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Research of Vapor-Gas Phase Formation Dynamics during the Thermal Treatment of Coal-Water Fuel

Water-coal fuel (WCF) is one of effective substitutions of coal, expensive liquid fuels and natural gas. Getting coal-water fuel from watery coal fines, wet slams and waste of concentrating enterprises which are not used at present, and its application in the energy sector can provide significant economic effect.

For use as fuel the coal-water fuel should have some specific properties, including high fluidity, resistance to separation into layers and a high concentration of the solid phase. Increasing the concentration of coal in the fuel is only possible up to a certain limit, above which obtaining a homogenous system with low viscosity is not possible.

Since the coal-water fuel contains large amounts of moisture, the process of combustion is different from combustion of solid fuels and it accompanies by extra costs for moisture evaporation.

One of the control parameters for achieving the required properties of coal-water fuel and necessary temperature level for the thermal recycling is preliminary heating of coal-water fuel. Furthermore, during the preliminary preheating of coal-water fuel structure of the organic substances is changed with the formation of the intermediate combustible compounds, which favorably influences the subsequent processes of heat recycling.

Preheated coal-water fuel derived from coal of different degrees of metamorphism, containing 55-73% solids was investigated.

Experimental and theoretical research of influence of coal-water fuel preheating on the gassing dynamics showed that the yield of fuel vapor-gas phase begins at 50° C and at temperatures of 100-200° C, occur an intensive its formation. The discrepancy between the experimental and theoretical value is not more than 10-12%.

The theoretical studies have found that during the process of coal-water fuel preheating, water (water vapor) reacts with carbon fuel and as a result CO₂, C_xH_y and small amounts of H₂ and CO are formed. The high content of hydrocarbon compounds in the vapor-gas phase can be explained by processes occurring in the production of coal-water fuel. The rate of reaction of carbon with water (water vapor) is greatly increased with increasing temperature.

Coal-water fuel preliminary heating to 180-200° C can increase the content of reducing components by 2-2,5%. Furthermore, it was proved that preliminary heating of coal-water fuel reduces the amount of oxidant needed for its gasification.