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Application of Numerical Methods for Calculating the Burning Problems of Coal-Dust Flame in Real Scale

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Abstract
The burning of low-grade coals in coal-dust boilers presents considerable difficulties because poor quality fuels adversely affects to the performance of the ignition process, stabilization of the burning torch and process of burning out of fuel, in addition, significantly reduces to the environmental and economic indicators of thermal power plants, as a result of emission of harmful gases (NO, SO, CO) and fly ash. This article presents the numerical methods for calculating the burning problems of coal-dust flame. The increase in moisture of fuel leads to the reduction of average values of temperature and concentration of carbon dioxide in the combustion chamber, and also to the reduction of concentration of carbon monoxide CO and nitrogen oxides NO in the field of combustion.

Keywords: Combustion, heat power plant, heat and mass transfer, moisture of coal, coal-dust torch.

Introduction

It is known, fuel moisture is the ballast that substantially reduces the effectiveness of its combustion. However, the studies on burning of coals of various moisture carried out by groups of scientists[1, 2, 3] showed the need for a more complete investigation.

Today, numerical modeling is rather effective method for predicting the behavior of systems difficult for analytical research, among them is the burning of low-grade coal in the combustion chambers of boilers on power plants. Computer simulation allows obtaining of qualitative and quantitative characteristics of the process and also the response of the system to the change of its parameters and initial conditions[4-7].

The main stages of process of modeling are: 1) the stage of subject modeling consisting of the formulation of basic laws, rules and approximations; 2) stage of mathematical modeling – the description of the main equations; 3) the stage of computer modeling including mathematical calculations and graphic interpretation of the obtained data.

Numerical modeling was carried out with FLOREAN[8, 9] software on the basis of the three-dimensional equations convective warm and a mass transfer for a prediction of influence of moisture content of coal for the general operation of the fire chamber and formation of products of combustion[1, 7].This software package was used for a basis of numerical researches and added by us the new GEOM software, which is always written in the selection of a new object of study (the combustion chamber), taking into account the geometry, sizes of burners, their shape and location in the space of the combustion chamber[10-15]. In this program all the characteristics of complex real physical and chemical processes in the object of research also the boundary conditions for the solution of the chosen research problem which are adequately reflecting this process are set[16, 17].

As the object of study was chosen real industrial steam boiler PK-39, mounted on the Aksu power plant (Kazakhstan) with dimensions7, 762x10, 76x29, 985m. Seven steam boilers PK-39 with rated capacity of 300 MW and steam production capacity of 475 t/h work at Aksu power plant. The combustion chamber of the boiler is equipped with 12 vortex coal-dust torches located on two tiers. The sizes of the burners: lower layer – d=1.2 m and upper layer – d=1.05 m The scheme of the combustion chamber of the boiler and its breakdown on control volumes is submitted in Fig.1.

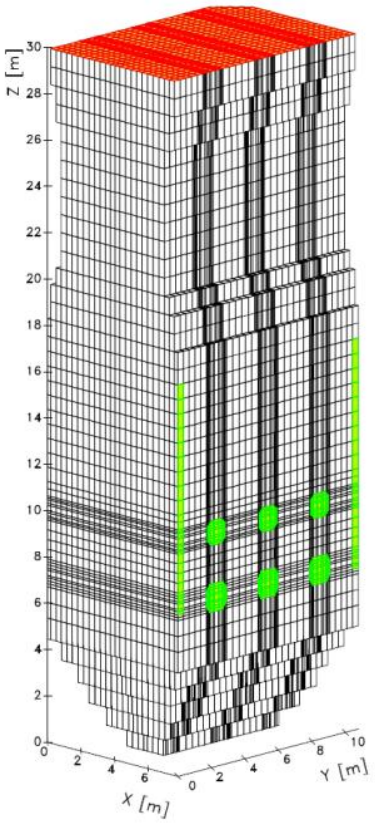

Figure 1: PK-39 boiler combustion chamber