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# Sorption study of radionickel on attapulgite as a function of pH, ionic strength and temperature


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作者

Lei Chen[1], Bin Gao[2], Songsheng Lu[2], Yunhui Dong[1]

[1]School of Chemical Engineering, Shandong University of Technology, Zibo, 255049 Shandong, China
[2]New Star Institute of Applied Technology, No. 451 Huangshan Road, Hefei, 230031 Anhui, People's Republic of China

摘要

Abstract
Sorption of radionickel on attapulgite is studied as a function of contact time, ionic strength, pH and temperature. The results indicate that the sorption of Ni(II) on attapulgite is strongly ionic strength-dependent at pH <8, and independent of ionic strength at pH >8. Outer-sphere surface complexation or ion exchange contributes to Ni(II) sorption on attapulgite at pH <8, whereas the sorption of Ni(II) is mainly dominated by inner-sphere surface complexation at pH >8. The sorption of Ni(II) on attapulgite increases with increasing temperature, and the thermodynamic parameters ($\Delta H^0$, $\Delta G^0$ and $\Delta S^0$) calculated from the temperature dependent sorption isotherms suggest that the sorption of Ni(II) on attapulgite is a spontaneous and endothermic process. The high sorption capacity of attapulgite suggests that attapulgite is a suitable material for the preconcentration and solidification of radionickel from large volumes of aqueous solutions.

**Keywords**

Attapulgite, Radionickel, pH, Temperature, Thermodynamic data

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**Lei Chen · Bin Gao · Songsheng Lu · Yunhui Dong**

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**Keywords** Attapulgite · Radionickel · pH · Temperature · Thermodynamic data

## Introduction

In the context of safety of nuclear waste repositories as well as for the assessment of radionuclide mobility in the environment, the interaction between radionuclides and minerals has been the subject of various studies [1–8]. Radionuclide $^{63}$Ni ($T_{1/2}$ = 96 a) is an important product of the neutron activation of the reactor materials, and the research works on $Ni^{2+}$ is essential to evaluate the behavior of $^{63}$Ni in the environment. The mobility, reactivity, and bioavailability of Ni(II) are significantly affected by the sorption properties of Ni(II) on minerals [9–13]. Many mechanisms have been synchronously postulated for Ni(II) sorption, including surface complexation, ion exchange, surface precipitation/coprecipitation and diffusion into particle micropores [14–18]. The results indicate that outer-sphere surface complexes are formed at low pH values, whereas inner-sphere complexes are formed at high pH values [19, 20].

Attapulgite, $[(Mg,Al)_4(Si)_8(O,OH,H_2O)_{26} \cdot nH_2O]$, a hydrated magnesium aluminum silicate present in nature as fibrillar mineral, generally has three kinds of water at room temperature: (1) free water; (2) zeolite water; and (3) crystalline water [21, 22]. In addition, some isomorphic substitutions in the tetrahedral layer, such as $Al^{3+}$ for $Si^{4+}$, develop negatively charged sorption sites to electro-statically adsorb metal ions. The special surface properties of attapulgite make it a very suitable material in the removal of metal ions from aqueous solutions [23–25]. However, to our best knowledge, the studies of Ni(II) sorption from aqueous solution to attapulgite is still scarce, especially the influence of temperature on Ni(II) sorption.

In this paper, we applied attapulgite as an adsorbent to adsorb Ni(II) from aqueous solutions. The main purposes of this paper are: (1) to study the sorption behavior of Ni(II) on attapulgite; (2) to study the influence of ionic strength and pH on Ni(II) sorption to attapulgite; (3) to evaluate the effect of solid content on Ni(II) sorption; (4) to study the effect of temperature on Ni(II) sorption and to calculate the thermodynamic parameters of Ni(II) sorption

L. Chen (✉) · Y. Dong
School of Chemical Engineering, Shandong University of Technology, Zibo 255049, Shandong, China
e-mail: chenlei7612@163.com

B. Gao · S. Lu
New Star Institute of Applied Technology, No. 451 Huangshan Road, Hefei 230031, Anhui, People's Republic of China



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