Bredel
Hose Pumps

Analysis of peristaltic pumping technology in the mining industry

Adding value, minimising costs

Key conclusions

There are key benefits associated with using peristaltic pump technology in the mining sector with respect to added value and cost reduction.

- On average, water savings of 71% can be achieved in comparison with typical centrifugal pumps.
- The treatment of less water ensures less chemicals and equipment are required.
- The number of filters after thickening applications can be reduced. Costing around $100,000 each (filter capacity can be reduced by 25%), the savings are substantial.
- No mechanical seal flush water is required: some centrifugal pumps need 72 litres of water per minute.
- Less storage is needed for tailings – the number of basins can be reduced.
- Lower environmental risks associated with a reduction of water usage.

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Mining industry faces up to water management responsibilities

In a paper prepared for the International Council on Mining and Metals, it was suggested that water access, quality, use and environmental impact directly affect the ability of the industry to operate worldwide. Despite these challenges, mine operators face ever increasing obligations to reduce water consumption.

The importance of water cannot be underestimated, and consequently all mines must carefully assess the impact of mining on local and regional water quantity and quality in order to retain a social licence to operate. With this in mind, best practice water management defines credibility for the mining industry while negating the potential impact of additional costs.

Less water equals fewer costs

Among the key drivers for water reduction and greater water re-use in the mining sector are:

- Environmental responsibility. For instance, the Pascau Lama project on the Chilean-Argentinean border was delayed by a decade because of possible environmental impact.
- The limited availability of water at mines located in desert areas or at altitude.
- Increasing price of water.
- Intake water needs to be conditioned i.e. alum dosing, pH control, etc.
- Effluent water of operation needs to be treated.

In order to increase production and, at the same time, minimise rising costs, companies need to optimise their mining procedures.

The less time a mine requires to pump, add or remove water in the course of processes translates into reduced operating costs. However, the relationship between maintaining a reliable supply of water to support mineral processing, and using as little water as possible in order to have the smallest volume on hand at any

Best practice water management defines credibility for the mining industry

time, means that water inventories must be managed carefully.

Pumps have a vital role to play, and peristaltic pumps specifically can be considered water-saving devices, not simply because they accommodate very high solids-content materials found commonly in mining operations, but because they do not have seals they don't require water for flushing, thus eliminating the requirements to both treat process wastewater or provide pump service water.

Benefits of peristaltic pump technology for mining applications

Peristaltic pumps supplied by Watson-Marlow Fluid Technology Group (WMFTG) can be considered as inherent metering pumps offering repeatability of 99.5%.

Bredel hose pumps from WMFTG, for instance, accommodate continuous flow rates up to 108m³/hr and are extremely durable (pressures up to 16 bar). There are no internal universal joints, valves, dead corners or glands to impact flow, and they are reversible for back-flushing.

Handling thicker slurry flows

Although one main goal of mine operators is to use less water in the transportation process, doing so creates thicker, more paste-like slurries, which in turn creates other issues. More product can be transferred at lower velocities, but pumps and hoses must be designed to handle thicker flows.

Bredel hose pumps can handle undiluted tailings and thickener underflow up to 80% solids. No seal water flush systems, strainers, dampeners, in-line check valves, run-dry protection devices or other ancillary equipment is needed. The entire family of pumps are self-priming to 9m, can run dry safely and can meter accurately to ±1%.

This innovative technology fits the demand for more efficient modes of high concentration slurry transport. The ultimate aim is to reduce water use, energy consumption and capital costs, as well as improve slurry transport reliability by establishing a more fundamental understanding of slurry flow behaviour and design.

Above: Bredel hose pumps have a corrosion-resistant enclosure which suits arduous mining environments

Optimising the transfer of paste backfill

One of the most commonly pumped materials in mining operations is paste backfill, a cementitious composite that is similar to concrete. It consists primarily of mine tailings mixed with hydraulic binders, which are typically Portland cement and some form of supplementary cementing materials, and water.

Residues, slimes or 'tailings' are the materials left over after the process of separating the valuable fraction from the worthless fraction (gangue) of an ore or mineral.

Paste technology is introduced to make the backfill quicker, easier and more cost effective to transport, deposit and cure. The goal for the high density paste formulations is to produce a pumpable material that does not segregate when transferred – the fines content should be a minimum of 15% by weight of the

80% solids

Bredel high pressure hose pumps can handle undiluted tailings and thickener underflow up to 80% solids

108 m³/hr

Bredel hose pumps handle flow rates up to 108m³/hr

±1%

Bredel hose pumps can run dry safely and can meter accurately to ±1%

paste. Naturally, choosing the right pump technology for the task is vital.

Accommodating high solids content

Pumping applications in the mining sector frequently involve abrasive, corrosive, shear sensitive and viscous liquid products. Solids such as rocks, sand and ore comprise different mineral contents and pump systems must be able to accommodate these variations.

Mining slurries often feature sub-micron solid contents of 80% by weight, with specific gravity often greater than 2.0. In addition to offering abrasion resistant slurry pumping performance in arduous conditions for extended periods, pumps must be capable of high operating pressures and flow rates to ensure a smooth liquid passage and deny the opportunity for the product to settle.

Other features include repeatable and reliable flow, self-priming functionality and low and easy maintenance. However, with so many pump types available it is little wonder mines frequently end up employing technology unsuitable for the task. Ultimately this leads to inefficiency and increased costs, typically due to excessive wear and downtime.

Limitations of centrifugal pumps

While centrifugal pumps have traditionally dominated the mining sector, particularly for operations such as thickener underflow applications, they are not without their shortcomings. For instance, the amount of dry solids which can be handled by centrifugal pumps is limited. In several applications, rotors or impellers on slurry pumps last only weeks and membrane pumps clog, leak or fail due to factors such as strong acidity in a matter of months. Attempting to overcome these problems, some mine operators purchased highly expensive special pumps constructed from acid-resistant materials.

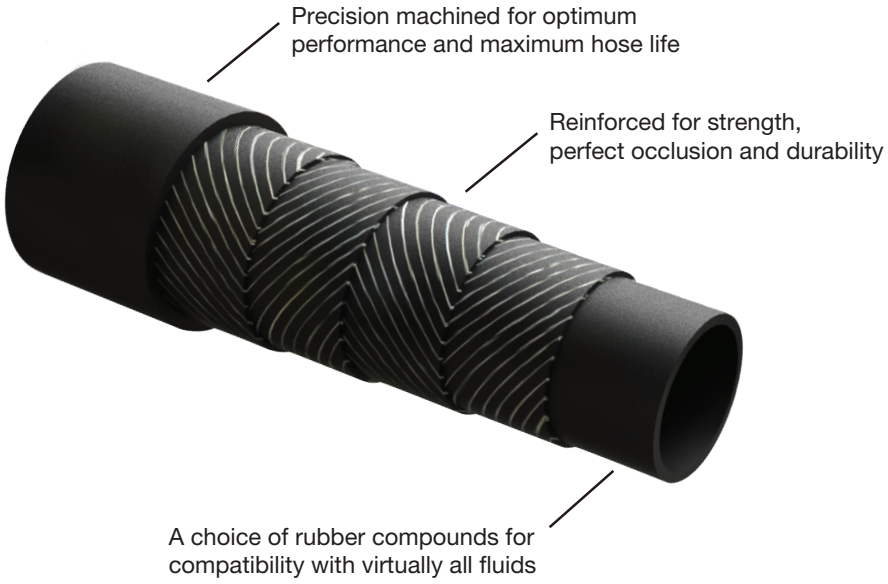
For these reasons peristaltic hose pumps are taking ever greater slices of market share. Among the many benefits of peristaltic hose pumps are:

- No mechanical seals
- No requirement for seal gland water
- No seal water flush systems
- No moving parts in the product zone
- Low and easy maintenance – just one wearing part; the hose
- Almost all materials can be pumped, including slurries
- Backflow and siphoning are prevented without the need for valves
- Wear-free performance

For the mining sector this last point is arguably the most advantageous. Obviously, the longer a pump can operate without maintenance or failure, the better. The wear-free performance of peristaltic pumps is an attribute that results from a unique operating principle. Unlike other pumps, the abrasive nature of the product has no bearing on pump life and the need for routine maintenance and spare parts is reduced greatly.

The only wear-part is the hose, which can be replaced quickly and without special tools

Below: Precision machined hoses guarantee tolerances and perfect hose compression



Hose is at the heart of peristaltic operations

In a peristaltic pump such as a Bredel hose pump nothing but the hose touches the fluid, eliminating the fluid contaminating the pump. Fluid is drawn in and trapped between two shoes before being expelled. The complete closure of the hose, which is squeezed between a shoe and the track, gives the pump its positive displacement action. The result is a pump ideally suited for the transport of typical mining slurries including pyrite, copper, zinc, uranium, nickel, cobalt, silver, platinum, lime and gold concentrate.

Pumps like the Bredel range are virtually maintenance-free as there are no impellers, liners or mechanical seals to replace, no check valves to clog and no rotors or stators to wear out. The only wear-part is the hose, which can be replaced in a matter of minutes with no special tools.

The hose is the secret at the centre of peristaltic technology. This is the part in direct contact with the slurry – so it needs to be both flexible and tough. At the heart of all Bredel hose pumps is a composite hose constructed from compounded rubbers reinforced with four individual layers of braided nylon, and finished by precision machining for enhanced suction, pressure and flow performance over its expected lifetime.

Design features such as these are important because over-occlusion of the hose stresses both the pump and hose, reduces hose life and places unplanned loads on the pump bearings.
Similarly, under-occlusion results in loss of pump efficiency and damaging back-flow, which also reduces hose life.

Calculating the benefits

In a thickener underflow application, consider an example of copper extraction based on froth flotation. Using a hose pump, higher slurry densities can be achieved compared to centrifugal alternatives. This ultimately introduces savings against process water and filtration equipment.

A typical slurry density goes up to a maximum of 3100kg/m^3: Based on 1m^3 of slurry, and assuming that the ore is chalcopyrite ($CuFeS_2$) at a density of 4300kg/m^3, it is possible to calculate volumetric solid content of 63%.
Based on published data for centrifugal pumps, it is known that the maximum dry solid content (by weight) will be 27-29% before efficiency begins to drop. Thus, assuming a maximum dry solid content of 30% by weight for a centrifugal pump, it can be shown that for the transfer of 70 tons of ore per hour (for example), a centrifugal pump will require a flow rate capacity of 181m^3/hr, some seven times greater than that of a Bredel 100 to perform the same task, which offers 26m^3/hr.

A centrifugal pump

will require a flow rate capacity of **181m³/hr** to transfer 70 tons of ore per hour

26m³/hr

A **Bredel 100 pump** will require a flow rate capacity of 26m³/hr to transfer 70 tons of ore per hour

Annual water usage: peristaltic compared to centrifugal pump

	Rubber lined centrifugal pump	Peristaltic hose pump
Sludge concentration by weight	30%	60%
Concentration of solids by volume	21%	47%
Maximum concentration by weight	30%	80%
Flow rate of slurry	3000 LPM	1350 LPM
Annual water consumption	1295m litres	371m litres
Water savings with peristaltic pump compared with a centrifugal pump		**924m litres/year (71%)**

Criteria

- Transferring slurry containing 70 tons of solids per hour, operating 24/7, 365 days per year
- Specific gravity of solids: 1.65
- Specific gravity of slurry 1.13

Not included in this example are savings achieved as a result of lower energy requirements and reduced maintenance.

Evidence of growing uptake

More and more mining industry customers are turning to peristaltic technology to provide solutions to specific problems. This is because peristaltic pumps can help mine operators face up to key challenges, which include:

- Reducing downtime
- Reducing operating costs
- Meeting environmental regulations
- Managing and reducing water inventories
- Reducing chemical usage
- Lowering maintenance costs

One beneficiary of peristaltic technology is a large copper and gold mining company in Arizona which had to frequently replace components on hard chrome iron centrifugal pumps used in a difficult tailings slurry application. The pump impellers were wearing out every two weeks, causing significant downtime and costly repairs. The mine considered several different pump technologies, finally selecting Bredel 100 hose pumps. In this application, the hose pumps transfer tailings slurry 670m to a separate plant. With no seals to flush and the ability to pump tailings with a high solids concentration (80%) the mine uses much less water with Bredel hose pumps, achieving considerable savings in both maintenance costs and water usage. Another example can be seen at Jaguar Mining Inc, which operates four gold mines in Brazil. The company first adopted Bredel hose pumps at its Turmalina mine when it was faced with pumping paste backfill comprising 4% cement and 69% solids. No centrifugal pump could handle the task.

To overcome the challenge presented by paste backfill, the mine operator installed a Bredel 100 on a trial basis and the results were so impressive that it subsequently purchased the pump, which is now transferring the mix with an S.G. of 2.8 at a rate of 50m^3/hr over a distance of 420m. Today, the Turmalina site has installed multiple Bredel hose pumps for applications including backfill operations; Flotation processes; leaching processes and working with reagents.

Above: Bredel 2100 hose pump handles paste backfill @ 69% solids and 4% cement at Turmalina Mine, Brazil

A similar success story at a large mine in New Brunswick, Canada, saw centrifugal slurry pumps replaced with Bredel hose pumps. The 65% solids of the zinc and lead thickener underflow slurries was too high to allow the centrifugal pumps to deliver the desired flow rate, while abrasive wear was causing an unacceptable frequency of costly repair. Because the abrasives in the slurry do not affect Bredel pump life, the mine is now able to minimise downtime and achieve reliability at the desired flow rate.

Accurate chemical metering

Another potential area of saving is through accurate chemical metering. The range of chemicals used in mining processes is vast and includes copper sulphate, xanthate, SIBX/ MIBX, GUAR, cyanide, sulphuric acid, lime, flocculants, zinc sulphate, aerophine, sodium silicate, BIOX, surfactants and sulphides to name but a

few. However, by using microprocessor-controlled brushless DC drive technology, Bredel hose pumps will properly maintain the flotation rates of ore extracts to ensure economical use of expensive chemicals and create significant process efficiencies. Bredel hose pumps have become first choice in mines throughout the world for applications that include dosing process reagents and pumping shear-sensitive polymers for flocculation and coagulation, abrasive lime slurries for pH control, or corrosive chemicals like cyanide for gold recovery.

Ores of course, have different mineral contents and pumps must consistently vary their dosing rates to optimise chemical usage and maintain plant throughput. Additionally, process reagents such as cyanides and acids are often highly corrosive but as the chemically resistive hose of a Bredel peristaltic pump is the only part in contact with the pumped product then there are no working parts exposed to the chemical.

The world's largest trona soda ash mine in Wyoming was experiencing problems with its diaphragm metering pumps used for dosing flocculant into the trona processing lines. The diaphragm pumps would last only five to six months due to the highly corrosive nature of the flocculant. Even after trying to add large amounts of water to the flocculants, which subsequently had to be removed from the process, the diaphragm pumps would still fail.

The mine purchased several Bredel hose pumps to address pump maintenance and flocculant wastage problems. The hose pumps' inherent corrosion resistance allows the mine to pump pure flocculant into the discharge lines and holding tanks. With no need to add water, the mine is saving money in water usage, process downtime and maintenance costs.

Above: Unlike other pumps, the performance of Bredel hose pumps is not affected by abrasive slurries and chemicals

Conclusion

Moving ores, concentrates and residues in slurry form are essential parts of industrial mining processes. In an effort to reduce water, energy and chemical consumption, and improve slurry transportation reliability, more and more mining operators are discovering the simplicity and benefits of peristaltic hose pumps. With thousands of Bredel hose pumps already at work around the world, there is little doubt that hose pumps are the solution. ■

Bredel Hose Pumps is a brand of Watson-Marlow Fluid Technology Group.

Watson-Marlow Fluid Technology Group is the world leader in niche peristaltic pumps and associated fluid path technologies. Comprising ten established brands, each with their own area of expertise, but together offering our customers unrivalled solutions for their pumping and fluid transfer applications

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