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CFD simulation of in-situ Drop Tube Furnace
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Abstract
A computational fluid dynamics code for calculating three dimensional reacting flows is used to predict the combustion behaviour of pulverized coal inside a Drop Tube Furnace (DTF). The CFD model has linked the eddy dissipation concept with the finite rate chemistry model in calculating the near flame zone field and the far field regions of the flame. Furnace model is based on the numerical solution of three-dimensional differential equations for conservation of mass, momentum and energy. The simulation is employing with a comprehensive representation of the features of gas phase fluid dynamics, combustion of coal particles, evolution of trace elements, heat transfer including radiation and chemical reactions to investigate the velocity profile, flame temperature, and product emissions at various locations in the combustion zones. Coal particles are treated as non-interacting spheres with full coupling of mass, momentum and energy with the gaseous phase. Moreover, the eddy dissipation model is coupled with Arrhenius type expressions for devolatilization, char combustion and COx production. The combustion sub-models treat particle devolatilization, char oxidation and additional gas phase reactions. The model uses the Lagrangian approach for tracking the particulate phase, the Eulerian approach for formulating the gas phase time-averaged conservation equations, the k - ε turbulence model, the eddy dissipation model for the gas mixture phase, particle to turbulence interaction, particle dispersion by turbulence and the discrete transfer model for particle radiation. The char remaining after devolatilization is considered to be pure carbon and its reaction is governed by external diffusion of oxygen to the particle surface. The particle tracking includes laws for inert heating, drying (wet combustion model), devolatilization, and char burnout. Chemical reactions were modeled using the Eddy- Break-Up model. The reaction mechanism was based on a 2-step mechanism with carbon monoxide as intermediate combustion species.

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