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METHODS OF SOLID FUEL COMBUSTION IN BOILER UNITS

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Abstract. Today, solid fuel consumption is growing at a tremendous pace. The combustion of solid fuel in combustion devices can be organized in several ways. This paper discusses various methods of burning solid fuels used in modern boiler units. The features of different solid fuel combustion technologies are described in order to make an informed choice of the most suitable one for each specific application.

СПОСОБЫ СЖИГАНИЯ ТВЕРДОГО ТОПЛИВА В КОТЛОАГРЕГАТАХ

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Ключевые слова: котлоагрегат, сжигание, топка, частицы, твердое топливо, слой, объем.
Аннотация. На сегодняшний день огромными темпами растет потребление твердого топлива. Сжигание твердого топлива в топочных устройствах может быть организовано несколькими способами. В данной работе рассматриваются различные методы сжигания твердого топлива, применяемые в современных котлоагрегатах. Описываются особенности разных технологий сжигания твердого топлива для осуществления осознанного выбора наиболее подходящей для каждого конкретного случая применения.

Recently, the world has seen a trend towards increasing consumption of solid fuel in boiler units and installations. The deterioration of fuel quality and the existing limitations in the use of traditional furnace designs, their low operating efficiency when burning low-grade coals stimulate the search for ways to improve combustion methods, which in turn predetermine the design of the boiler and its technological, economic and environmental performance indicators.

Currently, the main methods of burning solid fuels can be distinguished:

1) in a bed;

2) in volume.

Bed combustion, in turn, is distinguished between dense bed combustion and fluidized bed combustion. When burning in a dense bed, solid fuel, loaded with a bed of a certain thickness (height) onto a distribution grate, is ignited and blown (usually from the bottom up) with air. The main combustion occurs in the bed formed by pieces of fuel. Above the bed in the volume of the combustion chamber, volatile substances released from the fuel during its heating (H2, CO, CH4, etc.) burn, and small particles removed from the bed by the flow of air and combustion products also burn out. The speed of the gas-air flow in the bed is limited by the stability limit of its occurrence. An increase in air speed above a certain limit causes loosening of the bed, since air that breaks through the bed in certain places forms craters. Since polydisperse fuel is always loaded into the bed, this leads to the removal of a large number of smaller fuel particles that do not have time to burn out in the volume of the furnace [1].

Fluidized bed combustion is one of the technologies for burning solid fuels in power boilers, in which a fluidized bed of fuel particles and non-combustible materials is created in the firebox. To achieve maximum completeness of burnout of organic mass from particles of high-ash fuels. Basic principles of organizing the combustion process in a fluidized bed:

1. Organization of fuel combustion mode at a stable maximum possible bed temperature. In this case, the temperature of the bed must be lower than the softening temperature of the ash in order to eliminate deformation and reduce the porosity of the growing ash shell of the particle.

2. Ensuring the maximum concentration of the oxidizer in the gas flow surrounding the particle.

3. The use of a combustion chamber expanding upward with top discharge from the fluidized bed of excess ashed particles rising vertically upward in the bed and combustion chamber as their density decreases.

4. Ensuring the residence time of the largest particles in the fluidized bed is longer than or equal to the time of complete burnout of flammable substances from them. This condition can be easily achieved by selecting the optimal amount of inert material.

5. Reduction of dust entrainment and heat loss with mechanical underburning [2].

Volume combustion exists in several variants, namely:

1) flare;

2) vortex.

The flare method allows you to burn a wide variety of low-grade fuels with high reliability and efficiency. Solid fuels in a pulverized state are burned under boilers with a steam capacity of 35 t/h and above. Flare fireboxes are rectangular prismatic chambers made of refractory brick or refractory concrete. The walls of the combustion chamber are covered from the inside with a system of boiling pipes – combustion water screens. They represent an effective heating surface of the boiler, absorbing a large amount of heat emitted by the torch, and at the same time protect the combustion chamber masonry from wear and destruction under the influence of the high temperature of the torch and molten slag [3].

Another type of volumetric combustion is vortex combustion. A more technologically advanced way of burning solid biofuels. As a rule, it is used for burning fine fuels (particle size up to 6 mm), incl. dusty. With this method, most of the fuel is not on the grate, but rotates in the vortex flow of blast air, i.e. This is a way of burning fuel in suspension. Whirlwind combustion is ideal for dry sawdust and shavings, sanding dust, chopped straw, sunflower husks, etc. The firebox most often has the shape of a cylinder. On the inner surface of the combustion chamber there are tangentially located blow holes. The blown air forced by the fans enters the combustion zone through tangential nozzles, creating a vortex movement of the mixture of air and fuel. In this case, the fuel particles are in a suspended state – they float in the air, moving along the longest possible trajectory. The centrifugal force that arises presses the fuel particles against the internal hot surface of the firebox, promoting their more complete combustion and preventing the removal of unburnt particles from the firebox. Fuel is also supplied tangentially to the firebox with a horizontal axis of rotation, and to the firebox with a vertical axis of rotation it can be supplied to the vacuum zone along the axis from above (Figure 1). The firebox most often has the shape of a cylinder. On the inner surface of the combustion chamber there are tangentially located blow holes. The blown air forced by the fans enters the combustion zone through tangential nozzles, creating a vortex movement of the mixture of air and fuel. In this case, the fuel particles are in a suspended state – they float in the air, moving along the longest possible trajectory. The centrifugal force that arises presses the fuel particles against the internal hot surface of the firebox, promoting their more complete combustion and preventing the removal of unburnt particles from the firebox. Fuel is also supplied tangentially to the furnace with a horizontal axis of rotation, and to the furnace with a vertical axis of rotation it can be supplied to the vacuum zone along the axis from above [4].

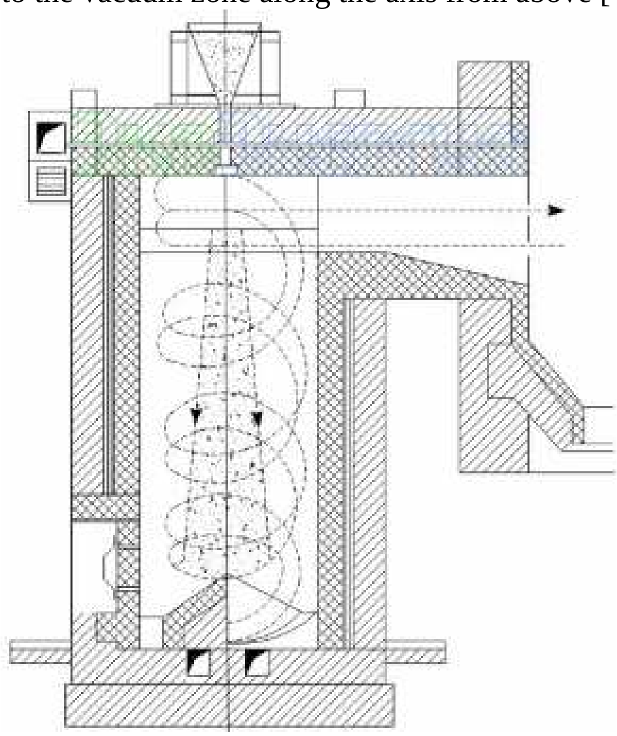

Fig. 1. Combustion with a vertical axis of rotation of the vortex

It is important to note that fuel combustion should be carried out in such a way that its more complete combustion is achieved, all kinds of fuel losses are minimized and a high temperature in the furnace is achieved. To maintain the normal combustion process of fuel it is necessary:

– have a draft sufficient to remove flue gases from the combustion space and allow air to enter the firebox to ensure a normal combustion process;

– break large pieces of coal and anthracite for combustion on a manual grate to a size of 50...75 mm;

– supply the air required for fuel combustion in a timely manner;

– throw fuel in small portions at the same time;

– maintain the required thickness of the fuel bed evenly throughout the grate;

– level the fuel bed by throwing coal;

– with blue flames in the firebox, reduce the thickness of the fuel bed [5].

Thus, methods of burning solid fuels in boiler units play a key role in the efficiency and environmental friendliness of the process of generating thermal energy. Important aspects such as boiler efficiency, the volume of emissions of harmful substances into the atmosphere and the cost of operating the equipment depend on the chosen combustion method. To achieve the best results in choosing a combustion method, a comprehensive approach is required, including the correct choice of fuel, regular maintenance of boiler units and compliance with operating recommendations. Only by taking into account all these factors can reliable and efficient operation of solid fuel heating systems be ensured.

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