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

# Technical Solutions on Retrofitting TPP-210A Boilers for Firing Low-Grade Coals with Low Reaction Capacity

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**Abstract**—Results from development of a conceptual project for retrofitting TPP-210A boilers worked out by specialists of EMAlliance are described. Operation of the TPP-210A boilers installed at the Tripolskaya thermal power station is subjected to a comprehensive analysis. The existing difficulties connected with firing anthracite culm are considered. Two boiler retrofitting versions involving the use of a regenerative or tubular air heater are proposed. The advantages of the retrofitting version involving installation of a tubular air heater are described.

*Keywords*: retrofitting of boilers, TPP-210A boiler, combustion of anthracite culm, regenerative air heater, tubular air heater

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Type TPP-210 supercritical boilers for a steam capacity of 950 t/h intended for firing anthracite and lean coals have been installed at the Tripolskaya, Zmievsk, Novocherkassk, Pridneprovsk, and Krivoi Rog GRES-2, and at Mosenergo TES-22 thermal power stations (TPS).

Anthracite culm (AC) is a coal having the lowest reaction capacity among those used in power engineering. Certain difficulties are encountered in firing this coal, the main of which is achieving stable ignition and economically efficient combustion. One of the main factors due to which the combustion of AC in 300-MW power units is characterized by rather low economic efficiency and degraded reliability is these boilers operation with decreased heating of air, which results not only in insufficiently stable ignition, but also in that the burners operate with decreased values of air excess factor, especially at a low load.

In view of the importance of selecting economically substantiated optimal temperature of hot air in designing new furnace devices intended for firing AC, specialists of the All-Russia Thermal Engineering Institute (VTI) and Central Boiler–Turbine Institute (TsKTI) carried out comprehensive investigations of the AC combustion process at different facilities with different levels of hot air temperature [1, 2]. Based on the results of these investigations, the required hot air heating temperature for AC specified in the Standard Method for Thermal Design of Boilers issued in 1998 was increased from 380–400°C (according to the Standard Method issued in 1973) to 450–470°C irrespective of ash removal method.

Instead of the design characteristics of coal intended for firing at the Tripolskaya TPS ($Q_i^r$ = 24.24 MJ/kg, $W^r$ = 7.5%, and $A^r$ = 19.0%), the coal delivered to the power station in 2010 had the following average characteristics: $Q_i^r$ = 21.61 MJ/kg, $W^r$ = 9.8%, and $A^r$ = 22.6%. The hot air temperature dropped from its design value equal to 401°C and even from the level of 365°C that was established in the first years of operation down to 328–340°C.

Increased air inleakages into the pulverized-coal system and into the furnace also contribute to degradation of the boiler performance characteristics. In addition, the use of high-concentration pulverized coal (HCPC) without modifying the burners and with nonoptimally arranged fuel mixers upstream of the burners did not allow the advantages of HCPC to be realized to the full extent.

The need to fire low-grade AC delivered to the power station, taken together with the above-mentioned drawbacks, leads to the following negative consequences:

—The throughput capacity of pulverized-coal systems becomes insufficient for providing the required amount of fuel to the boiler during its operation at the nominal power output.

—Worse conditions are created for the outflow of liquid slag from the furnace tap holes.

—The ignition of coke particles, which is the first stage of the AC combustion process, becomes less stable, and increasing the fraction of flame support fuel taken in combination with low values of air excess factor in the burners has a detrimental effect on operation of the furnace waterwalls' lower radiant part and the regenerative air heater.

The technical necessity of retrofitting the TPP-210A boiler No. 2 installed at the Tripolskaya TPS in