Part 1

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

1.5.5.6. An efficiency of application of tertiary blasting in furnaces, equipped with tangential burners

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In 2003 a low-cost reconstruction of BKZ-210-140F boiler of "Zapadno-Sibirskaya TPP" was carried out. Its goal was to increase the economical efficiency and dependability of kuznetsky coal combustion with the changing volatile content, as well as to stabilize a level of the superheated steam, and reduce specific emissions of nitrogen oxides. This boiler was equipped with four tangentially directed burners, like a "layer cake", set in the corner zones of the side furnace walls.

In each burner the discharge drying agent of coal-pulverization systems supplies the pulverized coal into the furnace by two channels of air and fuel mixture. In the lower air channel of the burner a fuel sprayer is installed. Oil is used for firing the furnace and as the emergency fuel. Coke oven gas, being the buffer and starting fuel is fed into the middle and upper air channels of the burner. The upper channel level is 11,4 m. The boiler has four rectangular tertiary air nozzles, set at the level of 14,8 m above the burners and directed coaxially with them in the horizontal projection. Tertiary air makes 15%.

On the basis of the aerodynamic model and calculations at the level of 14,08 m of the front and back furnace walls six additional tertiary air nozzles – by three on each wall were installed. The nozzles were inclined down at an angle of 30° and had dimensions of 500×200 mm. A total percentage of the tertiary air, entering the furnace from four sides, three front and three back nozzles, made 31%. Fig. 1.84 shows an intense mixing (extension) of jets, flowing from the newly installed front and back nozzles of the tertiary air. A very good filling of the furnace horizontal section by the mentioned blast jets should be noted. Significant expansion of jets shows a large mass transfer (mixing) caused by the fact that extra blast jets move in opposite-demolishing gas flow. Test results of the reconstructed boiler showed that the objectives have been achieved [24]. At the rated load, the following indicators have been reached:

- reduction of excess air after the steam superheater to 1,17, while ensuring the standard temperature of the superheated steam due to decrease in the convective component of heat transfer to screens and redistribution of coal dust into the upper channels of air and fuel mixture;
- twice unburnt carbon reduction, which made 1,1%, including without flame lighting by coke oven gas, due to better mixing of the burning down flame with blasting jets;
- specific emissions of nitrogen oxides significantly reduced and made less than 380 mg/m^3 due to more than twice increase in tertiary air;
- boiler gross efficiency increased to almost 92% thanks to reduction of heat losses with the unburnt carbon and flue gases;
- increase in reliability of coal ignition, including without the flame lighting by coke oven gas, since the total excess air at the outlet of the burners was reduced.

During the tests coal with the following characteristics was burnt: Q_l^w = 4603 ... 5090 kcal/kg, W^w = 12,22 ... 16,39%, A^w = 15,29 ... 20,72%, V^c = 38,58 ... 41,16 %, N^c = 2,5 ... 2,8%. Fineness of coal dust grinding was maintained at the accepted operational level: R_{90} = 13 ... 14%.

Between 2004 and 2006 at three TA-10 boilers of Tom-Usinskaya SDPP, equipped with tangential burners, under MPEI development and according to the project of "CKB Energoremont" tertiary blast nozzles were installed in order to ensure the standard specific NO_x emissions (before 470 mg/m^3). Coal dust is fed into the burners under high-concentration dust technology; for reliable dust ignition the conical spreaders of Tom-Usinskaya SDPP design are applied. The discharge agent from coal-pulverization systems is fed into the top of the burners.

The nozzles were set at a level of 15,5 m, by three at the front and back furnace walls, directed downward at an angle of 38°. Nozzle axes form in the horizontal projection of the furnace a system of high-speed jets. Percentage and velocity of tertiary air according to the project made 28% and about 50 m/s, accordingly.

Trials of the reconstructed boilers have confirmed an effectiveness of the introduced technical solutions. Concentration of nitrogen oxides in flue gases is between 380 and 420 mg/m^3, i.e., doesn't meet the standard ones. Application of tertiary blasting, at least, didn't worsen the economic performance of the boilers.

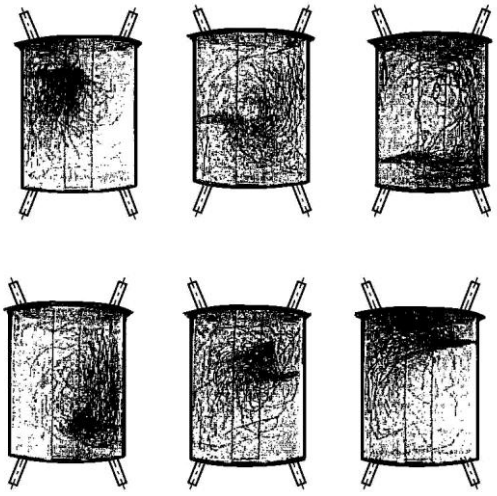

Fig. 1.84. A nature of mixing in the furnace section of jets, flowing from tertiary blast nozzles of the front and back walls of the furnace of BKZ-210-140F boiler