Chemical Engineering Journal 309 (2017) 503–512

Contents lists available at ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

Elemental mercury adsorption and regeneration performance of sorbents $FeMnO_x$ enhanced via non-thermal plasma

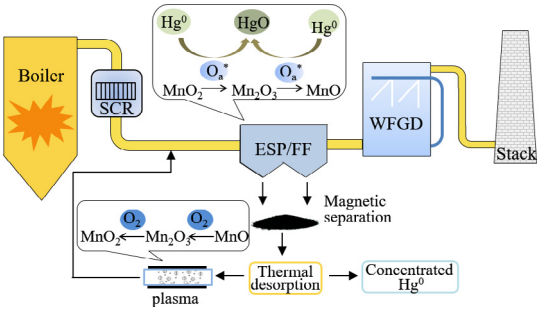
Xiaobo Zeng [a], Yang Xu [a], Bi Zhang [a], Guangqian Luo [a,*], Ping Sun [a,b], Renjie Zou [a], Hong Yao [a,*]

[a] State Key Laboratory of Coal Combustion, School of Energy and Power Engineering, Huazhong University of Science and Technology, Wuhan 430074, China
[b] Shenhua Guohua (Beijing) Electric Power Research Institute Limited Company, Beijing 100025, China

HIGHLIGHTS

- The mercury removal efficiency of the magnetic sorbents $FeMnO_x$ increased greatly by non-thermal plasma.
- Non-thermal plasma treatment increased the concent of Mn^{4+} and the lattice oxygen.
- O_2 and HCl promote the mercury removal performance on sorbents $FeMnO_x$.
- Non-thermal plasma treatment on the used sorbents $FeMnO_x$ improved the regeneration performance.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 19 August 2016
Received in revised form 10 October 2016
Accepted 13 October 2016
Available online 14 October 2016

Keywords:
Mercury
Non-thermal plasma
Manganese oxides
Lattice oxygen
Regeneration

ABSTRACT

Recent laboratory experiments and field tests have demonstrated the potential for modified regenerable materials to be a cost-effective alternative to expensive activated carbon for mercury control in coal-fired power plants. To develop a competitive and commercially viable technology, better mercury capture and regeneration performances of regenerable sorbents are required. For this purpose, non-thermal plasma was used to treat the magnetic sorbents $FeMnO_x$ synthesized by co-precipitation. The mercury adsorption tests showed that the treated sorbents with non-thermal plasma had higher mercury removal efficiency than raw sorbents, and longer treatment time resulted in higher efficiency. The main reason was that the content of the high valence manganese oxides and lattice oxygen were greatly increased by non-thermal plasma treatment, and this played a significant role in the mercury removal process. Further analysis showed that the lattice oxygen coming from the stepwise reduction of manganese oxide ($MnO_2 \rightarrow Mn_2O_3 \rightarrow MnO$) served as an oxidant in the reaction with Hg^0. The NO, SO_2 and H_2O inhibited the mercury adsorption while O_2 and HCl promoted mercury removal. High valence of manganese oxides and lattice oxygen were consumed during mercury adsorption, while non-thermal plasma treatment could replenish it and increase mercury removal regeneration performance better than without non-thermal plasma treatment. In summary, the combination of magnetic separation, thermal regeneration and plasma treatment makes $FeMnO_x$ an excellent recyclable sorbent for mercury emission control.

1. Introduction

Mercury pollution has attracted more and more attention because of its harm to humans and the environment. Coal-fired power plants are considered one of the biggest anthropogenic mercury pollution sources [1–3]. In coal fired flue gas, there are three

* Corresponding authors.
E-mail addresses: guangqian.luo@mail.hust.edu.cn (G. Luo), hyao@hust.edu.cn (H. Yao).

http://dx.doi.org/10.1016/j.cej.2016.10.047
1385-8947/