21st Century White 'Gold'

Extraction of lithium from geothermal waters

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Abstract

There is currently a large movement towards electric vehicles due to their lower environmental impact with respect to emissions. Lithium-ion batteries are commonly used in these vehicles, consequently increasing the demand for lithium. The Earth has extensive lithium reserves that can be utilized, but the task is finding efficient and economic ways of extracting the lithium that have minimal environmental impact. The main sources of lithium are from hard rock and brines[1].

My internship worked alongside Cornish Lithium Ltd, who are focused on sourcing lithium from geothermal waters within Cornwall. My project has focused on trialing novel and known methods of lithium extraction, such as anti-solvent and salt supersaturation methods.

Motivation

- To investigate into the optimal way to extract lithium from geothermal waters for its use in lithium- ion batteries.

Methods

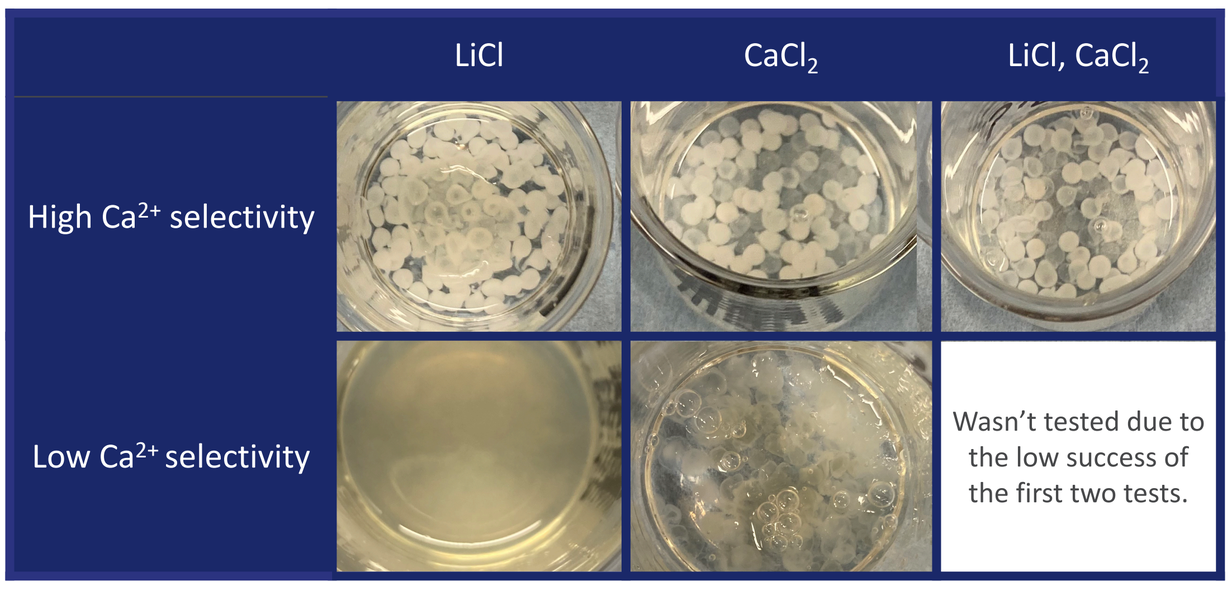
- Precipitation techniques considering anti-solvent and salt additions to aid supersaturation to form a lithium salt.
- Considering methodology to remove Ca ion – which inhibits Li extraction.

Results and Discussion

Limiting Ca interference:

The geothermal waters used for lithium extraction contain many different elements – calcium being the most problematic in our extraction methods, from our preliminary studies. Calcium can interfere with the extraction of lithium so it is desirable to remove it from the solution.

Reactant A was selected to remove the Ca^{2+} from solution – the composition of reactant A can vary however, resulting in different forms having different selectivity. Three mock-up solutions were produced: LiCl, $CaCl_2$ and a LiCl/$CaCl_2$ mix. Reactant A in the presence of Ca^{2+} forms a gel. Both variants of reactant A were studied with the mock-up solutions and the resulting gelation morphology observed, as shown below.

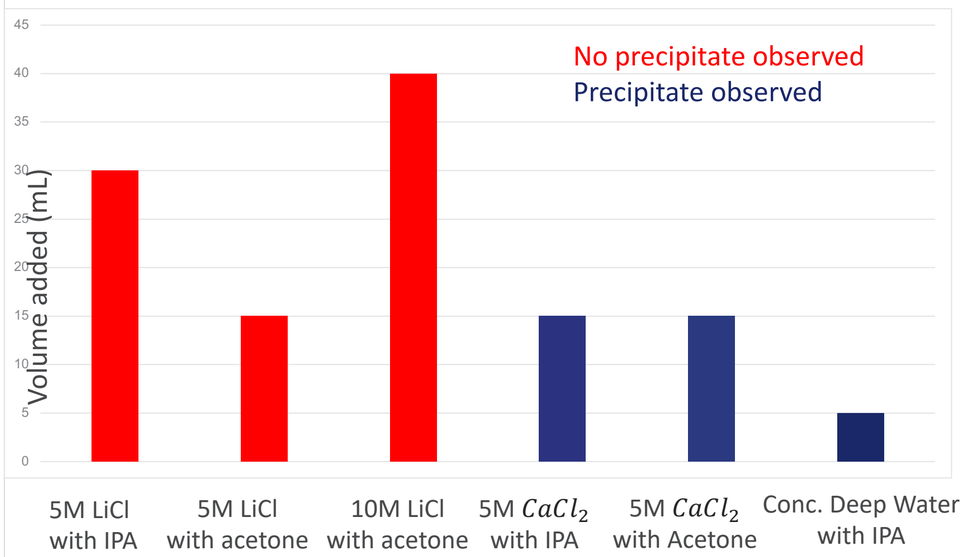


For the high Ca^{2+} selective variant, the gel products were filtered off, leaving a resulting solution for ICP-OES analysis to understand the elemental make-up.

While reactant A was effective in removing 40% of calcium, a reduction in lithium content was also observed.

Antisolvent:

Precipitation techniques using anti-solvent techniques were also considered. Iso-propanol (IPA) and acetone were selected for this trial. Varying amounts of anti-solvent were added to each solution depending on how long it took to observe a precipitate.



Conclusions

Using Reactant A to Limit Ca interference:

- The highly selective reactant strain formed gel balls much more effectively than the less selective strain, aiding separation. Unfortunately, Reactant A while reducing the calcium content, the loss of lithium was also noted.

Antisolvent:

- The anti-solvents were unsuccessful at precipitating LiCl out of the solution.
- Both IPA and acetone were successful at precipitating $CaCl_2$ out of the solution, however, the precipitate observed wasn't a large enough amount to collect for analysis.

Impact / Next steps

- To conduct the anti-solvent technique on larger scales to enable the collection of precipitates for analysis and to quantify separation efficiency.
- To continue alternative lithium extraction techniques (not reported here).

Outreach

My summer research work focused on primary lithium extraction but it also supported efforts in secondary (recycling work). During my internship, I have been part of the ReLiB team and been exposed to this research. I have also taken part in multiple outreach events. I visited Think Tank museum, where I led a battery recycling demonstration to help children think about how the different battery components could be separated and Ecobat, a battery recycling company where I helped interview researchers with questions from school children.

References

1 Understanding the Basics of Lithium Extraction, SAMCO Technologies:

https://f.hubspotusercontent20.net/hubfs/2531874/Understanding%20the%20Basics%20of%20Lithium%20Extraction.pdf (Accessed 11 July 2022).

2 Geocubed, Cornish Lithium Ltd. https://cornishlithium.com/projects/lithium-in-geothermal-waters/geocubed/ (Accessed 18 July 2022).

Intern bio

Erin Budge is studying Chemical Engineering at University of Birmingham.
I am extremely passionate about the environment and learning about different ways we can reduce our impact on it. I am therefore aspiring towards a career in sustainable energy generation in the hope that in the future the majority of our energy can be supplied using clean energy generation techniques.

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