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Research Paper

# Influence of low pressure on mercury removal from coals via mild pyrolysis

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## HIGHLIGHTS

- Reducing pressure would speed up Hg removal during the mild pyrolysis of coal.
- The role of pyrolysis pressure in Hg removal was limited by coal type.
- Hg removal depended on the temperature when the residence time was long enough.

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ABSTRACT

Anthropogenic Hg emission control has drawn worldwide attention along with enactments of strict legislation. In response to the need for mercury emission control from flue gases in coal combustion, studies have focused on mild pyrolysis as a promising technology for mercury removal before combustion. However, reaction pressure has not yet been studied, which might affect mercury removal in mild pyrolysis. In this paper, three types of powdery bituminous coal, Coals A-C, from the western plateau area of China, were studied. The core aim was to explore the effect of low reaction pressure on the efficiency of Hg removal. Data of the three coals under different pyrolysis pressures showed that reducing the pressure would improve the mercury removal rate and removal efficiency and that the effect was distinguished by coal type. The role of pyrolysis pressure in Hg removal was limited. When the residence time was long enough, the eventual Hg removal was dependent on the thermal decomposition temperature. These findings might be of some guidance for designing pyrolysis reactors. Furthermore, this article aims to provide some explanation about the mechanism and offer guidance for optimizing the technological parameters of Hg removal by mild pyrolysis.



## 1. Introduction

In recent years, hazardous trace elements such as Hg, As, Se in coal have been the focus of increasing interest [1,2]. Hg is one of the elements of most concern in terms of its high volatility and particularly high bioaccumulative ability, which can cause serious health problems. During coal utilization [3], such as combustion [4], coking [5] and gasification [6], most of the mercury evaporates as the form of gaseous elemental mercury ($Hg^0$) at high temperatures [7], which has been demonstrated to have quite adverse effects on human health. In coal combustion, as flue gas cools in the process, part of $Hg^0$ is converted to gaseous oxidized mercury ($Hg^{2+}$) and particulate mercury ($Hg^P$) [8], which are both easier to remove than $Hg^0$. And the degree of conversion is affected by the type of coal. $Hg^0$ has a long life in the atmosphere, and will result in global pollution [9]. Mercury content in coal is small, and different coals have different values: the average mercury content of coal in China is 0.20 mg/kg, in America, 0.22 mg/kg [10]. Coal-fired power plants release a large portion (19–72%) of Hg into the air [11,12]. Mercury has been identified as a target for emission control, because of its potential toxicity. In 2011, the United States Environmental Protection Agency (U.S. EPA) issued its "Mercury and Air Toxic Standards (MATS)," the first national standard for protecting the public from Hg and other air toxics emitted by power plants [13]. In China, the latest edition of "Emission Standard of Air Pollutants for Thermal Power Plants" was published officially on July 29, 2011, which confirmed an emission limit of 0.03 mg/m$^3$ for mercury. This new control standard for mercury was implemented in 2015 [14].

In response to the need for mercury emission control, extensive efforts have been made to develop technologies for reducing

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