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Effects of co-existing ions and natural organic matter on removal of chromium (VI) from aqueous solution by nanoscale zero valent iron (nZVI)-Fe_3O_4 nanocomposites

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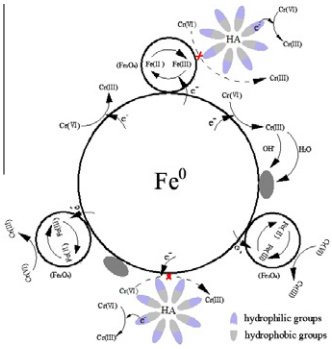
HIGHLIGHTS

- Environmental factors of Cr(VI) removal by nZVI-Fe_3O_4 composites were studied.
- Ionic strength was insignificant while temperature was critical for the reaction.
- Most of anions hindered the reaction, especially at higher concentration.
- Cations greatly facilitated the removal of Cr(VI), and Ca^{2+} effect was extraordinary.
- Appropriate concentration of natural organic matter enhanced the removal of Cr(VI).

GRAPHICAL ABSTRACT



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ABSTRACT

This study describes the chromium (VI) removal in aqueous solution by nanoscale zero-valent iron (nZVI)-Fe_3O_4 nanocomposites, which were prepared by a novel *in situ* reduction method. The effects of several factors, including ionic strength, temperature, co-existing anions and cations and natural organic matters were evaluated. The ionic strength was found to be insignificant to the removal efficiency, while temperature was critical. With the increase in temperature from 10–40 °C, 32% removal efficiency increased within 2 h from 49.96%. Most anions hindered the reaction, especially in high concentration, such as HCO_3^- and PO_4^{3-}, causing a drop of the removal efficiency from 66.48% to 57.47% and 59.93% respectively. In contrast, both cations and moderate natural organic matter facilitated the removal of Cr(VI). It is noteworthy that calcium hardness can greatly promote the reaction, 100% removal efficiency was achieved within 90 min and the rate constant k_2 reached 0.528 g mg^{-1} min^{-1} after adding 40 mg L^{-1} Ca^{2+}, which was ten times more than that in other cases. Possible mechanism was presented, and TEM, SEM and FITR analyses were used to verify these speculations. Hopefully, these results can contribute to a better development of the water treatment facilitates for nZVI-Fe_3O_4 composites, maintaining its high efficiency in real aqueous environment.

1. Introduction

Zero-valent iron (ZVI) particles have been widely applied to environmental remediation since their introduction by Gillham and O'Hannesin in 1994 [1]. ZVI is a suitable medium for permeable reactive barriers (PRBs) for *in situ* treatment of groundwater,

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