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Simulation of the furnace of the boiler P-49 in the package of applied programs fire 3D

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Abstract. The combustion of solid low-grade fuel in LTV-boiler furnaces is a pressing research questions currently. The aim of this work is the creation of a computational grid model LTV-furnace to calculate the package of applied programs FIRE 3D. The study created a model LTV-furnace. The model tested on brown coal from the Nazarovo Deposit. The resulting distribution of temperatures and velocities has proved the performance of the model.

1 Introduction

Low-temperature combustion technology (LTV-combustion) is one of the promising but still little-studied areas. This method of burning is interesting that in his study has identified a number of advantages: stabilization of ignition and combustion, increase thermal efficiency, reduce slagging and contamination of working surfaces, the reduction of emissions of nitrogen oxides and sulfur [1].

2 Object of study

Numerical simulation is a modern method of investigation of processes occurring in boiler furnaces.

A mathematical model of the LTV of the furnace created by using the package of applied programs FIRE 3D, which is based on modern approaches and methods of mathematical description of complex chemical and physical processes.

As the sample for the study selected boiler P-49, mounted on UDPS city Nazarovo. Boiler P-49 (Ff-1600-25-545/545) designed to receive superheated steam from the combustion of dried products Nazarovo brown coal with liquid slag removal. The boiler is designed for operation in unit with the turbine C-500-240 500 MW. Boiler P-49 is ramjet, consists of two buildings with a three-way arrangement working independently from each other. In 2015 he was transferred to NTV method of burning.

The original model was developed for boiler P-49: 12 burners, system bottom blast (SBB) is divided into five slits across the width of the combustion furnace, tertiary air of the lower tier (TL) in the amount of 24 pieces, middle tier (MT) in the amount of 12 pieces [2]

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3 Mathematical model

The size of the computational grid of this model 79x45x192 cells. Based on this model were carried out the first calculations. The model proved to be too cumbersome. The complete calculation took 3 to 4 days. It is not possible to quickly get the result. This model has aerodynamic ledge on the back wall of the boiler furnace. To solve these problems, the decision on the establishment of a new model. It must take into account all the flaws of the first model.

The furnace of the investigated boiler is symmetrical in width, all the burners and the air-supplying device are arranged in a plane parallel to the side wall of the furnace. Aerodynamics must be flat, therefore, can be used to model not the entire furnace volume, and only its third part.

The obtained grid has a size of 96x53x61 cells. Differences from the first model are:

– reduction of volume of the model, the number of burners and air supply four burners, SBB is a crack along the whole width of the boiler furnace, TL includes eight devices, MT and includes 4 of the device;

– the model takes into account both aerodynamic ledge;

– also considered the possibility of feeding the furnace of a dust of high concentration (DHCp) through the burner.

To do the calculation on the new model possible in a short period of time (12-20 hours). The accuracy of the calculation remains quite high.

The resulting model was test on brown coal from the Nazarovo Deposit. The station is equipped with a centralized preparation and the grinding of brown coal. Characteristics of coal dust supplied to the boiler from filesaved presented in table 1.

One of the results of mathematical simulation are the velocity field (Fig. 1) and the field of particle concentrations (Fig. 2) in cross section at the burner parallel to the side wall.

4 Characteristics of coal particles

Characteristics of Nazarovo coal deposits are presented in table 1.

Table 1. Content of produced SCF.

Name	Marking	Coal	Dust
Carbon, %	C^r	39	46.22
Hydrogen, %	H^r	2.5	3.2
Oxygen, %	O^r	12.5	15.6
Sulfur, %	S^r	0.3	0.49
Moisture, %	W^r	39.8	24
Ash, %	A^r	5.4	10
Nitrogen, %	N^r	0.5	0.49
Lowest calorific value, kJ/kg	Q_i^r	13702	22380

5 Temperature and oxygen distribution

Graphs of the distribution of temperatures and velocities obtained in the result of the calculation in the package of applied programs FIRE 3D. The results on the burners and between the burners is shown in figure 1 and figure 2.

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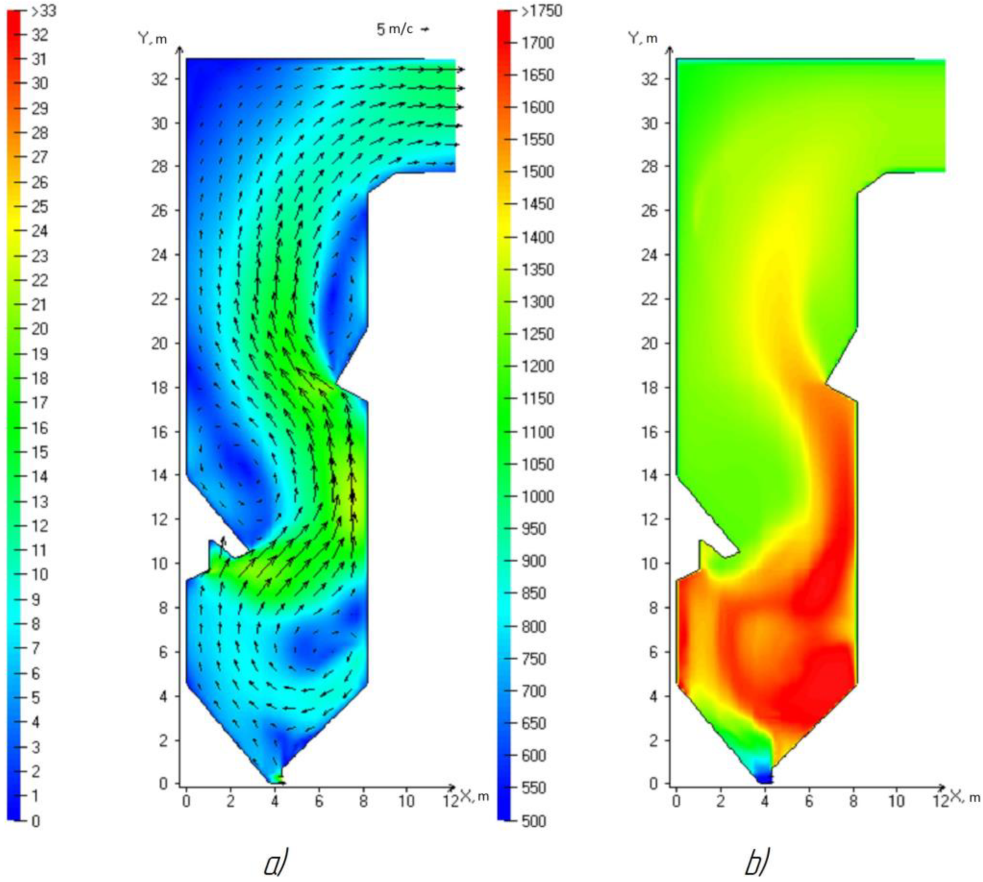

Fig. 1. The distribution of velocity (a) and temperature (b) in cross-section between the burners.

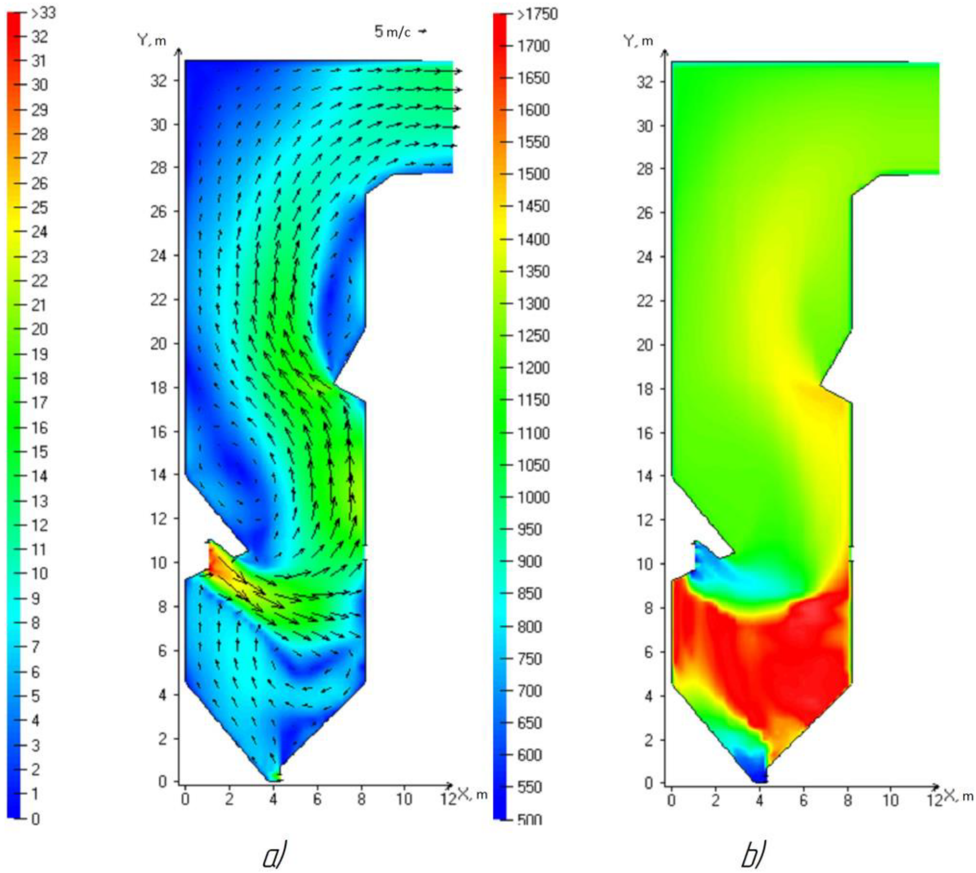

Fig. 2. The distribution of velocity and temperature in cross-section on the burners.

6 Conclusions

The mathematical model parts LTV-furnace boiler P-49 for calculations in the package of applied programs FIRE 3D. The obtained velocity field and particle concentration showed the performance of the model.

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