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New developments in equipment and applications in the mineral sands industry

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A modular design of a large trommel screen enables the end user to transport parts for erection or replacement. The drive has been changed to a variable speed direct end hydraulic drive. Work has been done on the drain rates of panels and the scroll configuration to be able to optimize throughput.

Inclined densification cyclones resolved the problem with varying spigot loading and a unique desliming installation can ensure that the slime content is maintained below 7% in the feed to the spirals in the wet plant with varying slime content in the as mined feed. Large capacity stacker cyclones simplified the design and control of the tailings stacker cyclones.

The three or two stage large diameter spiral reduces the costs of the plant as a preconcentrator. The traditional spaghetti piping and launder system have been resolved with a unique modular pipe launder system, consisting of special fittings and PVC pipe, lined with polyurethane.

In the MSP plant a new wet high intensity magnetic separator has been developed with high capacity, an improved magnetic circuit, removable salient plates and protection screens on the feed.

Special samplers have been developed for dry sampling of sand.

Introduction

The basic flowsheet of the wet plant is shown in Figure 1.

Trommel screens

A large capacity dredge and wet plant needed to replace a trommel screen. This was an opportune time to review the design where the following factors had to be considered:

- The logistics to handle the total mass of 37 tonnes, especially the transport to the floating wet plant
- The higher wear on the tyre pads on the front and rear ends
- Purfect® sheeting—lining protection and ease of maintenance
- Modular polyurethane panels for the ease of replacement
- Optimization of panel and scroll design for improved trommel efficiency.

This led to a modular design where the trommel screen was designed in three sections which are bolted together (Figure 2). The finite element analyses were cross checked by an independent contractor, appointed by the client.

The welding specifications were strict for such a large peace of equipment that rotates and can easily fail on fatigue if not correctly designed and manufactured. The trommels were thermally stress relieved to ensure longevity of the structure. These trommel screens have now been successfully installed and commissioned.

The drive of the trommel was a variable speed direct end hydraulic drive instead of the more conventional indirect drive.

Purfect® sheeting has been installed on both the feed and discharge end of the trommel. It consists of rubber backed 10 mm polyurethane sheeting that is bonded directly to the Trommel structure. It is quick and easy to install and maintain and improves wear life. (Figure 3.)

The images show different scroll configurations that have been modelled using Edam, a software package used to model the mass flow of solid particles. With the

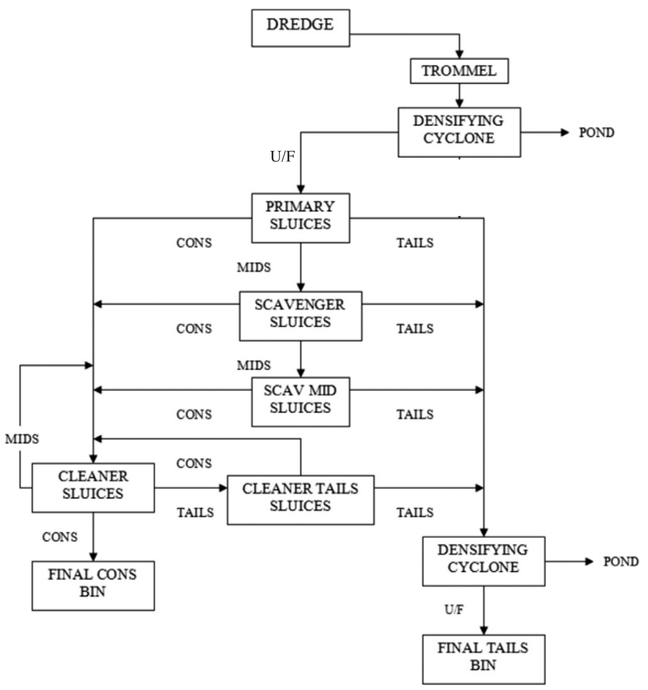

Figure 1. Basic flowsheet of the wet plants

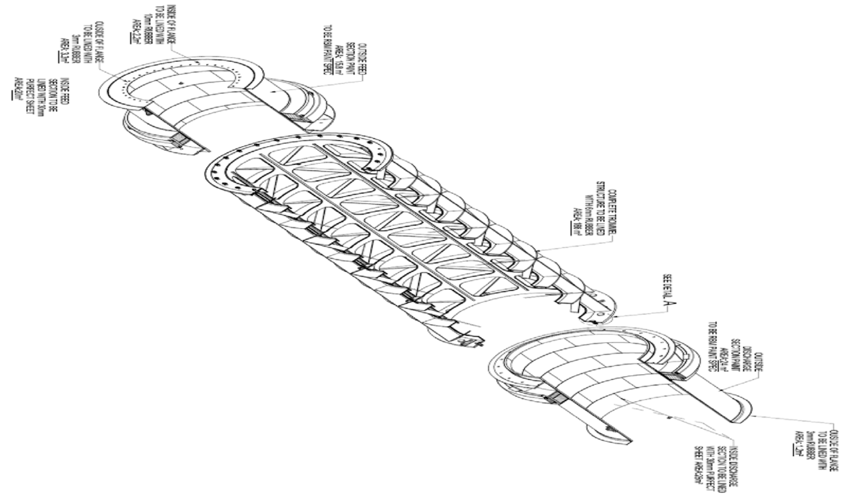

Figure 2

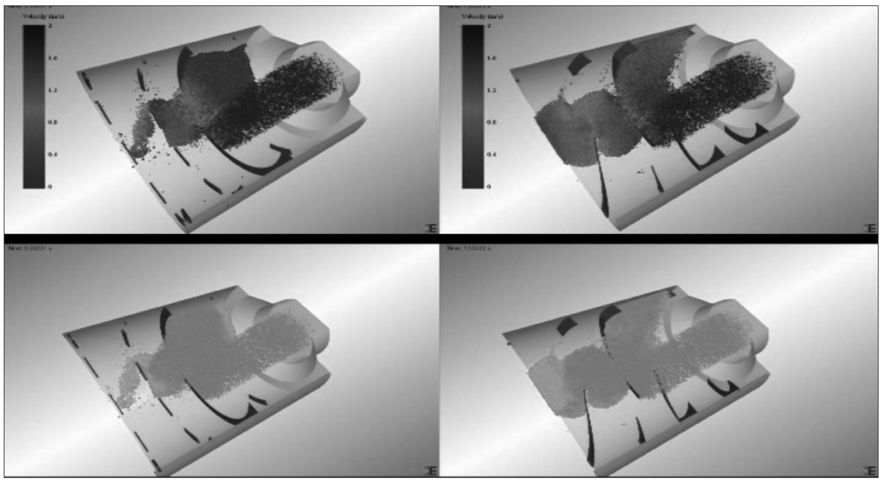

Figure 3. Modelled scroll configurations

combination of the variation of rpm of the trommel and the pitch and scroll configuration, the efficiency of the Trommel can be optimized.

In addition drain rates tests have been carried out on the screen panels and panel designs have been optimized to improve life and drain capacity accordingly. (Figure 4.)

Desliming cyclones

A large proportion of new projects has a higher content of slimes in the feed. Figures 5 and 6 show a typical effect of slimes on the performance of a spiral plant.

In a specific example the content of slimes should be less than 7.0% for good performance. Tests with a 350 mm diameter cyclone gave the results as shown in Table I.

The challenge was to maintain the specification of 7% slimes in the underflow when the slimes content in the feed varies between 15% and 32%. The feed coming from the trommel screen also had a relatively high solids content to minimize the energy costs. A system had to be designed to reach the maximum of 7% continuously. The solution was to have four distributors with two different spigot sizes fitted to the cyclones. With only two distributors required to handle the capacity, it gave the operator the opportunity to switch between distributors, depending on the slime content of feed. Typical operating philosophies are shown in Table II.

Figure 4. The RBM trommel during panel installation

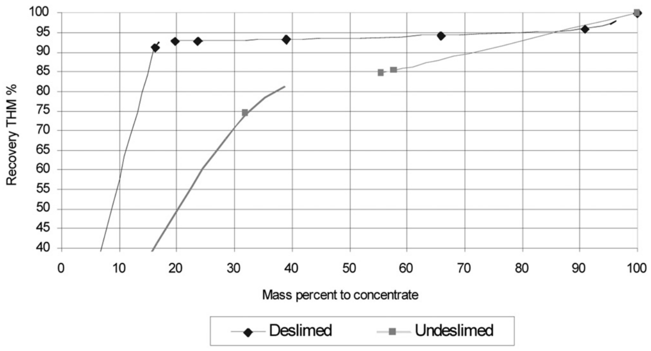

Figure 5. Plant tests, results-recoveries

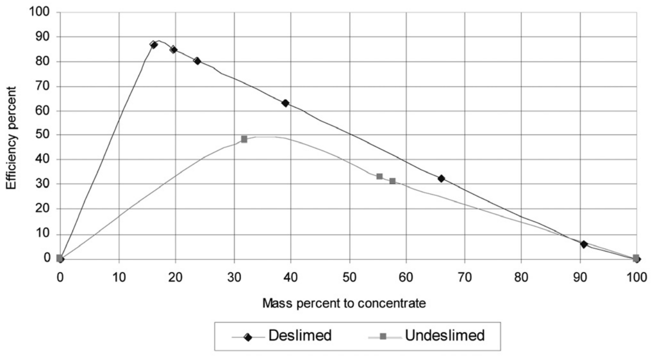

Figure 6. Plant tests, results efficiencies

Table I
Tests with a 350 mm diameter cyclone

	% Sand	% Slimes	% Sand recovery	% Slimes rejection
Feed	66.7	33.3		
Overflow	3.4	96.7		
Underflow	93.95	6.5	98.5	86.3

Table II
Typical operating philosophies

% Slimes	Distributor (Large spigot)	Distributor (Small spigot)
32.0	0	2
23.5	1	1
15.0	2	0

Densifying cyclones

In order to maximize the performance of the spiral plant, the feed density should be approximately 42% solids. In order to control the density, a portion of the feed from the feed sump is slipstreamed through densifying cyclones to regulate the density without losing valuable heavy mineral. The major problem encountered was that the solids loading to the densifying cyclones varied considerably, with the result that operational conditions were reached where the spigots roped. This resulted in the loss of valuable heavy mineral to the tailings and in some cases beaching at the back of the floating wet plant.

This problem was solved by inclining the densifying cyclones at 15° to horizontal (Figure 7). The major advantage of inclined cyclones is that a substantially larger spigot can be fitted with two to three times the spigot capacity. A high density underflow is maintained despite the varying load. The adjustment is made through the automatic variation in the size of the air core in the cyclone. The same principle is used for densifying the tailings feed to the stacker cyclones, where the density is high at between 55% and 60% solids to minimize energy costs.

Stacker cyclones

Modern large installations can have flow rates of tailings as high as 3 000 to 5 000 tonnes of sand. Traditionally stackers were designed with three 750 mm or three 900 mm cyclones to handle between 1 500 to 2 000 tph. (Figure 8.) This resulted in a distribution problems as well as difficulty with the control of the vacuum for the flapper valves.

A new design for the boom and stacker cyclone utilized a single 1 200 mm cyclone to handle a capacity of between 1 500 and 2 000 tph of sand. This simplified the controls and also reduced the mass of the whole stacker and boom

Figure 7. Density control in dredge mining

Figure 8. Cyclone tailings stacker

design. Figure 9 shows the design in operation. The process design of the stacker cyclone is complex in the case of tailings stackers as the volumetric split to the spigot can vary between 0% and 70% depending on the feed conditions.

Spirals

Large floating wet plants or fixed land based plants can have up to 2 000 spirals installed. This obviously requires a large space and is expensive. There was therefore a need for a preconcentrator to treat low-grade deposits with high recoveries at reduced costs. Cleaning of the rougher concentrate can be done with more efficient lower capacity circuits. As a preconcentrator, it will also be beneficial if one or more stages of scavenging can be achieved on a single spiral which removes the need to collect products and eliminates an additional pumping stage.

A 1 000 mm diameter multistage quad spiral has been developed, which can handle up to 20 tonnes per hour per spiral. Various configurations are available where roughing and scavenging can be performed on the same spiral with repulping in between.

Figures 10 and 11 illustrate the repulper and sliding splitter.

Obviously the best performance will be achieved with all auxiliaries fitted. The choice will, however, be determined by the performance on each deposit as well as the operational needs.

Figure 12 shows the effect of the repulpers on the performance of the spiral.

The savings in space achievable for a particular application compared to conventional 600 or 700 mm diameter spirals is in the order of 40%.

Figure 9. Stacker cyclone

Modular pipe launder system

In large installations the collection of products from the product launders underneath the spirals has been described as spaghetti piping and has often been referred to as a rain forest. Due to the fact that every plant varies in design, no

Figure 10. Repulper

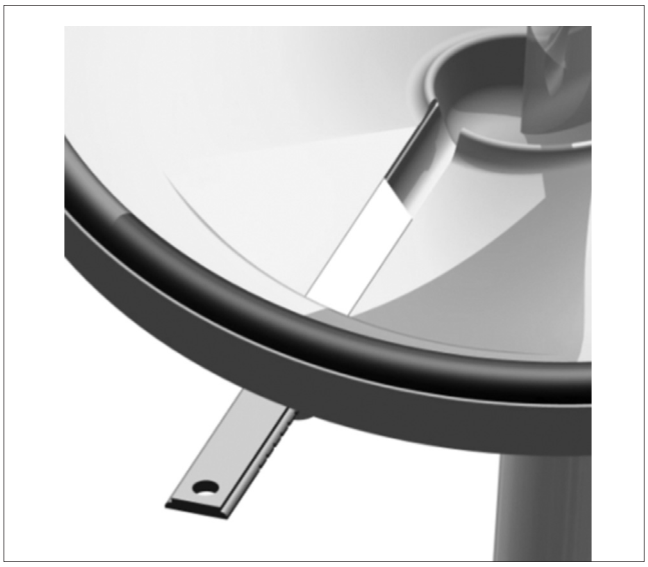

Figure 11. Sliding splitter

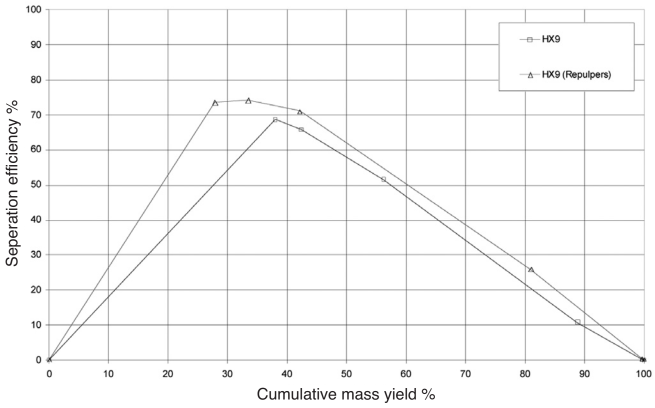

Figure 12. Separation efficiency curve – HX9

modular design was used and the maintenance and wear problems were significant. Downpipes from the product launders as well as the bottom launders were often HDPE piping. Larger capacity launders were made of steel and lined with either rubber or polyurethane.

The need was therefore to design a system that will satisfy the following criteria:

- Corrosion proof
- Wear resistant
- Ease of maintenance
- Tidy with no leaks
- Durable
- A minimum of spares.

A modular system was developed where PVC pipes were lined with polyurethane. Special deflector boots were fitted at the end of the downpipes to minimize the wear at the impact point. The downpipes are also PU lined PVC pipes.

Figures 13 and 14 show the basic design. In most cases the pipe lengths could be standardized on four basic lengths, which makes stock holding much easier.

The first installation has been running for more than seven years and a camera inspection showed hardly any wear.

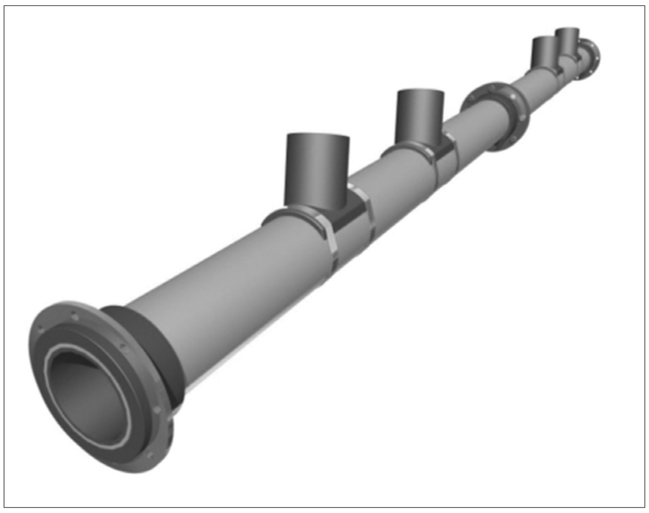

Figure 13. Pipe launder

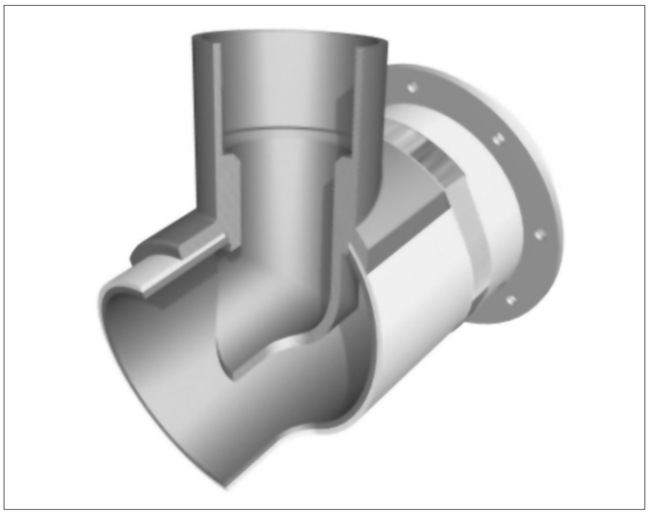

Figure 14. Deflector

This system has now been specified by two major end users and has been successfully installed on more abrasive and coarser applications such as chromite and iron ore.

Magnetic separation

In the MSP plant, wet high intensity magnetic separators are used to separate ilmenite and other magnetic minerals from the other valuable minerals. WHIMS machines with a capacity of 40 tph were traditionally used with a relatively inefficient magnetic circuit design. Maintenance is difficult and costs can be high especially with the coils.

A new high capacity WHIMS machine designed for the iron ore industry can effectively be used for ilmenite removal. The following advantages have been incorporated in the new design:

- High capacity up to 120 tph per machine, depending on rotor width
- An efficient magnetic circuit design with reduced power consumption of 30%
- Rotor with removable salient plates makes cleaning easy as well as the replacement or the use of different designs easy, if required
- Every feedpoint is screened for oversize particles with a special polyurethane box screen
- A coil protection circuitry was incorporated.

Figure 15 shows the WHIMS machine which has successfully been commissioned for the recovery of haematite.

Sampling

A successful slurry sampler was developed for metallurgical accounting in the gold and platinum industries in conjunction with some of the major end users.

This slurry sampler was successfully adapted and modified to sample dry sand in the MSP plant. Figure 16 shows a schematic drawing of the principle of operation.

The main advantages of the design are:

- High frequency of samples
- Small final mass of sample
- Accurate values
- Compact unit.

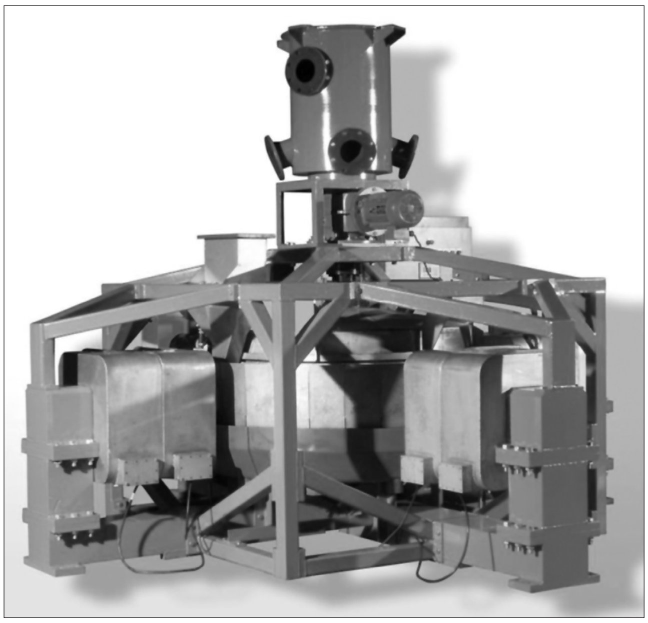

Figure 15. Wet high intensity magnetic separator

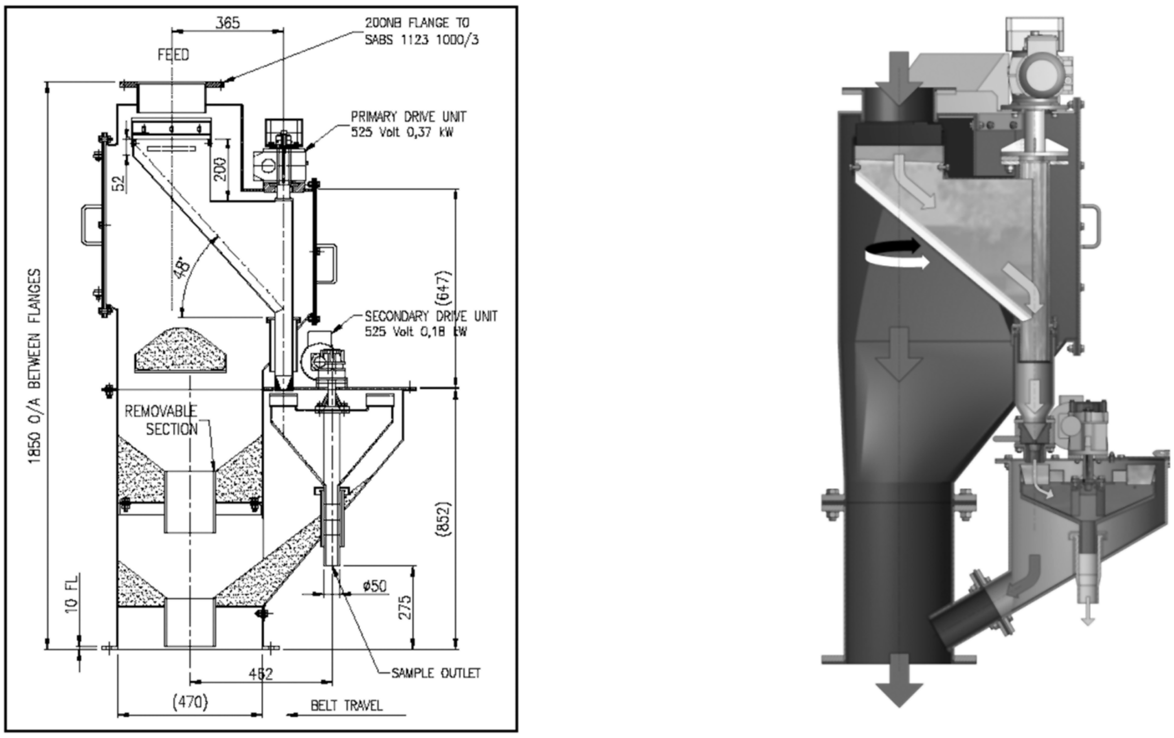

Figure 16. Combined primary and secondary sampler for dry sand

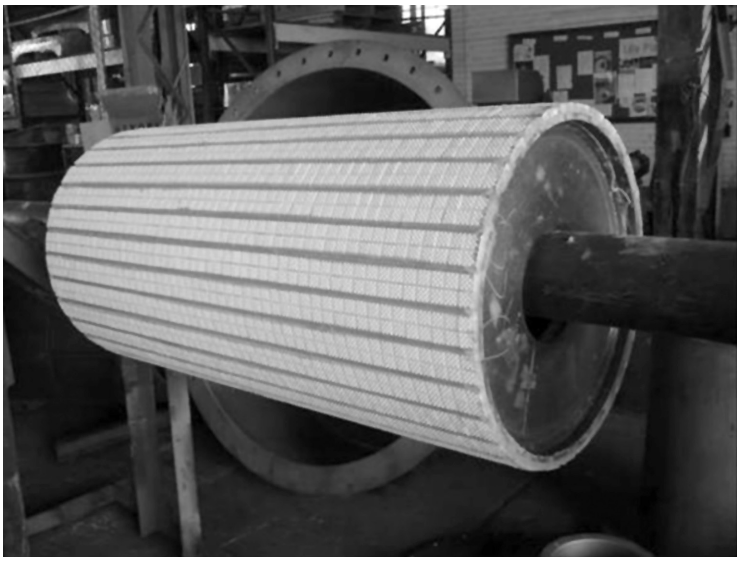

Figure 17. Typical pulley lagging

Ceramic linings

One very successful application of ceramics was the lining of pulleys where a special flexible epoxy was developed for the application. The design must also allow for the quick dissipation of water or slurry as well as good grip. Since the inception of the concept seven years ago over 4 000 pulleys have been installed mainly in Africa and Australia with only one failure due to the improper mixing of the epoxy. Figure 17 shows a typical pulley lagging.

Conclusion

The heavy mineral industry maintains a steady stream of challenging applications to suppliers. The successful development of solutions or improvements enabled the Multotec Group of companies to add value for the end user, not only for the mineral sand industry, but also other industries.

Acknowledgements

Multotec appreciates the willingness of the industry to try different solutions and in some cases develop solutions in conjunction with suppliers.

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1968–1972: National Institute of Metallurgy, Research Group, University of Natal
1972–1976: National Institute of Metallurgy, Ore Dressing Division
1976–1978: Electro Mechanical Construction
1978–Feb 2009: Multotec Process Equipment (Pty) Ltd, Managing Director:

Johan started Multotec Cyclones (Pty) Ltd in 1978 with the manufacture and supply of cyclones. In 1985 he started with spiral products and his own spiral production in 1989. Multotec is currently a significant supplier of cyclones and spirals globally. Johan started the sampling division in 1987 under license agreement with Siebtechnic GmbH and has the major market share in Africa.

In March 2009 Johan became the International Business Director or Multotec (Pty) Ltd. He is responsible for the Multotec Group export market and the Managing Director of Multotec Magnetics (Pty) Ltd. Johan also assists the Multotec Group in strategic planning.

Johan has presented papers at various national- and international conferences on cyclones, spirals and flotation and has a number of registered patents.