SmartCyclone™ innovations optimise separation efficiency and uptime

MechChem Africa visits the Stormill facility of FLSmidth's Pumps, Cyclones and Valves (PCV) business in Roodepoort to talk to the company's cyclone specialist, Abrie Schutte, about cyclone separation technology and the significant advantages that innovations such as SmartCyclone™ bring to mill circuit operations.

Abrie Schutte, senior applications engineer at FLSmidth responsible for KREBS® Pumps Cyclones and Valves (PCV) Product Business Line, describes himself as a cyclone whisperer. "My role is to support installations, to go to the customer and see that the equipment we supply to them is working at its optimum: to ensure that the equipment wear life is good and the actual duty is being achieved," begins Schutte.

"And I also help with training cyclone operators to understand the equipment, which isn't very difficult, but I show them how they can set up and use FLSmidth cyclones to get the best out of them," he tells *MechChem Africa*.

"We supply hydrocyclones to mill circuits all over the world for the recovery of minerals such as gold or copper. And through collaboration with mine operators, we strive to get the best possible operational performance and wear life out of them, and the minimum possible downtime," he says, adding that as well as the cyclones, he also takes care of the KREBS® pumps and valves that are installed along with the cyclones.

Describing the core purpose of a hydrocyclone, Schutte says ore coming from a mine must first be crushed and then milled down to the size fraction required to liberate the target minerals. "The cyclone separates oversized and finer particles, with the fines usually sent downstream for further processing: to leach or other minerals liberation processes," he explains, adding that the 'oversized particles' are extracted from the bottom of the cyclone and sent back to the mill for further milling.

"The key to success is that the product coming out of the cyclone overflow is as close as possible to the ideal size for liberating the gold, copper or whatever mineral the mine is producing," notes Schutte.

In principle, he says, a hydrocyclone relies on specific mass difference of particles and the water medium to separate efficiently. "Due to the centrifugal forces created by the cyclonic action, the coarser particles are thrown to the outside wall of the cyclone, while the finer particles accumulate in the core at the centre of the cyclone.

"The medium on the outside with coarse particles exits the bottom of the cyclone via the apex, while the fine particles move upwards through the centre and exit the cyclone at the top," he explains.

Optimising hydrocyclone performance

"There are several areas of focus for optimisation we take care of in the design and operation of our hydrocyclone solutions. Cyclones have only two exit openings: the overflow opening or vortex finder, and the spigot opening, which we call the apex. And if you can keep these two orifice sizes as constant as possible through the life of the cyclone, you get the maximum performance in terms of separation efficiency," he explains.

He says there are a few variables which are part of the cyclone itself that can be adjusted to improve the separation performance: such as the vortex finder and spigot diameters, the cyclone cone angles, the size of the cyclone diameter. Then there are the adjustable process variables, such as feed density and pressure, which also influence performance and separation.

Abrie Schutte, senior applications engineer, product business line KREBS® Pumps, Cyclones and Valves at FLSmidth.

"We can improve the wear life of each individual section of our cyclones. We have developed the capability to change inside liners of each separate part of a cyclone so wear life can be extended. We can use different liner materials in the different sections – such as ceramics for high wear areas and rubber for lower wear areas. This balances the wear life of each part and helps the cyclone to run efficiently for much longer before needing the liners to be replaced. It also ensures that all the liners can be replaced at the same time, which maximises availability and reliability," Schutte says.

He explains that the goal is to maximise the lifespan of the equipment, achieving up to 12 000 hours in certain applications. "This equates to approximately 16 to 18 months before liner replacements are necessary. We conduct audits on the cyclone during the initial installation to assess the rate of wear on the liners. Once identified, the liners are replaced with enhanced materials like ceramics, enabling us to extend the lifespan of the equipment.

"On a copper primary cyclone application, for example, which could be very aggressive, different grades of ceramic material are used to optimise the total wear life and to ensure that all the liners can be economically replaced at the same time."

The KREBS® SmartCyclone™ Wireless System from FLSmidth is a gamechanger for process plants.

Setting and maintaining the cut size

Schutte cites several variables that can influence the cut size in a hydrocyclone cluster: Mainly the feed density, the feed pressure, the apex size, the vortex finder size, and the slurry viscosity.

"We call these the control variables. The viscosity is generally a given, based on the nature of the ore and the external set up. But by controlling water addition or changing the number of cyclones in operation, the throughput volume in each cyclone in a cluster can be varied. The energy level going into each cluster is set by the pump pressure, and a combination of all the variables; the feed density, feed pressure, cyclone apex and vortex finder size, determines the cut size at which the particles separate.

Schutte explains that the key parameter used for optimising a cyclone is the D50 cut size and the P80 in the overflow product. The D50 cut size describes the cyclone and is the size of the particle that has a 50% chance of reporting to either the overflow or the underflow. The P80 size is the particle size in the overflow where 80% of the particles are smaller than this size.

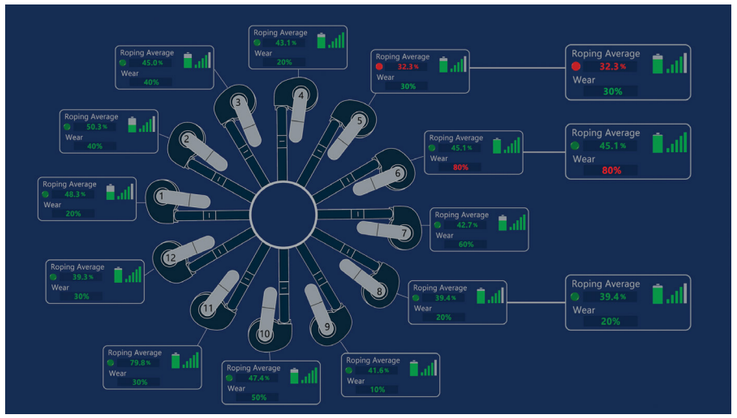
Key FLSmidth innovations

Schutte cites three key innovations that set FLSmidth KREBS® hydrocyclones apart from traditional equivalents. First is the gMAX® cone angle, second is the gMAX® inlet head geometry, and the third one is SmartCyclone™, an advanced control system for detecting roping in individual cyclones.

With reference to the cone design, Schutte says the KREBS® gMAX® cone angle increases the tangential velocity and the residence time in the cone sections. "In the end, you get a substantially finer separation, with fewer fines in the underflow and less coarse material in the overflow."

New cyclone inlet head geometry has been developed using computational fluid dynamics (CFD) to reduce wear and improve separation efficiency. "The new inlet head was developed to get improved pre-separation of the slurry and to reduce turbulence at the inlet head liner." says Schutte.

He adds that reduced turbulence results in better separation. "The profile reduces the amount of misplaced coarse particles that bypass to the overflow, while another big bonus is that this extends the life of the inlet liner – by at least 33%," he informs *MechChem Africa*.



The KREBS® SmartCyclone™ condition monitoring system is able to alert plant operators as soon as cyclone roping or unstable discharge is detected.

KREBS® cyclone manifolds have at least two cyclones on standby. As soon as roping or unstable discharge is detected, the operator will be informed via the SmartCyclone™ system and action can be taken.

The third and most significant KREBS innovation is SmartCyclone™, which enables mill operators to maximise their grinding efficiency through an automatic cyclone condition monitoring and control system.

Schutte explains: "The system starts with a sensor that monitors the underflow discharge for a condition called roping. If, due to high solid loading, for example, the apex becomes constricted or partly clogged, the underflow will change from a healthy conical flaring shape to a cylindrical 'rope' shape. When that happens, classified coarse material will start reporting to the overflow, reducing the separation efficiency, and roping in a cyclone is bad."

The unique sensor at the heart of the SmartCyclone™ system is a wireless sensor mounted externally below the apex/spigot of each cyclone in a cluster. "We size our cyclone manifolds to have at least two cyclones on standby, so on a 10 place cyclone cluster, two or more will not normally be in use. As soon as cyclone roping or unstable discharge is detected, the operator will be informed via the SmartCyclone™ system and action can be taken, such as to shut off the feed valve to the affected cyclone and open the valve to one of the extra cyclones in the cluster. This resolves the problem for the overall system and restores optimal separation efficiency.

"We can then send a maintenance technician to inspect and resolve the problem on the affected cyclone, making it ready for use," says Schutte

The net result, he says, is a cyclone cluster that can operate at optimal performance for long periods of time, resulting in significant savings from reduced downtime and reduced losses of valuable minerals.

"We have users of SmartCyclone™ reporting a downtime savings of US$250 000 per 1 000 tonnes of product. With typical volumes on a gold plant of 12-million tonnes per annum, the payback period on a SmartCyclone™ investment can be very short," says Schutte.

"At FLSmidth we offer world-leading technology and have become the clear Number 1 supplier of hydrocyclones around the world over the past few decades: for gold, copper, platinum and many other mineral plants. We are very proud of our SmartCyclone™ technology, our KREBS pumps that feed our cyclones and the valves used to manage them," he concludes.