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Direct Lithium Extraction – Questions to Ask

We get asked many questions about Direct Lithium Extraction (DLE). For systems using packed bed columns, here are some technical details to consider:

1. How good is the analytical data? How detailed are the sampling, sample preparation and analytical method procedures? The ICP instrument method is usually very good. It's the sample taking and sample preparation that might not be as rigorous.

2. How detailed, frequent and sequential are the sampling data points? Is there real time statistical process control at the critical points? Is there a live working model that shows expected results against actual? The key to success in these systems is being able to see problems early and in real time.

3. What is the lithium concentration of the DLE feedstock brine? The overall economics for a 10000 MT LCE plant usually start to pencil out favorably at about 200 ppm (mg/kg) Li. Under 100 ppm (mg/kg) Li and it gets tough to make the economics work. Between 100 ppm and 200 ppm requires much detailed consideration of other factors to see if it works economically. There are newer methods being developed in various labs that are trying to present economic solutions for the lower grade resources.

4. What else is in the feedstock brine and at what concentrations? Review the specific impurities to Li ratios at all the sample points in the system. The specific list might include: SiO_2 to Li, Fe to Li, SO_4 to Li, Ca to Li, Mg to Li, K to Li, Na to Li, B to Li, Mn to Li, and Sr to Li. These ratios will determine whether the economics of purification to hit the required finished product specification will work. No two brines are the same. Make sure the resource is well characterized. This goes back to question 1 on the quality of the analytical data presented. Many brine resources show variable ratios at different times of year, at different locations, and for different sampling procedures.

5. What is the disposition of each of the materials other than the lithium separated from the brine? Many projects get stopped short quickly if the spent brine and separated sludges can not be economically resolved. The spent brine disposition may involve complex agreements within existing permit conditions or operating procedures of the site. Correct characterization of the separated sludges could make or break the OpEx. Disposal costs of improperly characterized material could tank the economics. In the best case, the separated sludges may have interest to other parties as feedstock for other material extraction endeavors. Many times these might be based upon only ideas versus economically viable options. The disposition of these materials will be one of the main topics of the environmental permitting. The permit pursuit will most likely drive the overall schedule of the project through the regulatory approval process. A review of the constituent specific mass and energy balance should be reconciled against the material disposition details.

6. What is the operating sequence in the columns? What measurement controls the cuts: time, delayed analytical tests, experiential knowledge, or real time online data? The sequence is the key to the performance of the DLE which drives production and revenue. Cut too soon and you need more cycles, improper cuts and product cuts gets dirtied. Dirty product cuts from the DLE exponentially increases purification costs down stream. DLE is just the first step. The DLE columns are the heart of the system and do the bulk of the work in the impurities to Li ratio turn around. Leaving too many impurities in the DLE column product will overwhelm the downstream precip, IX, RO and evap systems to where they can no longer run economically. This is one reason why the analytical and the extent of the data set at all points in the system is so important. Up flow, downflow, bed change loading, all the steady state and transition state sequence pieces must be considered, and the interdependent aspects resolved to insure repeatable and predictable operation. Reviewing the load and strip curves and the transition procedures will help to answer these questions.

7. What is the bleed rate of the DLE media? What is the concentration of LiCl exiting the DLE columns? The bleed rate is one factor in how much lithium is lost from the feedstock. The product cut concentration drives the recirculation rate and the sizing of the overall flow paths through this part of the system. Keep in mind that a 10000 MT LCE/yr plant with a 200 ppm Li feedstock brine might be moving 5000 – 8000 gpm of liquid through the column system depending upon recirculation rates.

8. How strong is your solid sorbent or IX particle? Review the particle friability tests. These start with the crush strength on the bench. Also review the particle size distribution tests before and after service life of the material in actual operation. Review the pressure drop per flowrate over time. Look at the data at the end of the sorbent or IX particle life. Confirm the media replacement strategy and that the maintenance budgets reflect these details.

9. How well thought out is the hydrodynamic control of the liquid mass flows? Simple things like opening and closing a valve must be considered carefully in the control system as any abrupt change to flow dynamics will upset the needed laminar desire of the flow. Back mixing will muddle the needed chromatographic front for the mass transfer driving force and performance will be hindered. Hydrodynamic shock will cause the solid particles to grind themselves faster thus reducing the life cycle of the media. Review the column distribution header and collector design. Look for progressive pressure balanced distribution techniques in the physical design of the flow pathways. Maldistribution and channeling will also kill the DLE performance. Review the dynamic model of the control scheme for the switching of flows. Look for the dynamic impulse calculations, not just the base flow rates. Pay attention to the superficial velocity through the system. The superficial velocity should match the bench scale performance developed for the system. Remember that maintaining a complex system requires simple components. Too many moving pieces can lead to exponential growth in maintenance problems over time. Many systems are successful with these aspects

included in the details of the design, just make sure the considerations are built into the expectations for operational skills needed and the OpEx for the plant.

10. How will the plant obtain HCl? No matter what extraction method is applied, HCl will most likely be required the purification process downstream. This is one reason a well-run LiCl electrolysis plant is such an advantage. In addition to the LiOH H2O product, it also produces all the needed HCl and then some.

11. Do you have a cost effective steam supply? Sorbents work at higher temperatures. DLE will not get you all the way to finished product purity specifications. You will most likely need to heat solutions and evaporate at some point downstream. This is one reason hot geothermal brines are getting a lot of interest. Of course with a hot resource, the tradeoff is having more dissolved constituents in the feed brine. In any system, the residual K and Na must be dropped out, and final washing might not get it done within reasonable water usage and lost product parameters without some sort of evap ahead of it. Steam will be needed for an evaporator. The design of this evaporator is critical as you must consider the boil out and the sacrificial fouling surfaces. These are salt plants, and they will be subject to fouling and corrosion to much greater extent that other chemical plants. Wisely chosen materials of construction and significant thought into maintenance cycle in the design, and then built into the system, is the best weapon against having the plant fall to pieces due to fouling and corrosion in a couple of years after starting up. Consider applying mechanical vapor recompression. Think about creative uses of RO ahead of the evaporator to reduce the steam loads.