

AIR PROTECTION FROM POWER INDUSTRY EMISSIONS

1.5. Technologies of organic fuel combustion at TPPs with the lowered level of harmful emissions into atmosphere

1.5.5. Efficient reduction of nitrogen oxide emissions in the boiler furnaces by means of aerodynamic optimization of the staged fuel combustion

1.5.5.4. An efficiency of application of the combined "nozzle – direct-flow oil burner" unit

A.M. Arkhipov, MPEI (TU); A.A. Vagner, OJSC "RAO UES of Russia"; N.I. Solovyev, OJSC CKB "Energoremont"; V.V. Abramov, OJSC "Zapadno-Sibirskaya TPP"

At drum oil-gas boilers with front two-layer layout of vortex burners (for example, at boilers TGM-84, TGM-151-B, etc.) a gas combustion mode, using one and two burner layers, is practiced. When burning oil to raise a temperature of the superheated steam, burners of the third layer, are put into operation.

An interesting experience was obtained in MPEI, OJSC "CKB Energoremont" and Novogorkovskaya CHPP at reconstruction of TGM-84 boiler, conducted in 2004. One of reconstruction goals was to reduce nitrogen oxide emissions by gas combustion. To achieve this, instead of the vortex burners of the third layer at the same layout of screen pipes, three-channel direct-flow oil burners were installed [16]. At gas combustion peripheral air channels of burners were disabled and the central air ducts of rectangular shape, inclined downward at an angle of 35° (Fig. 1.77), remained in operation.

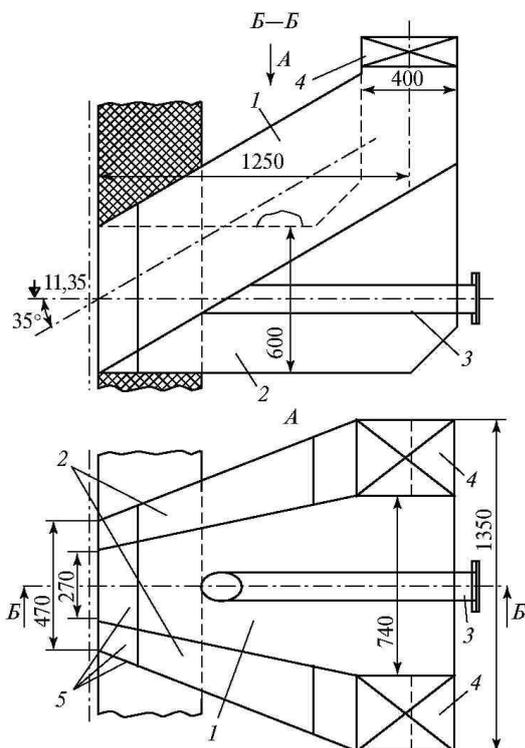


Fig. 1.77. Schematic diagram of "nozzle - oil burner" unit:
1 - nozzle, 2 - peripheral air channels for the oil burner, 3 - nozzle pipe, 4 - dampers, controlled by a single drive, 5 - output of channels of heat-resistant steel

In the process of model aerodynamic researches of the furnace section, an optimal angle of inclination of secondary air nozzles downward, making 35° , was determined. At that, an extent of discharge upward of the tail parts of the secondary air jets was considered (less than 60% for reduction of

the overall excess air in the furnace). Intensity of flame turbulence by tail part of jets was also taken into consideration (preferably, in the second half of the furnace throughout its depth to reduce formation of thermal NO_x). An optimal direction of twist of the vortex burners under condition of the flame lifting uniformity across the section width was also determined. Direction of twist according to the production version was the optimal.

As an example, a character of motion of the secondary air jet, a jet of the vortex burner of the second layer and a jet of the vortex burner of the first layer is presented in Fig. 1.78 a—в. It could be seen that the secondary air jet begins to expand rapidly (mixing with the flame) in the second half of the furnace. Vortex jet of the burner of the second layer is expanding due to the twist, starting from the burner. Discharge of the tail mass of the jet upward occurs on the trajectory, close to the one of lifting branch of the secondary air jet. Vortex jet of the first layer in the second half of the furnace goes down by 40% and moves along the bottom, and then goes up through the interjet spaces of burners, mixing, mainly, with the fresh secondary air jet.

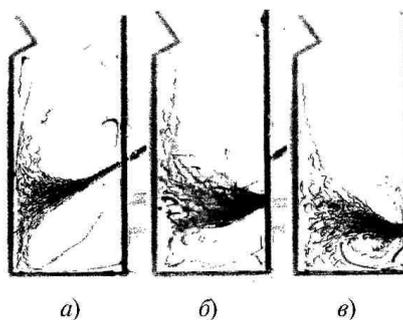


Fig. 1.78. A nature of motion of jets in the furnace model of TGM-84 boiler: а - secondary air, б - the upper layer burners, в - the lower layer burners

The data obtained during the tests at the reconstructed boiler at gas combustion in the staged combustion mode and stoichiometric oil combustion (using steam and mechanical nozzles) are resulted in Tab.1.35. It should be noted that the staged gas combustion an additive DeNO_x effect (approximately by 15%) was obtained as a result of gas redistribution to the lower layer of burners. This activity was easily implemented with the help of a regulatory system of CJSC "NPO Amax".

Recovery of design stuffing of the regenerative air heater and modernization of a gas distributing burner unit contributed into improvement of economic performance of the boiler. Instead of frequently burnt out tubes of central gas distribution in factory burners, during operation of which under condition of zero incomplete combustion, increase in excess air was required. At their modernization gas was discharged from eight tubes of 50×4 mm in diameter, placed along the

circle of 580 mm in diameter [17]. Gas distributing headers of 504 mm in diameter were made of a heat resistant steel and had (each): one butt hole, four side holes and one side hole, directed toward the burner axis of 17, 9 and 14 mm in

diameter. As standard tests of the modernized burner, conducted by OJSC "NPO CKTI" showed, it satisfies all the requirements for gas burners.

Table 1.35. Operational parameters TGM-84 before and after reconstruction

Parameter	Before reconstruction	After reconstruction
Excess air in the mode cross section (in water economizer crosscuts) at D_{nom} and gas burning	1,18	1,075
Reduced temperature of flue gases under the same conditions, ° C	174	146
Secondary air excess at D_{nom} and gas burning	—	0,24
Electricity consumption for draft and blowing at an average annual load of 280 t/h, kW h/Gcal	8,7	5,3
Increase in gross boiler efficiency at the same load,%	—	2,56
Specific NO _x emissions at D_{nom} and oil/gas burning, mg/m ³	250/370	85/280