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STEAM BOILERS, POWER-GENERATING FUEL, BURNERS, AND BOILER AUXILIARY EQUIPMENT

Retrofitting the Operating Coal-Fired TP-87 and BKZ-320 Boilers for Vortex Fuel Combustion Technology

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Abstract—Scientific and technical problems concerned with retrofitting the TP-87 boiler installed at the Novokemerovo cogeneration station and operating on Grade 2SS Kuznetsk coal and the BKZ-320 boiler installed at the Novosibirsk TETs-3 cogeneration station and operating on Berezovo coal from the Kansk–Achinsk coal field for vortex combustion technology are addressed. A conclusion is drawn that low-cost retrofitting of obsolete boilers at thermal power stations with retaining the existing boiler unit infrastructure is presently the most reasonable strategy of their further use.

Keywords: coal, boiler, furnace, combustion chamber, cooling chamber, retrofitting, environmental matters, slagging

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Retrofitting of boilers is an intricate and multidisciplinary problem, the solution of which is wholly connected with the level at which furnace processes, generation of toxic emissions, and slagging of heat-transfer surfaces are simulated in physical and mathematical models, with the results obtained from pilot industrial combustion of low-grade fuels, etc. At the present stage, retrofitting of power-generating coal-fired boilers pursues the following objectives:

(i) securing energy-efficient combustion of low-grade coals (primarily off-design local ones) the properties of which may vary in a wide range,

(ii) achieving essential improvement in environmental indicators (mainly with respect to nitrogen oxide emissions), and

(iii) achieving less intense slagging of heating surfaces.

As a rule, the possibilities of any retrofitting are always strictly limited; therefore, different versions of substituting technological schemes must be subjected to a scientifically grounded comparative analysis; all advantages and disadvantages of these versions must be considered, and their feasibility study must be carried out in order to make the final choice of the most rational (optimal) version. Such a problem can be solved in the most efficient manner and at the minimal cost by replacing the furnaces of the TP-87 and BKZ-320 boilers that are subject to retrofitting by the vortex furnace (VF) designed by N.V. Golovanov (the Central Boiler–Turbine Institute). A large amount of studies devoted to physical and mathematical simulation of the VF that were carried out by Golovanov and by other specialists, results of numerous pilot tests, and positive field experience gained from operation of vortex furnaces at many power stations are factors speaking in favor of using this version. The experience gained from the operation of vortex furnaces at the Novosibirsk TETs-3 cogeneration station and the Nazarovo district power station testifies that boilers fitted with vortex furnaces have sufficiently good environmental and economic indicators and that they are able to successfully fire a wide range of coals [1–10]. In addition, with this version of retrofitting, the slag-tap removal and coal pulverization systems available in TP-87 and BKZ-320 boilers are used, and the VTs are well fitted to the existing overall dimensions of the operating boilers.

The results obtained from previous physical and mathematical simulation of the combustion process served as a basis for selecting the vortex furnace design and operating parameters. These are primarily the data on the vortex chamber geometrical characteristics, on the level of working temperatures, maximal rates, calorific intensities in the furnace volume as a whole and in its sections, radiant and total heat fluxes, waterwall thermal efficiency coefficients, toxic emissions, etc.

The results of comprehensive investigations reported in [11] enabled certain scientific-technical recommendations on selecting a vortex furnace for a coal-fired boiler to be suggested:

(i) The diffuser inlet section area must be approximately equal to 40% of the combustion chamber's diametral section.