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Sorption of radiocobalt(II) from aqueous solutions to Na-attapulgite

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摘要

Abstract
The sorption of Co(II) on Na-attapulgite as a function of contact time, solid content, pH, ionic strength, foreign ions, fulvic acid (FA) and temperature under ambient conditions was studied. The kinetic of Co(II) sorption on Na-attapulgite was described well by pseudo-second-order model. The sorption of Co(II) on Na-attapulgite was strongly dependent on pH and ionic strength. The sorption of Co(II) was mainly dominated by outer-sphere surface complexation and/or ion exchange at low pH, whereas inner-sphere surface complexation or surface precipitation was the main sorption mechanism at high pH values. The presence of FA did not affect Co(II) sorption obviously at pH <7, and a negative effect was observed at pH >7. The Langmuir and Freundlich models were used to simulate the sorption data at different temperatures, and the results indicated that the Langmuir model simulated the data better than the Freundlich isotherm model. The thermodynamic parameters ($\Delta G°$, $\Delta S°$, $\Delta H°$) calculated from the temperature-dependent sorption isotherms indicated that the sorption of Co(II) on Na-attapulgite was an endothermic and spontaneous process. The results suggest that the attapulgite sample is a suitable material in the preconcentration and solidification of radiocobalt from large volumes of aqueous solutions.

Keywords

Co(II), Sorption, Na-attapulgite, pH, Thermodynamic parameters

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Keywords Co(II) · Sorption · Na-attapulgite · pH · Thermodynamic parameters

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Introduction

The fate of radionuclides in the natural environment is controlled by the sorption, diffusion, and complexation on different natural and manmade materials [1–5]. Cobalt is widely present in various industry wastewaters including petrochemical wastewater and nuclear wastewater, the presence of Co(II) in the environment is of important concern due to its toxicity and health effects on human and living creatures. ^{60}Co(II) is one of the most serious radionuclides affecting the environment due to its long half-life ($T_{1/2}$ = 5.27a). The radionuclides ^{60}Co and ^{58}Co are present in liquid wastes released from pressurized water nuclear power reactors [6]. High levels of cobalt may affect several health troubles such as paralysis, diarrhea, low blood pressure, lung irritation and bone defects [7–9]. Thereby, the removal of Co(II) from the aqueous solution is crucial for the environmental protection. In the last decade, the removal of Co(II) from aqueous solution has been studied extensively [10–17], and the results suggested that the sorption of Co(II) was strongly dependent on pH values. However, the investigation of Co(II) sorption at different temperatures is still scarce.

Attapulgite $[(Mg,Al)_4(Si)_8(O,OH,H_2O)_{28}{\cdot}nH_2O]$ is a crystal hydrated magnesium silicate mineral. Its ideal structure was studied by Bradley in 1940 and is shown in Fig. 1 [18]. The isomorphic substitutions in the tetrahedral layer, such as Mg^{2+}, Si^{4+}, develop negatively charged sorption sites to electro-statically adsorb cations. Many studies have been reported on the sorption of toxic metal, lanthanides and organic pollutants from aqueous solution by natural or modified ones [19–25]. However, to the best of our knowledge, studies of Co(II) sorption on Na-attapulgite are still not available, especially the thermodynamic study.

Nuclear Chemistry [CrossRef]

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