EXPERIMENTAL AND THEORETICAL RESEARCH OF AERODYNAMICS IN A VORTEX FURNACE OF NEW TYPE

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ABSTRACT: In connection with perspectives for the coal industry development, necessity to create new technologies and devices for power-efficient and environmentally friendly coal fuel combustion is growing. As a rule, expansion of fuel base can be provided by the use of low-grade coals. This raises requirements for steam generator characteristics and therefore the need of new approaches to be applied for development of furnace devices. The technology of pulverized-coal torch burning in vortex flow is one of the most prospective technologies to improve efficiency and ecological compatibility of boiler units for heat-power stations. In current work the results of experimental and numerical study of aerodynamics in the isothermal model of the new type furnace device with horizontal vortex and distributed tangential input are shown.

For non-contact measurement of steady-state distribution of flow velocity in the model sections of interest the laser-Doppler precision measurement system (automated Laser Doppler Velocimeter LAD-05), developed at IT SB RAS has been used. Automated measurement complex LAD-05 measures two components of the flow velocity lying in the plane perpendicular to the optical axis of optoelectronic block. Compressed air was used as working gas.

Mathematical model of the steady-state three-dimensional isothermal turbulent flow is based on Reynolds-averaged continuity and momentum equations closed with so-called "realizable" modification of k-ε turbulence model. The "sticking" boundary conditions are set for velocity components at walls, and "enhanced wall treatment" method is applied for near-wall turbulence modelling. A uniform profile of mean flowrate velocity is prescribed at inlet sections of rectangular nozzles, with this the intensity of inlet turbulent pulsations is assumed equal to 5%.

To achieve favourable aerodynamic features of new dual-nozzle vortex furnace design, some geometric and regime parameters of new design were tested in a series of numerical predictions. This numerical study has allowed to draw conclusions on the choice of these parameters. Also it should be noted that, from the viewpoint of obtaining good overall performance of pulverized coal combustion process in the new dual-nozzle vortex furnace, the presence of additional bottom nozzle in new design provides more flexibility to control the furnace working regime, e.g. different air excess ratios of fuel-air mixture can be prescribed at the upper and the bottom nozzles.

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