

Arc Plasma Thermochemical Preparation of Coal to Effective Combustion in Thermal Power Plants

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Abstract : This work presents plasma technology for solid fuel ignition and combustion. Plasma activation promotes more effective and environmentally friendly low-rank coal ignition and combustion. To realise this technology at coal fired power plants plasma-fuel systems (PFS) were developed. PFS improve efficiency of power coals combustion and decrease harmful emission. PFS is pulverized coal burner equipped with arc plasma torch. Plasma torch is the main element of the PFS. Plasma forming gas is air. It is blown through the electrodes forming plasma flame. Temperature of this flame is varied from 5000 to 6000 K. Plasma torch power is varied from 100 to 350 kW and geometrical sizes are the following: the height is 0.4-0.5 m and diameter is 0.2-0.25 m. The base of the PFS technology is plasma thermochemical preparation of coal for burning. It consists of heating of the pulverized coal and air mixture by arc plasma up to temperature of coal volatiles release and char carbon partial gasification. In the PFS coal-air mixture is deficient in oxygen and carbon is oxidised mainly to carbon monoxide. As a result, at the PFS exit a highly reactive mixture is formed of combustible gases and partially burned char particles, together with products of combustion, while the temperature of the gaseous mixture is around 1300 K. Further mixing with the air promotes intensive ignition and complete combustion of the prepared fuel. PFS have been tested for boilers start up and pulverized coal flame stabilization in different countries at power boilers of 75 to 950 t/h steam productivity. They were equipped with different types of pulverized coal burners (direct flow, muffle and swirl burners). At PFS testing power coals of all ranks (lignite, bituminous, anthracite and their mixtures) were incinerated. Volatile content of them was from 4 to 50%, ash varied from 15 to 48% and heat of combustion was from 1600 to 6000 kcal/kg. To show the advantages of the plasma technology before conventional technologies of coal combustion numerical investigation of plasma ignition, gasification and thermochemical preparation of a pulverized coal for incineration in an experimental furnace with heat capacity of 3 MW was fulfilled. Two computer-codes were used for the research. The computer simulation experiments were conducted for low-rank bituminous coal of 44% ash content. The boiler operation has been studied at the conventional mode of combustion and with arc plasma activation of coal combustion. The experiments and computer simulation showed ecological efficiency of the plasma technology. When a plasma torch operates in the regime of plasma stabilization of pulverized coal flame, NOX emission is reduced twice and amount of unburned carbon is reduced four times. Acknowledgement: This work was supported by Ministry of Education and Science of the Republic of Kazakhstan and Ministry of Education and Science of the Russian Federation (Agreement on grant No. 14.613.21.0005, project RFMEFI61314X0005).

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