

THE APPLICATION OF MEMBRANES and PHOSPHORIC ACID PURIFICATION

By

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ABSTRACT

Membrane applications in process plants are relatively novel, though becoming increasingly more accepted as a process unit operation.

One example of a membrane application is the Acid Recovery Plant (ARP) that has been successfully installed and commissioned at the Kayelekera Uranium Mine in northern Malawi. A Solvent Extraction plant would have been a more traditional approach for reagent recovery, following Ion Exchange, but the cost effectiveness of membrane technology led to its implementation.

The installation of the membrane-based ARP in a uranium mine is believed to be the first commercial-scale operation of its kind in the world. The design has successfully demonstrated that a uranium-containing acid stream can be separated into a clean, uranium-depleted acid stream containing the majority of the acid and a low-volume, concentrated uranium stream. Apart from the significant acid savings (circa 40 t/day 98% sulfuric acid), the ARP also resulted in significant reagent savings in neutralising chemicals downstream of the ARP. At a capital cost of US\$5M, the net operating cost savings of approximately US\$3 per lb U₃O₈ resulted in a simple payback period of 7 months.

Based on the success of the first membrane plant at Kayelekera, a second plant was designed, installed and commissioned at the Langer Heinrich Uranium Mine. This plant, designed to recover sodium bicarbonate from the Concentrated Eluant (CE) stream, was successfully commissioned and performed above design expectation.

While both applications recover the eluant following the Ion Exchange unit operation, a key difference with the process at LHM is that an alkali eluant is used, sodium bicarbonate. The Bicarbonate Recovery Plant (BRP) at Langer Heinrich recovers sodium bicarbonate from the CE and produces a clean, uranium-depleted sodium bicarbonate stream and a low-volume, uranium-rich stream. With a capital cost of US\$7M, this project has demonstrated a simple payback period of 3 months.

Membrane technology is establishing a proven track record in challenging operating environments. Further applications of membrane technology in the process industry is being explored as a cost-effective alternative to traditional approaches.

Arafura Resources Nolan's Bore Project is a rare earth rich massive apatite deposit located in the Northern territory. Phosphoric acid is produced as a by-product of its pre-leach process and its flowsheet currently utilizes an IX process to reduce uranium and thorium from this product down to trace levels.

While IX is the current process on the flowsheet, Arafura is investigating the use of membrane technology to compliment the flowsheet. The attraction of lower capital and operating cost is an incentive to use membrane technology.

Desktop modelling showed significant promise, leading to membrane testwork being undertaken with a variety of membranes using process fluid from prior upstream testwork. Test results have shown that the uranium and thorium is significantly stripped from the phosphoric acid, while also stripping other contaminants like iron and aluminum.

While membrane durability testwork and phosphoric acid purification flowsheet development is still underway, the use of membrane technology to purify the phosphoric acid stream is showing significant promise and the potential of adoption into the Nolan process flowsheet.

Keywords: acid recovery, membranes, nano filtration, phosphoric acid, BMS Engineers, Arafura Resources