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Preparation and characterization of a novel magnetic biochar for arsenic removal

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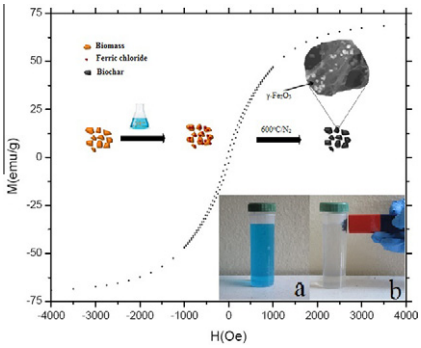
HIGHLIGHTS

- A magnetic biochar can be fabricated via pyrolysis of $FeCl_3$ treated biomass.
- Colloidal or nanosized γ-Fe_2O_3 particles grow within biochar matrix.
- Biochar/γ-Fe_2O_3 composite has excellent ferromagnetic properties.
- Biochar/γ-Fe_2O_3 composite has strong sorption ability to As(V).

GRAPHICAL ABSTRACT



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ABSTRACT

A magnetic biochar based adsorbent with colloidal or nanosized γ-Fe_2O_3 particles embedded in porous biochar matrix was fabricated via thermal pyrolysis of $FeCl_3$ treated biomass. The synthesized samples were studied systematically by X-ray diffraction, X-ray photoelectron spectroscopy, transmission electron microscopy, selected-area electron diffraction pattern, scanning electron microscopy, energy-dispersive X-ray analysis, superconducting quantum interference device, and batch sorption measurements. The characterization analyses showed that large quantity of γ-Fe_2O_3 particles with size between hundreds of nanometers and several micrometers tightly grow within the porous biochar matrix. Biochar/γ-Fe_2O_3 composite exhibited excellent ferromagnetic property with a saturation magnetization of 69.2 emu/g. Batch sorption experimental results showed that the composite has strong sorption ability to aqueous arsenic. Because of its excellent ferromagnetic properties, the arsenic-laden biochar/γ-Fe_2O_3 composite could be easily separated from the solution by a magnet at the end of the sorption experiment.

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1. Introduction

Arsenic is a toxic heavy metal widely distributed in the Earth's crust, which has also been used in pesticides and antibiotics for agricultural and medical uses. Thus, it can get into water systems, especially groundwater aquifers, from various ways. Drinking of arsenic contaminated water has become a serious threat to the public health and has affected millions of people across the world (Mudhoo et al., 2011). As a result, the US Environmental Protection Agency has set the arsenic standard for drinking water to a level of less than10 μg/L. This stringent arsenic standard inevitably requires many water utilities to upgrade their present treatment systems or to consider new purification technologies. During the past decades, much effort has been spent developing high-efficiency and cost-effective adsorbents for arsenic removal, such as metal

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