New Ph. D. thesis

COMBUSTION OF PULVERIZED COAL IN AXISYMMETRIC TURBULENT FLOW FIELD

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In dissertation, the results of investigating processes and parameters relevant for combustion of pulverized coal in swirl burners and furnaces are outlined. A complex mathematical model of PC combustion in swirl flow was developed. Closure of Reynolds turbulent flow equations is accomplished by the k-ε model of turbulence, considering the presence of particles. Solved are equations of conservation of mass, momentum, kinetic energy of turbulence and its dissipation, energy and each particular gas component. Radiation heat transfer is modeled by the 6 flux method. Motion of particles is treated via the Lagrangian stochaistic-deterministic model of particle dispersion. Solved are the equations of convective and radiative heat transfer between the particles and the surrounding gas *i. e.* furnace walls, and the equations of particle mass change due to combustion.

Within the framework of this complex model, global combustion model was chosen. Phenomena of devolatilization, homogeneous and heterogeneous combustion are treated together, considering the global reaction rate based upon the experimental observations in laboratory conditions. Determined are, to date non existing values of parameters (pre-exponential term and energy of activation in the Arrhenius expression for reaction rate) characteristic for combustion of PC of 6 domestic lignites based upon the results of experiments performed at the laboratory tubular furnace. These values were used as the initial conditions during the computations performed by using the developed model.

Verification of the developed model was performed in stages, starting with the one-phase isothermal flow case, including the phenomena one by one (two-phase isothermal flow, two-phase flow with heat transfer, and two-phase flow with combustion and heat and mass transfer). A qualitative analysis of the model was performed by testing its response to variation of relevant parameters – particle size, swirl number and excess air. The model was verified by comparing comutational and experimental results for combustion of PC in experimental furnaces. First, a PC flame within the IFRF (International flame research foundation) furnace No.1 in Ijmuiden-u (Netherlands) with a jet burner was considered, and computational results compared with experimental and computational results of other authors. Then a computation was performed of PC combustion within a furnace with a swirl burner and the results compared with data obtained in measurements at the horizontal axisymmetric furnace in the Laboratory for thermal energy research in VINČA Institute. On the basis of the results of the performed verification, it is concluded that the developed model can be successfully used for prediction, computation and optimization of parameters and design of swirl burners, for different burner geometries, flow and temperature boundary conditions and coals of different rank.