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Removal of Ferric Iron from Aqueous Solution by Adsorption onto MOF-FeBDC-EDTA

Doan Van Duong, Luong Thuy Phuong, Pham Duc Anh, Tran Thuong Quang, Nguyen Xuan Truong*

School of Chemical Engineering, Hanoi University of Science and Technology, Hanoi, VIETNAM
**Email: truong.nguyenxuan@hust.edu.vn*

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ABSTRACT

The efficient removal of heavy metal ions from water has become an important issue from environmental aspect. Recently, porous metal-organic frameworks (MOFs) have been proposed as promising materials in the capture of various toxic substances, including heavy metal ions, due to their unique characteristics. Herein, we report the development of MOF-FeBDC-EDTA material as a ferric iron trap by incorporation of ethylenediaminetetraacetic acid (EDTA) into the robust MOF-FeBDC (BDC = benzene 1,4-dicarboxylic acid). The experiments show that the trap is very effective with Fe^{3+} removal efficiencies of >86%. The adsorption of ferric iron onto FeBDC-EDTA material obeys the Langmuir model through the coordination interaction with the absorption capacity is of 244 mg/g.

Introduction

Removal of heavy metal ions from polluted water is of great concern to increase water quality. Iron is one of the indispensable metal ions and plays an important role in many biological processes such as oxygen-carrying and cellular metabolism [1, 2]. If iron concentration exceeds the normal level it may become potential health hazard such as anemia, liver damages and hemochromatosis [3-5]. However, ferric iron was found as a common heavy metal ions from polluted water. To date, methods for the removal of heavy metal ions from water include chemical precipitation, ion exchange, membrane, flocculation and adsorption. Adsorption is the most preferred method due to its simplicity and cost efficiency [6–8]. Diverse adsorbents have been developed and investigated for their removal performance [9–12]. In recent years, metal-organic frameworks (MOFs) have been employed extensively as a new adsorbent for the removal of a number of heavy metal ions from water.

In this study, the MOF-material FeBDC has been modified with ethylenediaminetetraacetic acid (EDTA) for the removal of heavy metal ions from water. Because the large coordination number and strong binding affinity, EDTA can bind to various heavy metal species [13]. The immobilization of EDTA on porous materials could facilitate separation and recovery for reuse while maintaining active sites for heavy metal ion capture.

Herein, we demonstrate that a MOF-FeBDC-EDTA material as a new type of adsorbent can be achieved by grafting EDTA to a highly robust MOF-FeBDC. The resulting MOF-FeBDC-EDTA shows good adsorption performance for ferric iron with the removal efficiency is >86%. The porous FeBDC-EDTA material has a high adsorption capacity, 244 mg/g.

Experimental

Chemicals

Benzene 1,4-dicarboxylic acid (H_2BDC), $FeCl_2.4H_2O$, $FeCl_3.6H_2O$, formic acid, ethylenediaminetetraacetic acid disodium salt (EDTA-2Na), NaOH, HCl, all solvents