Adsorption behavior of silicic acid on anion exchange resin with trimethyl ammonium groups consisting of cellulose framework

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Diatoms, known as the unicellular eukaryotes microalgae, capture silicic acid selectively to form the complex cell wall consisting of silica. The bio-deposition of silica by diatom is important for understanding of geochemical silicon circulation on the surface of earth. Therefore, the elucidation of the mechanism is in geochemistry an attractive investigation. Silaffin, which is a protein in diatom, has been confirmed to play an important role for the aggregation of silicic acid in vitro. In this study, we focus on the trimethylammnonium group in the silaffin A_1 (a kind of silaffins) because of the main functional group in strong base anion exchange resins which can adsorb effectively silicic acid. We selected an anion exchange resin having trimethylammonium groups on cellulose framework which is bio-related substance and examined kinetically the adsorption behavior of silicic acid. In addition, we also investigated whether the adsorbed silicic acids polymerize to form silica by ^{29}Si MAS NMR.

Swollen OH type anion exchange resin (Cellufine Q-500, JNC Corp., 5 cm^3) was added into pure silicic acid solution (500 cm^3) without coexisting ions with various concentration (8.48 ~ 151 ppm as Si). At adequate intervals, the suspended solution was filtered with a 0.45 μm membrane filter. Si concentration in filtrates was determined by spectrophotometry to estimate the amount of silicic acid adsorbed. The polymerization state of the silicic acid adsorbed on the anion exchange resin was measured by ^{29}Si MAS NMR.

Silicic acid was adsorbed vigorously and concentrated on the anion exchange resin. Despite that silicic acid concentration in solution was lower than the solubility of amorphous silica, the adsorbed silicic acids polymerized. From the kinetic analysis, the adsorption of silicic acid was classified into two kinds of reactions: (1) anion exchange reaction between OH^- on the resin and silicate ion in solution and (2) polymerization of silicic acid. In conclusion, the adsorption of silicic acid on the anion exchange resin having trimethylammonoium group as a functional group is considered to be a model reaction for bio-deposition of silica by diatom.