CONVERSATIONS WITH OLI EXPERTS

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Lithium Mining: Maximizing yields and lowering costs with electrolyte simulations

Conversations with OLI Experts on Science of Electrolyte Chemistry Issue 2.0

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Key Questions for the OLI Expert:

- What do we mean by Lithium extraction? Can you give us some context on how this is done and why it is important?

Li is present in minerals, dissolved in brines, and waste batteries. All groups represent an extractable source of lithium. The key, like all commodities is extracting and purifying the lithium in a profitable and environmentally acceptable way. The two most important extraction process at present are the harvesting of lithium from very saline brines and the separation of lithium from silicate minerals.

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Lithium demand is expected to increase several-fold in this decade and sourcing this lithium in existing or new deposits is the challenge moving forward. For now, optimizing Li extraction from existing sources is the most common reason that clients come to us.

- What are the different ways to 'mine' or extract Lithium? Is one approach better than the other? Why is this challenging?

These three extraction processes differ significantly.

Lithium from saline brines is obtained by evaporating the liquid in ponds to precipitate less soluble salts like NaCl, CaSO4, KCl and other evaporative salts. This produces a final liquid comprised of MgCl2 and lithium. The fraction of evaporation may be 95% and higher, which has the effect of increasing the lithium concentration by a factor of 20x. Lithium must then be extracted from this bittern brine and is done by chemical addition.

Lithium from silicate ore follows a multi-step extraction procedure. The Li-bearing mineral, spodumene, petalite, or lepidolite is removed from the rock by sorting or other separation process. This ore is then roasted to change the crystal structure. This modified crystal is more susceptible to acid leaching. Then an acid solution extracts the lithium from the mineral and this pregnant leach is then sent through a series of chemical washing and separation steps to concentrate the lithium and removing impurities.

Lithium from waste materials like batteries follows yet another set of extraction procedure. In this case, the metals are leached from the waste using a strong acid. Following this step, transition metals (Cd, Ni, Mn, and whatever else it contains) are separated. The lithium is then purified with chemical precipitation.

- How are electrolytes and water chemistry relevant to lithium extraction?

Lithium extraction from salt basins is a wholly electrolyte-based process. In fact, because of the high concentrations and because there are many different elements in the water (multicomponent), it is next to impossible to perform an accurate mass balance of the process without a rigorous model. The evaporation process does not form simple salts like NaCl or KCl only. In fact, there are several double and even triple salts that will precipitate as concentrations increase. Thus, the pond overflow composition will differ from any composition estimated using a basic water chemistry program.

- What is the science behind the effective extraction of lithium?

The principle science behind Lithium extraction in any of the above forms is understanding the properties of these very concentrated electrolyte solutions. Salar brines will have salinities in the hundreds of thousands of mg/l, extracting lithium from batteries creates a black mass, that does not resemble any normal liquid phase. Perhaps the only fluid that is recognizable as a normal water is the pregnant leach extracted from the silicate rock. That still needs to flow through a series of reaction and separation processes before it is purified.

Thus, without critical understanding of this science, designing and operating processes must rely on heuristics and past experience to produce optimal results.

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- What specifically is OLI doing to improve the design and operation of processes for lithium extraction?

OLI is approaching this industry in a few ways. The first, and most important was started six years ago when we started development of the Salar component thermodynamic modeling. This included the chemistry around Li, Na, K, Mg, Ca, SO4, CO3, B(OH)3, and Cl. The second was to use this technology in our software tools to simulate and optimize existing salar operations. An ALTA 2019 paper authored by Diana Miller and me describes the evaporation process of six major salar brines in the Andes and in the western US. Lastly, we are using our capabilities in ion exchange and solvent extraction to model and optimize the next generation of lithium extraction technologies.

- What are the key technology elements of OLI's solution for optimizing the lithium extraction process?

The key technology element is what we call solution chemistry, the ability to predict the properties of the water and the salts it contains. When we developed the salar database, we include the solubilities of twenty-seven important salts that can play a part in salar evaporation.

The next important step will be to harness our capabilities in ion exchange, adsorption, and solvent extraction to help clients develop more environmental-friendly and more cost-effective processes.

- How can our viewers learn more about improving the design and operations of more effective lithium extraction processes?

Some processes that we work on are generalized operations, and in these cases, we can help them improve design and operations simply by simulating their current BOD or process. Thus, simply by contacting our technical support group, we can together, work up their current process can compare predictions with the measured values. Thus, a phone call and a design of their process is all they need to get started.

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