Post-print: Remediation of Cadmium-Contaminated Groundwater Using a Permeable Reactive Barrier with Bamboo Charcoal-Zeolite Mixture

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Abstract

This study analyzed the adsorption mechanism and temporal effectiveness of cadmium removal by bamboo charcoal-zeolite mixture-filled Permeable Reactive Barriers (PRBs) using physical-mechanical testing, static batch and dynamic column experiments, microscopic characterization analysis, and groundwater numerical simulation. When bamboo charcoal (particle size $>$ 0.18 mm) and zeolite (particle size $>$ 0.5 mm) were mixed at mass ratios of 1:10 3:10, the mixture could not only effectively remove cadmium from groundwater but also exhibited good permeability and shear strength. The adsorption capacity of the bamboo charcoal-zeolite mixture for cadmium increased with increasing bamboo charcoal proportion and decreasing particle size; breakthrough and exhaustion times of the PRB columns decreased with increasing groundwater flow rate and cadmium concentration. The cadmium removal process by the bamboo charcoal-zeolite mixture primarily involved complexation reactions, chelation, and ion exchange reactions. In cadmium-contaminated groundwater sites, the greater the PRB wall thickness and the slower the groundwater flow velocity, the longer the effective operation time of the PRB.

Full Text

Preamble

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Experimental Study on Remediation of Cadmium-Contaminated Groundwater by Permeable Reactive Barrier with Bamboo Charcoal-Zeolite Mixture

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Abstract

This study investigates the adsorption mechanism and long-term effectiveness of a permeable reactive barrier (PRB) filled with bamboo charcoal-zeolite mixture for cadmium removal using physical-mechanical testing, static batch and dynamic column experiments, microscopic characterization analysis, and groundwater numerical simulation. When bamboo charcoal (particle size > 0.18 mm) and zeolite (particle size > 0.5 mm) are mixed at mass ratios of 1:10 to 3:10, the mixture not only effectively removes cadmium from groundwater but also exhibits excellent permeability and shear strength.

The adsorption capacity of the bamboo charcoal-zeolite mixture for cadmium increases with higher bamboo charcoal proportion and decreases with larger particle size. Breakthrough and exhaustion times of the PRB column shorten with increasing groundwater flow velocity and cadmium concentration. The removal of cadmium by the bamboo charcoal-zeolite mixture primarily occurs through complexation, chelation, and ion exchange reactions. For cadmium-contaminated groundwater sites, thicker PRB walls and slower groundwater flow velocities result in longer effective operation times.

Keywords: Groundwater; Cadmium pollution; Permeable reactive barrier; Long-term effectiveness

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