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Efficient removal of elemental mercury by magnetic chlorinated biochars derived from co-pyrolysis of $Fe(NO_3)_3$-laden wood and polyvinyl chloride waste

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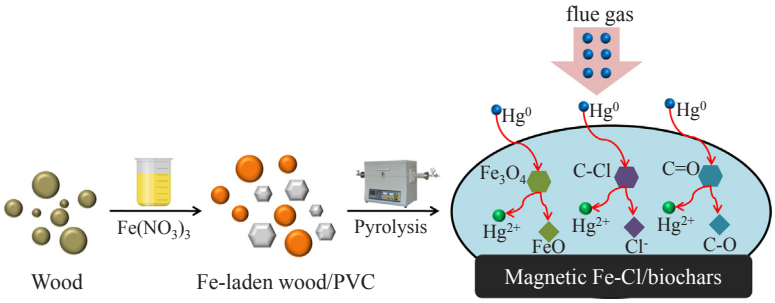
GRAPHICAL ABSTRACT



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ABSTRACT

Chlorinated biochars (Cl/biochars) prepared by co-pyrolysis of biomass and polyvinyl chloride (PVC) waste were demonstrated as cost-effective sorbents for elemental mercury (Hg^0) removal in our previous study. But the decrease in specific surface area of Cl/biochars caused by PVC melting inhibits the further increase of Hg^0 removal performance. Moreover, the difficulty in separating the used Cl/biochars from fly ash restricts the utilization of fly ash as a cement additive. To solve these problems, magnetic chlorinated biochars (Fe-Cl/biochars) are synthesized through one-step pyrolysis of $Fe(NO_3)_3$-laden wood/PVC mixtures in this study. The sample characterization showed that magnetic Fe_3O_4 was introduced into the Fe-Cl/biochars. Besides the magnetism, both increased specific surface area and more C═O groups were obtained under Fe catalysis. The Fe-Cl/biochars showed far better Hg^0 removal performance compared to the Cl/biochars over a broad reaction temperature range (25–220 °C). O_2, HCl and NO promoted Hg^0 removal whereas SO_2 had little effect on Hg^0 removal H_2O slightly suppressed Hg^0 removal. Compared to the commercial activated carbon manufactured specifically for Hg^0 removal, Fe-Cl/biochars was superior in both Hg^0 adsorption capacity and adsorption rate at 140 °C. The mechanism of Hg^0 removal over Fe-Cl/biochars was chemisorption reaction, where Fe_3O_4, C−Cl and C═O provided active sites for Hg^0 removal.

1. Introduction

Mercury has received widespread attention due to its toxicity, bioaccumulation and persistence in the ecosystem [1,2]. Among various human activities, coal-fired utility boilers are deemed as one of the largest anthropogenic source of mercury emissions. The world has

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