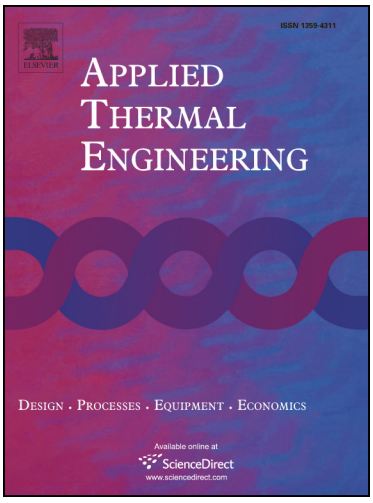

Numerical Investigation on Ash Fouling Characteristics of Flue Gas Heat Exchanger

Lei Fu, Pengfei Liu, Guojun Li

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Numerical Investigation on Ash Fouling Characteristics of Flue Gas Heat Exchanger

Lei Fu*, Pengfei Liu, Guojun Li
(*Key Laboratory of Thermo-Fluid Science and Engineering of MOE, School of Energy & Power Engineering, Xi'an Jiaotong University, Xi'an 710049, China*)
∗E-mail: leifu@mail.xjtu.edu.cn

Abstract

The particulate deposits on flue gas heat exchanger surfaces can increase thermal resistance, reduce heat transfer efficiency and increase the instability of equipment operation. Reasonable designing of heat exchanger is of vital importance to efficiently avoiding ash fouling. This paper adopted a numerical model to predict the collision, adhesion and rebound of fly ash particles on the surface of flue gas heat exchanger. The effects of flow parameters and geometry parameters on fouling rate are examined for six row tube heat exchangers, and the feasibility of using oval tube is explored for the purpose of fouling reduction. It is confirmed that particle deposits accumulate primarily in the flow stagnation region, recirculation region, the vortex separation and the reattachment regions. Increasing the velocity can lead to a lower deposit rate. The big particles tend to deposit on the front of tubes, and the small particles are easy to follow the fluid and deposit on both the front and the back of tubes. The elliptical tube is recommended for the fouling reduction of heat exchangers, while the arrangement of tube bundles depends on the typical diameter of fly ash to soothe ash fouling.

Keywords: ash fouling; heat transfer; particulate deposition; flue gas heat exchanger

1. Introduction

Ash deposition which would put an adverse effect on the heat transfer efficiency is one of the major problems heat exchangers suffer in waste heat utilization. The heat transfer efficiency may decrease for about 25% when the heat transfer walls are only covered with several millimeters of ash deposits in heat exchangers such as the cooler part of an economizer. The theoretical model for the main mechanisms on ash deposition needs to be constructed to avoid as much the accumulation of fly ash on heat transfer surfaces as possible during heat exchanger design. With the rapid development of computational fluid dynamics, particle motion could be predicted by applying the gas solid two phase flow model. However, exploration on the collision between the particulates to the walls is still rather complex. When the fly ash particles collide with heat exchanger surfaces, they may stick to, reflect from or move the deposited particles from the deposit layer. Thus, researchers tried to define reliable model to analyze the complex phenomenon that particles collide with deposit layers.

In 2006, Van Beek [1] adopted the two-body collision model to consider the collision between the incident particle