

## Documents

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### CFD Modeling of Toxic Element Evolved During Coal Combustion

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#### Abstract

The combustion of coal is a complex series of reactions, dominated by the transport mechanism. An aspect that is poorly understood is the influence that the evolution of trace elements has on the environment and the pollution level. To explore this impact, a mathematical model of arsenic was incorporated into a computational fluid dynamics code to predict the behavior of its evolution during the combustion of pulverized coal inside a Drop Tube Furnace. Coal particles are treated as non-interacting spheres with full coupling of mass, momentum and energy with the gaseous phase. The eddy dissipation model is coupled with Arrhenius-type expressions for devolatilization, char combustion, and CO<sub>x</sub> production. The simulation employs the  $k - \epsilon$  turbulence model, the eddy dissipation model for the gas mixture phase, 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 simulation outcome showed a fair prediction of the flame progress, as the flame base was found to be close to the fuel feed source. Flow recirculation was shown to be very lean, resulting in no coal and/or ash particulates near the furnace walls, hence keeping the by-product gas streams flow smoothly toward the furnace exit. The simulation results have also proved that complete combustion in the combustion zone was obtained for the prescribed coal/air ratio. Hence, less NO<sub>x</sub> gasses are emitted. Arsenic oxide, the product of oxidization of the evolved arsenic, is observed to concentrate at high temperature spots, while the trioxide arsenic spreads out through the combustion zones. The conclusion obtained from the simulation could be used as a benchmark for comparison with available experimental data for agreement. © 2015, King Fahd University of Petroleum & Minerals.

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