reports a rotor bearing life of 3 or 4 months. The shredder manufacturer claims that the short life is attributable to the incorrect shaft material. At each of these factories, the bearings used are 23144 CCK/C3 W33 which are 220 mm diameter bearings. On at least two occasions at Le Gol during the 1993 season it was necessary to change bearings because of cracked inner races. A cracked inner race is typical of a bearing that has been subjected to shock loading.

Elgins have recently supplied a new shredder rotor shaft to Le Gol machined from EN 24, condition T, which means it is oil quenched and tempered, and which has a tensile strength in the range 850 to 1 000 MPa. As a matter of interest, the Tongaat shredder rotor is machined from EN 3A which has a tensile strength in the range 420 to 700 MPa. It will be of great interest to see what effect this new shaft will have on bearing life at Le Gol.

The bearings on the Sucoma shredder are 23156 CCK/C3 W33 on a 280 diameter tapered landing machined on the shaft. The shaft material is EN3A. At the commencement of the 1993 season, which was their shredder's first season, the residual clearance after mounting the bearings was the recommended minimum of 140 microns. At the end of the season the clearance was 180 microns. A possible explanation for this increase in clearance is that the shaft material has extruded. This certainly was the case with a rotor shaft at Le Gol which was made from EN3A.

Conclusions

The reductions in capital outlay, absorbed power and maintenance cost are significant for a whole-stalk shredder when compared with a conventional heavy duty shredder and cane knives.

If the drive is an electric motor then careful consideration must be given to the trade-off between the degree of slip and the speed recover current.

The choice of rotor shaft material and of rotor bearings are issues which have not been resolved. There is evidence to suggest that EN3A and 23144 bearings are not suitable for the arduous duty required of whole-stalk shredders. The recommended rotational speed of these shredders is 1 000 r/min. At this speed a 22256 bearing has a dynamic load rating some 50% higher than a 23144 bearing. Mounting this bearing on a tapered landing of an EN24 shaft would be the best option until more experience has been gained.

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