# Adsorption Characteristics of Xanthan Gum-Modified Bentonite for Sr2+ and Cs+: Postprint

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## Abstract

Safe and efficient disposal of radioactive waste represents one of the critical challenges urgently requiring resolution in the environmental field. Developing economical, green, and environmentally benign adsorption materials for nuclear wastewater treatment has become a key technical imperative for ensuring environmental security and sustainable development. This study employed natural biopolymer xanthan gum (XG) to modify Gaomiaozi bentonite (GMZ), preparing xanthan gum-modified Gaomiaozi bentonite (XG/GMZ), and systematically investigated its adsorption performance and mechanisms toward typical radionuclides $Sr^{2+}$ and $Cs^{+}$ in nuclear wastewater. The effects of initial concentration, adsorption time, and solution pH on XG/GMZ adsorption performance were examined, and characterization techniques including X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM) were utilized to elucidate the modification mechanisms and microstructural evolution. Results demonstrate that with increasing initial nuclide solution concentration, both the total adsorption capacity and ion-exchange adsorption capacity of XG/GMZ for $Sr^{2+}$ and $Cs^{+}$ exhibit an upward trend, approaching stability under high-concentration conditions. Mechanistic analysis reveals ion exchange as the predominant adsorption mechanism, constituting a higher proportion particularly at low concentrations. When nuclide concentration exceeds 8 mmol/L, the adsorption capacity of XG/GMZ bentonite is significantly enhanced. Further investigations indicate that the optimal XG additive content in XG/GMZ bentonite is 1.5% for $Sr^{2+}$ and 0.25% for $Cs^{+}$. During $Sr^{2+}$ adsorption, XG/GMZ demonstrates higher adsorption capacity and faster adsorption rate; whereas for $Cs^{+}$ adsorption, although the adsorption speed does not accelerate, the adsorption effect is substantially improved. Moreover, XG/GMZ bentonite exhibits excellent acid-base resistance across a broad pH range, demonstrating broader adaptability for applications in complex hydrochemical environments.

## Full Text

# Study on the Adsorption Characteristics of $Sr^{2+}$ and $Cs^{+}$ by Xanthan Gum-Modified Bentonite

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## Abstract

The safe and efficient disposal of radioactive waste remains one of the critical challenges in the environmental sciences. The development of economical, green, and environmentally friendly adsorbent materials for nuclear wastewater treatment has emerged as a key technological issue for ensuring environmental safety and sustainable development.

This study employed the natural biopolymer xanthan gum (XG) to modify Gaomiaozi bentonite (GMZ), preparing xanthan gum-modified Gaomiaozi bentonite (XG/GMZ), and systematically investigated its adsorption performance and mechanisms toward typical radionuclides $Sr^{2+}$ and $Cs^{+}$ in nuclear wastewater. The effects of initial radionuclide concentration, adsorption time, and solution pH on the adsorption performance of XG/GMZ were examined, and characterization techniques including X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM) were employed to elucidate the modification mechanisms and microstructural changes.

The results demonstrate that both the total adsorption capacity and ion-exchange capacity of XG/GMZ for $Sr^{2+}$ and $Cs^{+}$ increase with rising initial radionuclide concentrations, eventually stabilizing under high-concentration conditions. Mechanistic analysis reveals that ion exchange is the dominant adsorption mechanism, particularly at low concentrations where its contribution is more pronounced. When radionuclide concentrations exceed 8 mmol/L, the adsorption capacity of XG/GMZ bentonite is significantly enhanced.

Further investigations indicate that the optimal dosage of XG/GMZ bentonite is 1.5% for $Sr^{2+}$ adsorption and 0.25% for $Cs^{+}$ adsorption. During $Sr^{2+}$ adsorption, XG/GMZ exhibits higher adsorption capacity and faster kinetics, whereas for $Cs^{+}$ adsorption, although the rate does not increase substantially, the overall adsorption performance is markedly improved.

Furthermore, XG/GMZ bentonite demonstrates excellent acid–base resistance across a wide pH range, indicating strong adaptability for applications in complex hydrochemical environments.

**Keywords:** xanthan gum; bentonite; $Sr^{2+}$; $Cs^{+}$; adsorption

*Note: Figure translations are in progress. See original paper for figures.*