Facile synthesis of β-FeOOH nanoparticle-loaded secondary fly ash composites for enhanced removal of copper ion

Heng Yang\textsuperscript{a,b}, Qi Zhou\textsuperscript{a,b}, Wenjun Luo\textsuperscript{a}, Chunjie Yan\textsuperscript{a,b,*}

\textsuperscript{a}Faculty of Material and Chemistry, China University of Geosciences, Wuhan 430074, China, Tel./Fax: +86 27 67885098; emails: yh061053@126.com (H. Yang), roundzking@163.com (Q. Zhou), wandering_in_field@126.com (W. Luo), chijian2005@126.com (C. Yan)

\textsuperscript{b}Engineering Research Center of Nano-Geomaterials of Education Ministry, China University of Geosciences, Lu Mo Road 388, Wuhan 430074, China

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ABSTRACT

Based on the “treating wastewater with wastes” strategy, an acid-dissolved fly ash residue derived from the extracting aluminum industry (denoted as secondary fly ash (SFA)) was chosen as very cheap and suitable solid support to be modified as an adsorbent for the removal of Cu\textsuperscript{2+} from wastewater in this article. A facile liquid-phase deposition method was introduced to achieve the loading of active β-FeOOH nanoparticles on the SFA surface wherein the gelatin was added to regulate microstructure and dispersity of the nanoparticles. The texture and composition of products were characterized using various techniques such as FE-SEM, XRF, X-ray diffraction, N\textsubscript{2} adsorption/desorption, and \textsuperscript{27}Al MAS NMR. Results of batch adsorption experiments showed that SFA-Fe exhibited an obviously enhanced adsorption performance than the raw one. The optimal adsorption of Cu\textsuperscript{2+} was achieved at pH 5.5, and high temperature was beneficial to the adsorption with an increasing adsorption capacity (12.59−14.91 mg g\textsuperscript{-1}) as environment temperatures rise from 298.15 to 318.15 K. The experimental data were determined to be well described by the pseudo-second-order kinetics and Freundlich isotherm model. Furthermore, thermodynamic analysis revealed that the adsorption process of Cu\textsuperscript{2+} by SFA-Fe is endothermic and spontaneous. In addition, the electrostatic interactions and proton exchange are manifested to be the two main mechanisms for Cu\textsuperscript{2+} adsorption. This investigation not only provides a utilization approach of the SFA but also fabricates a potential and low-cost adsorbent for treatment of Cu\textsuperscript{2+} contamination.

Keywords: Cu\textsuperscript{2+} adsorption; β-FeOOH nanoparticle; Secondary fly ash; Surface modification; Adsorption mechanism

*Corresponding author.

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