Numerical investigation of heat and mass transfer processes in the combustion chamber of industrial power plant boiler. Part 1. Flow field, temperature distribution, chemical energy distribution

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Abstract

In the present paper, the furnace chamber of the BKC-160 boiler of Almaty TPP-3 (Kazakhstan) has been calculated. The thermal characteristics of the process were studied in the form of the distribution of temperature fields and chemical energy, and the aerodynamics of the combustion chamber was also calculated. The type of fuel, its elementary and fractional composition, exerts the greatest influence on the course of heat-mass exchange processes and aerodynamics. The computational experiment was carried out with two models of particle size distribution: a polydisperse fuel flame (the particle diameter varies from 10 to 120 μm) and monodisperse fuel flame (particle size identical and equal to \(d_p = 60\) μm). Based on the results of the computational experiments, the main regularities in the distribution of heat fluxes in the combustion chamber volume and flow aerodynamics were obtained. It is shown that the greatest thermal load falls on the central region of the walls of the combustion chamber and the location of the burner devices, which is typical for both mono- and polydisperse fuel flames. The temperature data obtained as a result of the computational experiment showed better convergence with the empirical data obtained directly at TPP-3. Aerodynamics of the flow for the two selected models of particle size distribution has insignificant differences, but how they affect other characteristics of the process is one of the following tasks in view of the authors. It should be noted that the calculation of the polydisperse fuel flame takes much more calculation time.

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1. Introduction

In the study of a wide range of modern problems of science and technology, numerical simulation of heat and mass transfer process is particularly important and has enormous practical application [12]. Interaction of reacting flows is described by a complex system of nonlinear partial differential equations. Indispensable effective method of theoretical study of such flows is a numerical simulation [13]. Numerical modeling is sufficiently accurate and inexpensive way to analyze complex processes that occur during combustion of the fuel in the combustion chambers of real power plants, and it allows considering simultaneously the complex of processes that are almost impossible to do, conducting in situ experiments [7].

However, today there are modern technologies for measuring temperature fields under extreme conditions, which could not be done earlier. This technology (Acoustic gas temperature

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