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Development of waste-derived sorbents from biomass and brominated flame retarded plastic for elemental mercury removal from coal-fired flue gas

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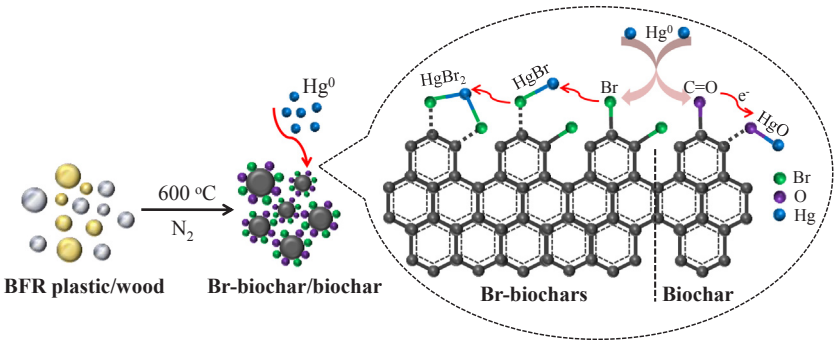
HIGHLIGHTS

- A novel method was proposed to prepare cost-effective sorbents for mercury removal.
- Biomass and BFR plastic in municipal solid waste were chosen as raw materials.
- Br-biochars exhibited far better Hg^0 removal performance compared to virgin biochars.
- The Hg^0 adsorption capacity of Br-sorbents was close to those of commercial activated carbons.
- The Hg^0 removal mechanism was revealed by experimental data and kinetic model.

GRAPHICAL ABSTRACT



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ABSTRACT

A novel method using one-step pyrolysis of waste biomass and brominated flame retarded (BFR) plastic was proposed to prepare brominated biochars (Br-biochars) for elemental mercury (Hg^0) removal from coal-fired flue gas. This method could simultaneously realize the disposal of municipal solid waste and the preparation of mercury sorbents. The sample characterization showed that an interaction effect between BFR plastic and biomass occurred during the co-pyrolysis process. The addition of BFR plastic would deteriorate the pore structure of sorbents because the melted plastic residues were aggregated on their surface. But Br emitted from BFR plastic was fixed into the co-pyrolyzed chars in the form of Br^- and C–Br group. Br-biochars exhibited far better Hg^0 removal performance compared to virgin biochar. The optimum pyrolysis temperature and plastic/biomass mass ratio were 600 °C and 1:1, respectively. The effects of gas hourly space velocity, adsorption temperature and individual flue gas on Hg^0 removal performance were also explored. The Hg^0 adsorption capacity of Br-sorbents was close to those of commercial activated carbons. Both the experimental data and kinetic model showed that the Hg^0 adsorption over Br-biochars was mainly controlled by chemisorption, where C–Br bonds were the active sites for oxidizing Hg^0 into $HgBr_2$. This was confirmed using mercury temperature programmed desorption experiments.

1. Introduction

It has long been recognized that exposure to mercury can cause diseases such as neurological, immune, behavioral, and sensory dysfunctions [1,2]. Medical literature and data from US officials specified that children's idiopathic autism is also induced by mercury pollution [3,4]. These issues can be traced back to the victims of contaminated fish (Minamata disease in Japan) or grain (Iraq, Guatemala,

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