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

A Prospect for Achieving More Efficient Combustion of Kuznetsk Lean Coal in a Boiler with Dry-Ash Removal

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Abstract—A new high-efficient technology for staged combustion of Kuznetsk lean coal in PK-10 boilers with dry-ash removal is proposed, which involves the use of direct-flow burners, secondary-air nozzles, and combined nozzles, all installed on the furnace lateral walls. It is expected that more reliable, economically efficient, and environmentally friendly operation of the boilers will be achieved after putting the new technology into operation.

Keywords: staged combustion, lean coal, dry-ash removal, direct-flow burners, nozzles, reliability, economic efficiency, environmental friendliness, boilers

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The list of main problems concerned with combusting Kuznetsk lean coal in boilers with dry-ash removal includes high specific emissions of nitrogen oxides into the atmosphere, high fraction of unburned carbon, and pulsating mode of combustion at loads below the nominal level. This, for example, was pointed out in [1], where the specific features relating to operation of the PK-10 boilers installed at the South Kuzbass district power station (DPS) were considered in the cases of using them in the standard factory makeup and in a few versions with modified furnaces and burners for implementing staged combustion of fuel. A conclusion was drawn in [1] that neither the use of operational nor application of retrofitting methods makes it possible to achieve efficient combustion of Kuznetsk lean coal in the worn PK-10 boilers, which were manufactured around 50 years ago, and bring their operation in compliance with the existing standards.

In [2], this conclusion was in fact classified as a premature one, and a promising technology for combusting lean coal was suggested, which involved the use of tangentially directed and downwardly inclined direct-flow burners and nozzles. After publication of paper [2], specialists of the Moscow Power Engineering Institute (MEI), working jointly with specialists of the South Kuzbass Power Company and Energoremont Central Design Office (TsKB Energoremont) developed a new high-efficient technology for staged combustion of Grade GR Kuznetsk coal. This technology, which involved the use of an oppositely shifted layout of burners and nozzles installed on the furnace lateral walls, was put in operation in four K-50-14-250 boilers used in the boiler house in the town of Tashtagol. As a result, the specific emissions of NO_x and the

fraction of unburned carbon were decreased to the levels complying with the relevant standards. But the most important result was that along with these achievements, the available range of boiler loads was extended to a level equal to 0.3–0.4 of the nominal load (50 t/h) without the need to support the flame with fuel oil [3].

The fuel combustion technology used in each of the retrofitted boilers was subjected to minor modifications, but its basic features, the list of which is given below, remained unchanged:

- (i) The burners and nozzles have an oppositely shifted arrangement.
- (ii) The direct-flow burners are inclined downward at an essential angle.
- (iii) Secondary air is admitted into the furnace below the level of burners through the direct-flow nozzles that also serve as starting fuel-oil burners.
- (iv) The ascending burner flames are turbulized by jets flowing out from the combined nozzles.
- (v) Measures are taken to obtain a larger perimeter over which the dust–air mixture comes in direct contact (without an interlayer of secondary air) with furnace gases in the burner outlet section.
- (vi) Arrangements are made for forcedly admitting furnace gases to the initial segments of dust–air jets.

A conclusion was drawn first in [4] and then in [3] that measures ensuring early ignition of pulverized coal are of essential importance for achieving satisfactory comprehensive indicators characterizing the efficiency of staged combustion of Grade GR Kuznetsk coal in different types of boilers installed at thermal power stations in the Kuzbass region that were retrofitted according to the proposals worked out by MEI