(excerpt from Chemical Engineering Nov. 2017 article by Mary Page Bailey titled: "Extending Membranes' Reach Across the CPI")

Lithium recovery

New membrane technologies from Membrane Development Specialists (MDS; Escondido, Calif.; www.mdsamericas.com) enable the recovery of lithium from two diverse sources: lithium clay and recycled batteries. Due to the dilute lithium concentration of clays, achieving efficient recovery is quite challeng-ing. MDS' patent-pending process (Figure 2) involves acid digestion of clays with proprietary NF, ultrafiltration (UF) and reverse-osmosis (RO) membrane processes.

"In this process, we are concentrating lithium as a sulfate: The permeate will contain 50-80% of the acid that is used, which is recycled back into the process," explains Larry Lien, managing director of MDS.The technology enables the use of lithium deposits that previously were viewed as too dilute for feasible recovery. The technology has been demonstrated at bench scale, and MDS is currently working with stakeholders to develop it for larger-scale operations. Since the process is based on established technologies, and requires no underground mining, Lien is confident in the scale up potential. Lien projects that a 1,000-gal system could produce 5 tons of lithium carbonate per day.

After acidifying the clay, a UF unit removes the suspended solids. Next, a specialized NF membrane removes divalent cations like calcium and magnesium, and in some cases, rare-earth elements (REE) that can be concentrated in this step as well. The resulting permeate is a relatively pure stream of lithium sulfate, chloride or nitrate, which is concentrated with acid. "We concentrate the lithium stream up to 1,000 to 2,000 ppm, depending on what the osmotic pressure will allow," explains Lien. "We can recover up to 96% of the lithium that is leached out of clays, so it is a pretty attractive solution," he adds.

End-of-life batteries are another potential source of lithium. Since the lithium used in batteries is already quite pure, the process is

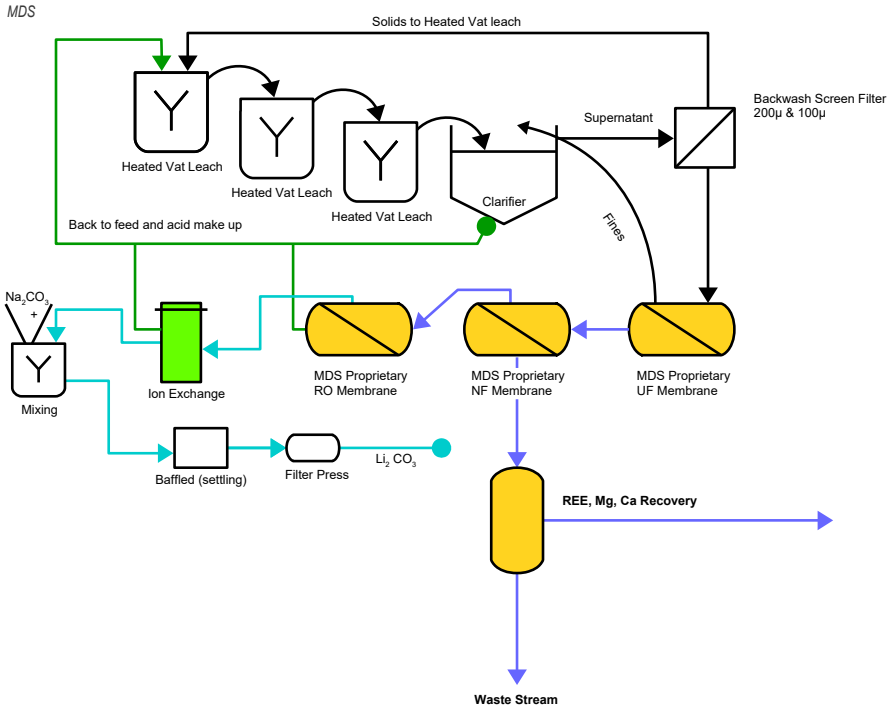

FIGURE 2. Several membrane steps enable the recovery of a concentrated lithium stream from dilute clay

somewhat simpler than recovering lithium from other sources, and MDS has already commercialized an analogous process for lead-acid batteries. For lithium recovery, batteries are first acid-digested, and the carbon and suspended solids are removed using a specialized hollow-fiber UF membrane. Then, subsequent NF and RO steps concentrate and separate lithium from cobalt and other components, while 75% of the acid and 90% of the water are recycled for reuse. "You end up with a highly concentrated lithium sulfate or chloride solution that can be precipitated out," says Lien. The process can be configured as a permanent, fixed installation, or as a mobile, fully contained skid.

According to Lien, the challenge lies not in the extraction or purity of the lithium, but in the logistics of collecting a sufficient number of batteries to make the process economically sustainable. Here, the infrastructure for efficient, large-scale recycling is critical to the project's feasibility. MDS is currently working to license this technology in China, where specific recycling mandates have been implemented. According to Lien, the recovery of cobalt, and other battery materials, such as graphene, may further contribute to the economics of the process.

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