CCD thickeners: a retrofit opportunity

MechChem Africa visits the Constantia Kloof premises of FLSmidth to talk to Terence Osborn, commercial manager of minerals in sub-Saharan Africa, and Roy Hazell, the region's head of sales, about the company's counter-current decantation (CCD) thickeners, its P-Duc feedwell innovation and the use of LDX stainless steel for highly acidic application.

"A few years ago, our business was about helping mines to increase production. Today we have an added dimension and the focus is on operational efficiencies, such as reducing clean water consumption, using less flocculant, improving reliability and extending life. Our current role is to use what mines already have and do more with it," begins Hazell.

"Along with our REFLUX™ Classifier (RC™) technology, another driver of our customer vision towards sustainable success is our CCD thickener technology," he says, adding that a definite market for thickener optimisation has been identified and several retrofits have already been done.

Thickeners are an essential component of mineral processing plants. Following production of the final mineral concentrate, solid concentrate needs to be dewatered before being dried and shipped for smelting. For solution-based mineral processing, such as the liquor needed to produce copper or uranium in electro winning, ion exchange or solvent extraction processes, the liquor solution needs to be concentrated to extract the maximum possible amount of the dissolved metal from a mineral slurry.

In the above scenarios, FLSmidth offers retrofit thickener solutions that can improve recoveries, as well as purpose-designed new-build systems that give optimal thickener performance.

"Thickeners rely on gravity to separate liquids and solids from a slurry. The clear supernatant is taken off at the top as a clear liquid overflow, while the solids are allowed to settle before being extracted from the underflow of the thickener," explains Osborn.

The solid particles in the slurry may be relatively course or very fine, depending on the mineral and the treatment process being used. The finer the particle, the more likely agents will be required to aid settling, and two common additives are used: flocculants and coagulants.

"Flocculants are a long chain polymer with active charge sites that make them act like 'sticky string', attracting and clumping small suspended particles into bigger aggregates that can more easily be settled out.

"Coagulants, on the other hand, work on a surface charge effect, binding particles via electrostatic forces to enable them to coagulate and settle," Osborn tells *MechChem Africa*.

"And some complex slurries might need both to be used at the same time," adds Hazell.

"There are many applications for FLSmidth thickeners: sometimes a dilute slurry needs to be concentrated up, so the mineral product is in the underflow; sometimes simple dewatering is required to recover process water for reuse in the plant, in which case a very high underflow density will be targeted; then there is the third option, where the liquor from the overflow is the product required," Osborn continues.

FLSmidth 40 metre diameter CCD thickeners.

The thickener feed arrangement with P-Duc.

35 metre diameter CCD thickeners in a copper leaching circuit.

Typical solid to liquid densities of underflow slurries are around 56% solids by weight, but if recovering water or liquor, a taller paste thickener can sometimes be used, which can achieve densities of up to 70% solids.

Counter-current decantation CCD

For hydrometallurgical circuits where the mineral product is already dissolved in an acid solution, the role of the thickener is to remove the solids, while recovering a clear liquid solution with the highest possible concentration of the dissolved mineral. "Our CCD solution is about optimising this concentration while minimising the amount of water used," says Hazell.

Osborn explains how this works: "The solution concentration process will usually involve a row of several thickener units. Each has a tank bridge across the top to house the mechanical drive for the rake, which turns very slowly above the bed of sediment, pushing it towards an underflow outlet at the centre of the tank.

With CCD, low metal concentration slurry taken from the underflow of the second last thickener in the row, is mixed with the 'fresh' water coming into the last thickener in the row.

The underflow – from the last thickener unit – is then discarded, but the very dilute liquor proceeds to be pumped up the row of thickeners, becoming more and more concentrated as it passes through each unit.

"At the top/first thickener, the now concentrated liquor is mixed with the incoming slurry, which at this point has the full mineral load in solution. The overflow supernatant is then removed, having been concentrated as much as possible by this counter flow process," Osborn explains.

"The solids flow in the opposite direction to the liquids, so every time liquor and slurry are mixed, more of the mineral solution is transferred to the liquor, while the slurry is becoming more and more dilute in metal concentration. We can have up to seven of our thickeners on a CCD circuit," adds Hazell.

The E-Volute™ feedwell system

FLSmidth's best known patent on its thickeners is its E-Volute™ feedwell and dilution system, which governs the way the slurry and the fresh water/liquor enter the feedwell and are mixed to promote maximum interaction. "We are unique with respect to our patented E-Volute feedwell arrangement," says Hazell.

"A very specific solid to liquid content in the E-Volute feedwell is required to promote optimal settling and we are able to control this due to several innovations," Osborn explains. First, the evolute shape of the feedwell promotes a tangential mixing action for better mixing efficiency. In the E-Volute feedwell, the slurry and dilution liquid streams are combined and mixed to achieve an optimal density of about 10 wt. % solids.

"This is not always possible, however, so we also add a system to pump additional supernatent from the top of the thickener back into the feedwell. This flowrate is controlled via a variable speed driven P-Duc pump so that exactly the right amount of liquid is added to give ideal feedwell density. That is the P-Duc concept," Osborn tells *MechChem Africa*.

Materials and construction

Another key design feature of FLSmidth's thickeners involves the materials of construction: "which are very important because we are often dealing with acidic solutions with pHs down to less than two".

"While 316L stainless steel was the material of choice in the past, we have moved onto a material called LDX – lean duplex stainless steel – which has corrosion resistance as good as 316L but with the strength properties much greater than carbon steels. This applies for everything that comes into contact with liquid: the tank – the feedwell, the rake and the inlet and outlet piping.

From a construction perspective, FLSmidth has also developed a bolted thickener design: "Tanks usually get sent to site in rolled sections and these are welded together. But this requires skilled welders, who are not always readily available.

"So we can offer a bolted thickener tank design with flange connections, which enables onsite assembly by relatively unskilled workers in far less time. In addition, we trial assemble sections the system in our workshop prior to delivery to make sure that everything fits and that nothing is missing," Hazell says, adding that on disassembly, the parts are then match-marked before sending to site to make assembly foolproof.

"In some of the places we go in Africa, such as Mali and Mauritania, for example, skills are scarce, but semi-skilled workers for bolted assembly work are available. And while the flanged system is a little more expensive in mass and fabrication, construction costs and delay risks can be significantly reduced," he suggests.

In terms of costs, Hazell says that FLSmidth offers only the best technology, but also strives to be cost competitive. "When FLSmidth fabricate, we are finding we can supply our better-technology systems at lower landed costs than competitor products from China, even for mines in Africa under Chinese ownership."

Osborn adds: "And we can retrofit our CCD, P-Duc, feedwell, feed pipe, bridge and rake technologies onto existing thickener tank systems to make it very easy for existing mines to optimise their mineral's processing streams."

"FLSmidth is recognised for its innovative technology and everything we install is built for ease of operation, ease of maintenance, optimised minerals recovery and low ownership costs," Hazell concludes. ❑