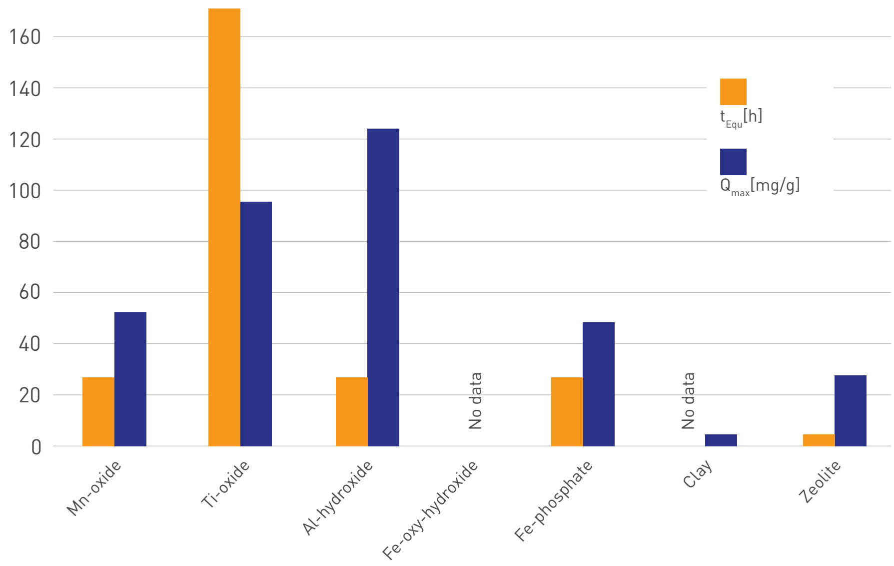
Lithium Extraction Techniques

and the Application Potential of Different Sorbents for Lithium Recovery from Brines: A summary

Increasing demand and pressure on the lithium market is expected in the future and geothermal brines, enriched in lithium, might represent an exploitable resource, not yet processed at industrial scale. Evaporation and direct precipitation are commonly applied to recover lithium from brines rather than membrane-related processes, solvent extraction or sorption and ion exchange, which are subject of current research.

The implementation at industrial scale in geothermal power plants is challenging due to the chemical variability of the brines and operating conditions at T = 60–80°C, P = 20–50 bars and flow-rates of 30–90 L/s. Due to different technical limitations, direct precipitation, evaporation, solvent extraction and membrane processes are unlikely to be implementable into operating power plants. However, sorption and ion exchange as direct lithium extraction (DLE) technique are regarded most promising for implementation into operating geothermal power plants. The general DLE technology will be similar for all different sorbents and ion exchangers making the DLE universally applicable for different fluid compositions.



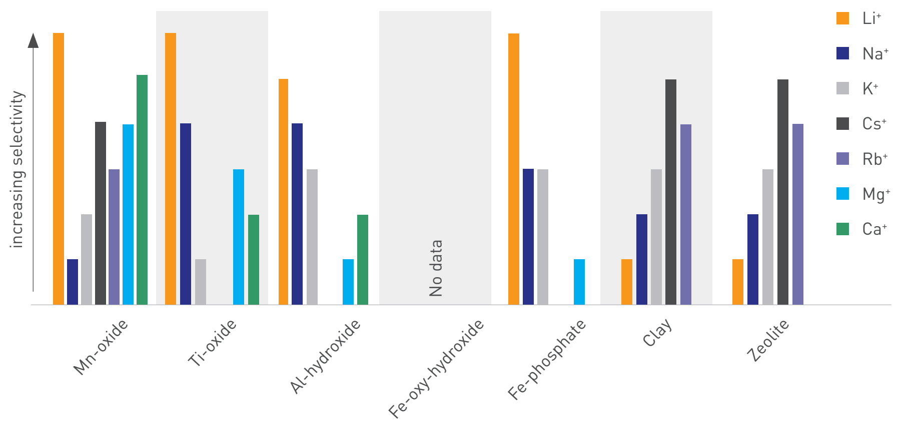


Figure 1. Comparison between sorbents according to equilibrium time (t_{Equ} [h]), maximum sorption capacity (Q_{max} [mg/g]) (top) and relative qualitative selectivity of different ions (bottom) (Greene-Kelly, 1955, Colella, 1996, Chitrakar et al., 2000, Hawash et al., 2010, Zhang et al., 2010b, Zhang et al., 2010a, Han et al., 2012, Shi et al., 2013, Intaranont et al., 2014, Lemaire et al., 2014, Hoyer et al., 2015, Lawagon et al., 2016, Prodromou, 2016, Choubey et al., 2017, Heidari and Momeni, 2017, Wiśniewska et al., 2018, Bajestani et al., 2019, Jiang et al., 2020).

Inorganic sorbents, such as lithium–manganese oxide, titanium oxide, aluminum hydroxide, iron phosphate, clay minerals, and zeolite group minerals besides other sorbents, e.g. zirconium phosphate, tin antimonate, antimony oxide, tantalum oxide, and niobium oxide, have been evaluated for the selection of alternative sorbents.

In summary, lithium–manganese oxides show fast kinetics, high selectivity for lithium and reach high sorption capacities. Sorbents like iron phosphate and zeolite show fast kinetics and variably high sorption capacities, making them promising alternatives. The general conditions of operating geothermal power plants, however, remain challenging for all sorbents and need to be studied in detailed laboratory and pilot plant experiments to conclusively evaluate their potential for a feasible implementation into operating geothermal power plants for commercial lithium-extraction.

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