Part 1

# AIR POOL PROTECTION FROM EMISSIONS OF THE POWER INDUSTRY

## 1.1. Reducing nitrogen oxides emissions

### 1.1.2. Technological methods to reduce nitrogen oxide formation in the boilers during combustion of different types of organic fuel

#### 1.1.2.2. Modernization of the furnace process

##### *1.1.2.2.2.* Flue gas recirculation (FGR)

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This method is the selection of the flue gases (5…30 %) from the flue duct at 300…400 °C and feeding these gases into the active combustion zone (preferably through the burners, using selected nozzles or in a mixture with air supplied for combustion). Flue gases reduces the maximum temperature at the flame core and reduce the concentration of oxygen in the combustion zone. The first factor affects the rate of the thermal $NO_x$ formation and the effect turns out that more than higher was a maximum temperature before recirculation input.

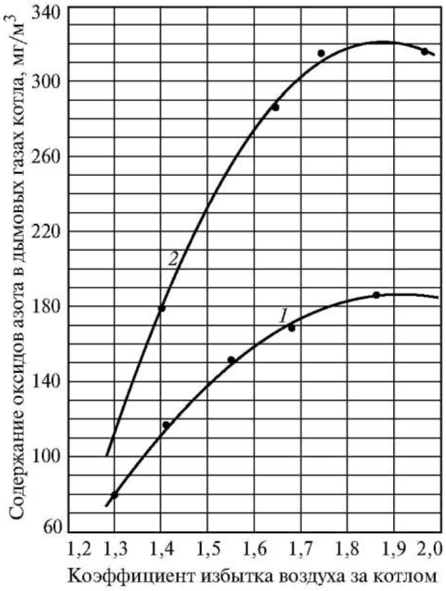


**Fig. 1.16. Dependence of the reduced nitrogen oxides concentration from the excess air ration $\alpha_к''$ at the open (curve *1*) and closed (curve *2*) gate feed gas recirculation into the burner**

The second factor plays a significant role at black coal combustion: if instead of the primary air to use a mixture of air and gas recirculation, the oxide concentration in the initial section of the flame will be lower than, of course, reduce the amount of the flue $NO_x$.

As an example in Fig. 1.16 shows the nitrogen oxides concentration in flue gases behind the gas-oil boiler PK-35-360 of the experimental TPP VTI. The boiler is equipped with a furnace chamber, at the bottom are four gas-oil burners near the corners on the tangential scheme. Recirculation of flue gases is made at the suction fan VDN-11.2 and provide the delivery of gas-air mixture in the burners to reduce nitrogen oxide emissions. All nine experiments whose results are shown in Fig. 1.16 were conducted at constant loading and at constant parameters of the boiler ($p$ = 15,1 MPa, $t_{heat}$ = 560…570 °C).

Changes only the excess air. Four experiments were conducted without recycling, and five – at applying gases recirculation into the burner.

As seen from the graph, the characteristic curve of $NO_x(\alpha_к'')$ at the presence of recycling lies considerably below the curve which characterizing the $NO_x$ concentration without recycling.

At the solid fuel combustion (especially in furnace with bottom-ash removal) factor of maximum temperature in the flame core plays a minor role. However, reducing the oxygen concentration in the primary air (at the introduction of recycled flue gases) effect on $NO_x$ emission. So, when tested boilers BKZ-160-100 of TPP of Baikal integral pulp-and-paper mill was found that $NO_x$ in the flue gases of a boiler at full loading varies from 460 to 720 mg/m$^3$ (with increasing excess air) at the brown coal combustion in the chamber with tangential configuration of the straight-flow burners.

At one of the boilers BKZ-160-100 with scheme of flue gases recirculation at nominal loading in the same range of excess air concentration of nitrogen oxides was significantly lower: 380…550 mg/m$^3$ (converted to $NO_2$ приstandatd conditions 0 °C, 101,3 kPa, 6 % $O_2$) [13].