Particle Resolved Thermo-Chemical Conversion of Pulverized Coal Clusters

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Abstract

During pulverized coal injection (PCI) into a blast furnace, turbulence is causing the formation of clusters of coal particles. Understanding the limiting factors of the conversion of such coal clusters is of great practical importance for PCI. We can increase this understanding by studying the oxygen depletion, as well as the distribution of carbon-monoxide, and carbon-dioxide in the space between the individual particles that make up such clusters.

We investigate the group combustion of coal clusters by means of particle resolved simulations of a static cluster using the open source CFD software package OpenFoam®-7. We employ a detailed particle model that resolves the inside of each particle using an Euler-Euler approach to simulate the porous structure within the particles without resolving the individual pores. The surrounding gas phase is modeled as an Euler phase. The resolved particles are suspended in this gas phase, interacting with it by means of explicit Robin-Neumann-coupling for species concentrations, pressure, and temperature. The mass transport inside the particles is modeled according to the theory of porous media. Furthermore, a fixed reaction-rate chemistry model is used to model the conversion of the particles, while the GRI-Mech 3.0 mechanism is used for gas-phase chemistry in the cluster.

In this work, we will give a short summary of the theory behind the resolved particle approach followed by the setup of our numerical experiments. Finally, we will present our findings and their relevance to the practical application of PCI.