Gentle Recovery of Lithium Ions from Sea Water for Protection of Environment

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Summary

At a lithium symposium, the demand for lithium recovery was described for energy applications such as lithium battery and thermonuclear fission reactors. Several methods have been proposed for lithium recovery from sea water and brine, e.g., coprecipitation with insoluble compounds such as alminate and alminosilicates, solvent extraction, ion exchange separation by resins and so on. However, solvent extraction method is not suitable for contamination of the sea water by the solvent and reagents. The ion exchange reaction is very hopeful to apply lithium ion recovery from sea water with much less contamination. The uses of the alminate and and alminosilicate, and ion exchange resins are not suitable because of low selectivity for a small amount of lithium ions in a large quantity of other alkali and alkali earth metal ions in the sea water.

In recent year, it has been found that some inorganic exchange materials such as λ-MnO_2 and monoclinic antimonic acid(M-SbA) showed an extremely high selectivity for lithium ions. The λ-MnO_2 showed topochemical reaction with redox reaction. Especially, monoclinic antimonic acid(M-SbA) showed lithium ion memory exchange behavior with high selectivity.

The addition of Nb_2O_5 or Ta_2O_5 to M-SbA (Li-Sb-NbA or Li-Sb-TaA) showed an improvement for the rate of desorption of lithium ions by proton from lithium ion form of the starting materials. The M-SbA and Nb or Ta added M-SbA are both of the strong acid type ion exchangers that release proton with high concentration by exchange of lithium ions. The release of proton with high concentration gives a contamination of sea water. More gentle change in the pH of sea water may be needed for release of proton during recovery of lithium ions.

Hydrogen carbonate showed following two step dissociations;

$$H_2CO_3 + H_2O = HCO_3^- + H_3O^+ \quad pKa_1 = 6.35 \qquad 1)$$

$$HCO_3^- + H_2O = CO_3^{2-} + H_3O^+ \quad pKa_2 = 10.55 \qquad 2)$$

More gentle recovery of lithium ions for from sea water was possible for protection of environment by the pH buffering effect, when sodium hydrogen carbonate has been added to the sea water before recovery of lithium ions by the hydrogen form of (H-Sb-NbA or H-Sb-TaA) ion memory exchanger.