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Is zeolite 13X a potential sorbent for direct Li extraction?

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Critical raw materials, like Li, will be increasingly required in our future society. Technical development of a method for direct lithium extraction (DLE) from geothermal brines can contribute to a resilient supply. Geothermal brines, with 0 – 480 mg/L Li, are regarded as a promising alternative Li resource, potentially mineable by sorption to inorganic sorbents.

We investigate the impact of grain size, stirring time, pH and temperature on Li sorption, and the structural and compositional variation in zeolite 13X. By physisorption and ion exchange of Li^+ with Na^+ or H^+, a maximum sorption capacity of 20.3 mg/g is reached using 13X powder, whereas only 8.6 mg/g Li is sorbed to 13X beads. Temperatures between 25 – 80 °C do not affect Li sorption. Structurally, Li sorption is related to shrinking of the unit cell.

The Li sorption capacity decreases by 68 % at pH = 5 compared to unbuffered conditions at pH > 8. Dissolution of zeolite has been observed by acid treatment, disqualifying any acid solution for desorption. Lithium recovery of 94 – 100 % was achieved using NaCl or CH_3COONa solutions. Full reversibility was achieved for Li sorption and desorption, but irreversible changes in lattice parameters are indicated at a local scale due to dealumination of framework Al during Li sorption. Aiming at a direct Li extraction technique in the future, this study shows that zeolite 13X is a promising sorbent although challenges regarding limited selectivity need to be resolved.