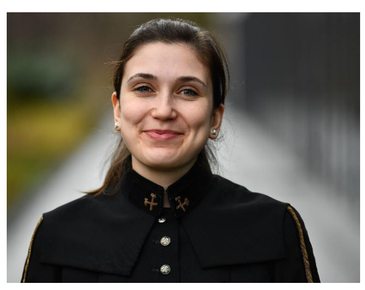
XXII Conference of PhD Students and Young Scientists

Technological review of lithium recovery from brines - an introduction to the BrineRIS project

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Introduction

Lithium is the most desirable metal for storing various forms of energy. It is mainly used in lithium-ion batteries, which contain up to 7% lithium. The demand for this element is huge and constantly growing (Fig. 1). Due to the great importance of Lithium, methods for its recovery are a frequent subject of research. As an introduction to the BrineRIS project, the available recovery methods were analyzed and three of them that will be of practical use in the project were described in detail.

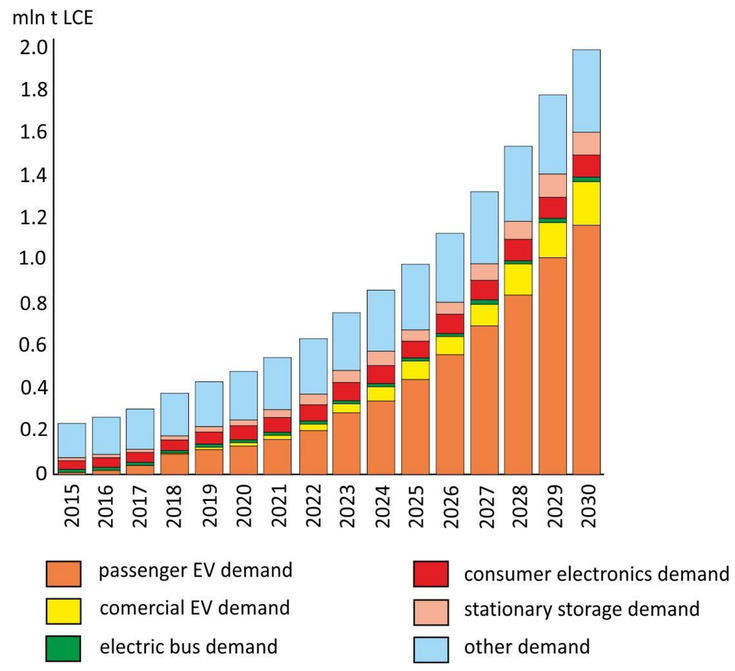

Fig. 1. Increasing Lithium demand in Europe, (based on BloombergNEF, Avicenne)

Evaporative separation

Evaporative separation is a commonly used method to recover lithium from brines, especially in the so-called "Lithium Triangle", e.g., Argentina, Bolivia, and Chile. In this method, lithium recovery from saline waters involves the evaporation of water exposed to sunlight in a hot and dry climate with low precipitation and moderate wind.

Moreover, the evaporation method affects the landscape, as large areas have to be developed for this type of investment, which often becomes irreversibly transformed and damaged. Another limitation is the very long duration of the process, which takes several months, and a high-water consumption. However, despite its many disadvantages, the evaporation method is inexpensive and energy-efficient.

Unfortunately, the described requirements disqualify European areas as potential locations for evaporation ponds. Therefore in the following part, more attention is devoted to emerging recovery technologies like Direct Lithium Extraction (DLE).

Direct Lithium Extraction technologies

Direct Lithium Extraction (DLE) is an innovative process in the mining industry. DLE technologies produce high-quality lithium carbonate or lithium hydroxide using geothermal energy - a renewable energy source to power the recovery process. This makes these methods not only faster than evaporation but also carbon neutral. There are many different techniques under the name DLE, as shown in Table 1.

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Direct Lithium Exctraction

Table. 1. Direct lithium extraction techniques

Method
Precipitation
Organic sorbents
Organic ion-exchange resins
Ion-imprinted polymers and other organic sorbents
Inorganic sorbents
Aluminium hydroxides
Manganese oxides
Titanium oxides
Other inorganic sorbents (various metal oxides)
Organic solvents
Crown ethers
Multicomponent
Extractant, co-extractant, diluent
Alternative diluents - ionic liquids, supercritical CO_2
Supported liquid membranes
Membranes
Reverse osmosis
Nanofiltration
Electrochemical separation
Electrodialysis
Combination with membrane and ion-exchange processes

In preparation phase of the BrineRIS project, various DLE recovery technologies were analyzed and compared based on desk research and literature study. By identifying and reviewing the different technologies, it was possible to identify the best available techniques for the recovery of lithium from geothermal brines. These include the adsorption method, which allows the selective separation of lithium by adsorption in hydrochloric acid solution. Moreover, electrochemical extraction of Li from brines and solvent extraction were analyzed, as one of the most developed methods for separating metals from aqueous solutions. These methods will be applied in the BrineRIS project in order to recover lithium from geothermal brines coming from RIS (Regional Innovation Scheme) countries – Poland, Czech Republic, Slovakia, Hungary, Spain and Portugal. Each of these methods, through a series of chemical processes, allows for the rapid, isolated production of lithium in a saleable form. DLE methods, despite their technical advantage, are more energy consuming than evaporative extraction. Thus, to optimize the processess and increase their efficiency, geothermal Energy is considered to power the recovery plants (Fig. 2).

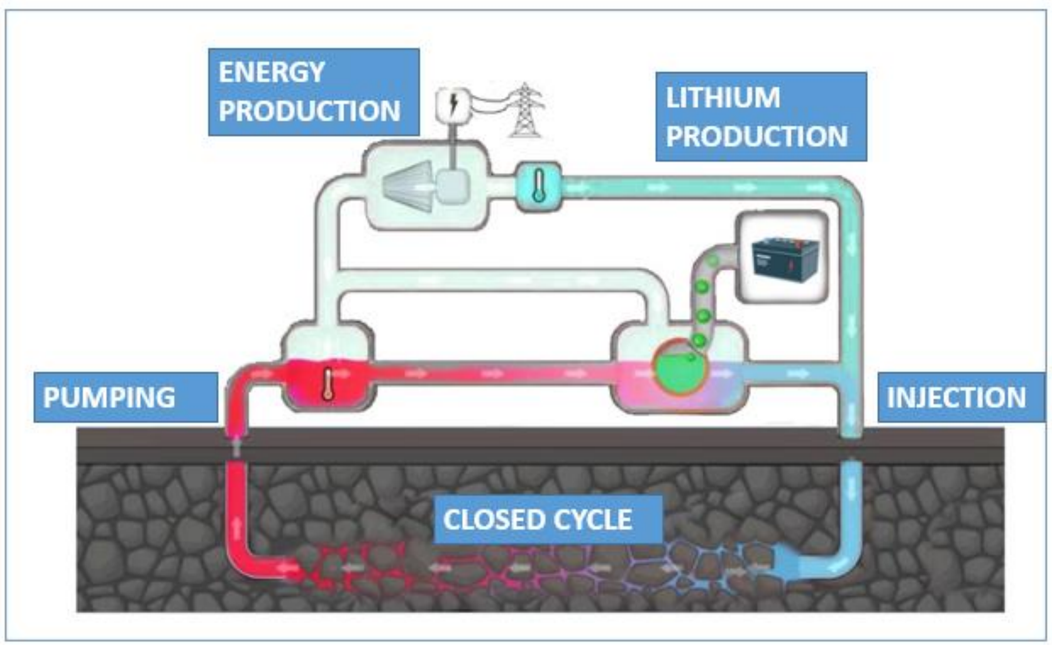

Fig. 2. Ideation scheme of carbon-neutral production of geothermal lithium

Conclusions

Lithium is undoubtedly a metal of the future, the skillful recovery of which from geothermal brines can bring many economic benefits to Europe. Three technologies chosen to test within the project are the most promising in terms of effectiveness and possible powering with renewable energy. The BrineRIS project develops emerging and environmental-friendly recovery methods, and therefore it fits into the global trend of sustainable and carbon-neutral critical raw materials supply for Europe. By implementing an interactive platform dedicated to geothermal brines data, the project is expected to attract investors to RIS countries.