Desalination of mine water at Sasol Secunda

Besides air, water is typically the prime environmental medium affected by mining activities. Consequently, sound management practices to prevent or minimise water pollution are fundamental in order for mining operations to be sustainable.

An example of best practice in this field is in operation at Sasol’s Synfuels operations in Secunda, where excess water from underground mining operations in Secunda is desalinated by means of a membrane plant (Electro-Dialysis Reversal or EDR) and further desalinated using a spiral reverse osmosis (SRO) membrane. The SRO permeate is re-used in the Sasol Synfuels operations as high-purity boiler feed water.

Desalination is the process of removing salts and minerals from water in order to produce an end-product that is suitable for human and animal consumption, irrigation or industrial use, or discharge back into the surface water system.

Explaining the Secunda plant process, Morné Bezuidenhout, Principal Process Engineer at Secunda says, "Excess water is collected in a holding dam. From the holding dam it is pumped to the first of two desalination plants (Desalination East) by means of an 11 kilometer long pipeline. The water enters the flash mixer where it is dosed with anionic flocculant to start the removal of iron and manganese."

He adds that flocculation is the action of polymers to form bridges between smaller non settling-particles that form large settling-particles commonly referred to as flocs. Bridging occurs when segments of the polymer chain adsorb on different particles and help particles aggregate. An anionic flocculent will bind to a positively charged suspended particle, adsorbing a number of particles' surface, which results in a stable aggregate.

From the flash mixer the water is fed to a clarifier where it is further dosed with a cationic polymer. The water flows vertically up and the flocs form a suspended bed. The flocs keep growing and once it is large enough, it will sink to the bottom of the clarifier from where it is pumped to Inside Ash for final disposal. The clarified water flows through a sand bed to remove any suspended particles. From the sand filter the water is stored in an underground tank and then pumped through 10 micron filters and on to the heat exchangers in order to increase the temperature to 300°C — the optimum temperature at which the membranes in the Electro-Dialysis Reversal process operate.

Electrodialysis (ED) is a process based on the principle that most dissolved salts are positively or negatively charged and will migrate to electrodes with an opposite charge. Selective membranes that allow passage of either anions or cations make separation possible. ED uses these membranes in an alternating fashion to create concentrate and product streams.

The anions are able to pass through the anion-selective membrane, but are not able to pass by the cation-selective membrane, which blocks their path and traps the anions in the brine stream. Similarly, cations move in the opposite direction through the cation-selective membrane under a negative charge and are trapped by the anion-selective membrane.

In this manner, dissolved solids in the form of salts are removed from the wastewater stream.

Electrodialysis Reversal (EDR) is similar to electrodialysis but the polarity of the electrodes is regularly reversed, thereby freeing accumulated ions on the membrane surface and preventing scaling and fouling. Once the EDR process is complete, the water passes through five micron filters and a spiral reverse osmosis (SRO) process. During osmosis, a solvent (water) naturally moves from an area of low salt concentration through a semi-permeable membrane to an area of high salt concentration. The pressure exerted by the molecules of the solvent on the membrane they pass through is called osmotic pressure. Applying an external pressure to reverse the natural flow of solvent is called Reverse Osmosis (RO).

Through the application of pressure to a medium solute concentrate when it is on one side of a selective membrane or filter, reverse osmosis removes water from the medium concentrated stream making it more concentrated. Large molecules and ions do not pass through the membrane. The end result is that the large molecules, ions and pollutants are retained on the pressurised side of the membrane and the purified water is allowed to pass to the other side and is referred to as the permeate. The permeate is of good quality and can be used as feed to the boilers.

The brine that is formed in the RO process is fed to the evaporator crystallizer plant. It is firstly acidified to bring the pH level down and de-aerated to avoid the build-up of calcium carbonate scale while the water is evaporated. The concentrate formed is purged to a filter system to strain the suspended solid particle of calcium sulphate.
The filtrate is sent to a second crystallizer where more water is removed to form sodium sulphate which is sold into the market. The final purge from the plant is less than 0.5% of the original stream which is routed to the ash plant. The brine combines with other brines from the factory routed to the ash plant where it is used as a transporting medium for ash to the outside ash dams.

Bezuidenhout points out that the whole desalination process is an integrated environmental management system in terms of which condensate, for example, is recovered and re-used in the plant. “Sasol is the only company in South Africa to use EDR in the mining water desalination process and this is saving approximately 8 million litres of water per day,” he said.

Water quality testing at Secunda