

NMR studies on the selectivity of monovalent ions onto an amphoteric ion exchanger

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Summary

Absorbents such as ion exchangers have widely been used for recognition, separation and concentration of various ionic species. Some absorbents selective to a monovalent ion have been developed and applied for the separation/concentration process until now. Amphoteric ion exchanger can also be used for the separation/concentration method. The use of water or dilute salt solution as an eluent is possible for some separations, which is not only suitable for instrumental analysis by ion chromatography or ICP-MS but also good in terms of environment-friendly and low cost method.

The adsorbability of alkaline metal ions and anions toward the amphoteric ion exchanger is weak. It is difficult to determine the amount of adsorbed species from the data about the difference in concentrations of the target species in the original and equilibrium solutions. Therefore, we applied NMR method for the clarification of the characteristic of amphoteric ion exchanger internal solution. The ion exchanger beads absorbing a chemical species were loaded into an NMR tube together with a small amount of equilibrated solution, and then, NMR spectra for the gel bed were recorded in the same way as that for an ordinary solution. The concentrations of monovalent ions in the amphoteric ion exchanger were estimated and the distribution and selectivity coefficients were evaluated from the NMR signal intensities. The sequences of sorbability were almost the same as those for ordinary ion exchangers, that is, $\text{Cs}^+ > \text{Na}^+ \approx \text{Rb}^+$ for alkaline metal ions and $\text{ClO}_4^- > \text{SCN}^- > \text{NO}_3^- > \text{Cl}^- > \text{PH}_2\text{O}_2^- > \text{CH}_3\text{COO}^-$ for monovalent anions. The lower the salt concentration, the difference in the selectivity of anion became larger: in the case of perchlorate and thiocyanate the adsorbability is rather high under low salt concentration. This characteristic can be utilized for the practical separation/concentration of monovalent ionic species. The selectivity of divalent anion was lower than monovalent anions as opposed to a strong base type anion exchanger. This is attributed to the strong electrostatic interaction between fixed anionic groups (carboxylate groups) of the amphoteric ion exchanger and the divalent anion.