
# Thermophoresis effects on gas-particle phases flow behaviors in entrained flow coal gasifier using Eulerian model

Chao Dai, Fan Gu

PII: S1004-9541(16)30234-8
DOI: doi:10.1016/j.cjche.2016.11.016
Reference: CJCHE 724

To appear in:

Received date: 30 March 2016
Revised date: 7 June 2016
Accepted date: 28 November 2016

Please cite this article as: Chao Dai, Fan Gu, Thermophoresis effects on gas-particle phases flow behaviors in entrained flow coal gasifier using Eulerian model, (2016), doi:10.1016/j.cjche.2016.11.016

**Fluid Dynamics and Transport Phenomena**

# Thermophoresis effects on gas-particle phases flow behaviors in entrained flow coal gasifier using Eulerian model

Chao Dai (戴超)，Fan Gu (顾璠)

School of energy and environment, Southeast University, Nanjing,210096, China

**Abstract**: A numerical model based on the Eulerian-Eulerian two-fluid approach is used to simulate the gasification of coal char inside an entrained flow gasifier. In this model, effects of thermophoresis of coal char particles are thoroughly investigated. The thermophoresis is due to the gas temperature gradient caused by absorpted heat of coal char gasification. This work, firstly, calculates the gas temperature gradient and thermophoretic force at 1100℃,1200℃,1300℃ and 1400℃ wall temperatures. Then, the changes of particle volume fraction and velocity in the gasifier are studied in the simulation with thermophoresis or not. The results indicate that considering the particle thermophoresis has some effects on the calculation of particle volume fraction in the gasifier, especially at wall temperature of 1400℃,and the maximum particle volume fraction variance ratio reaches up to 1.38% on wall surface of the gasifier. These effects are mainly caused by large gas temperature gradient along the radial direction of the gasifier. For the particle velocity, the changes are small but can be observable along radial direction of the gasifier, which has good agreement with the distributions of radial gas temperature gradient and thermophoretic force. These changes above may have certain effects on gasification reaction rates in this Eulerian model. So the change of gasification reaction rates in the simulation with thermophoresis or not is studied finally.

**Key words:** gasification; thermophoresis; Eulerian model; two-phase flow

## 1. INTRODUCTION

The Study on the pulverized coal gasification has attracted interests of researchers. Improvements of experimental studies have laid a firm foundation for coal gasification study. Ahn *et al*. [1] studied the effects of gasification temperature pressure on gasification kinetics of coal-char with $CO_2$ at elevated pressure with a pressurized drop tube furnace reactor. Kajitani *et al.* [2][3] concluded the gasification rate of four different coal chars gasified with $CO_2$ using a PDT or TGA at high temperature and pressure.

In addition, establishing a coal gasification simulation model is also important for investigation of coal gasification. Irfan *et al.* [4] reviewed the kinetics and the reaction rate equations for char-$CO_2$ gasification both in the reaction kinetic control region (low temperature) and the diffusion control region (high temperature) and at both low and high pressures. Their work facilitates the further improvement of the coal gasification model. As is known, coal gasification system is one of gas-particle phases flow reaction systems. Both Lagrangian and Eulerian models have been applied to simulating gas-particle phases flow system. Compared to the Lagrangian model, the Eulerian model treats all different phases mathematically as continuous and fully interpenetrating and reducing number of governing equations. Vicente *et al*. [5] developed a coal gasification simulation model in entrained flow coal gasifier using Eulerian methods, considering gravity and drag in the model. Their results show good agreement for both the main and minor species, and temperature with experimental data. In