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ZWIĘKSZENIE WYDAJNOŚCI KOTŁA NA PALIWO STAŁE

Streszczenie: W tym artykule omówiono główne sposoby poprawy wydajności kotłów na paliwo stałe. Zaproponowano system wielociągowego pompowania korzystnych gazów kotłowych. Zaimplementowano schemat dopalania gazu w specjalnej komorze wtryskowej. To ulepszenie znacznie zwiększa sprawność kotła i minimalizuje uwalnianie szkodliwych substancji do atmosfery.

Słowa kluczowe: kocioł, sprawność, komora wtryskowa

INCREASING THE EFFICIENCY OF THE SOLID FUEL BOILER

Summary: The main ways of improving the efficiency of solid fuel boilers are considered in this article. A system for multi-pass pumping of beneficial boiler gases is proposed. The gas afterburning scheme in a special injection chamber has been implemented. This improvement significantly increases the efficiency of the boiler and minimizes the release of harmful substances into the atmosphere.

Keywords: boiler, efficiency, injection chamber

1. Introduction

Today, the problem of energy generation and energy saving is given the greatest attention in European countries in connection with the war in the east and oil and gas blackmail of Russia. The cost of gas and oil is constantly increasing, and a situation is predicted when these sources of supply may cease altogether. Therefore, in addition to alternative energy, typical solid fuel generators of thermal energy - wood boilers - can be in great demand. In addition to ordinary wood, furniture production waste, wood chips, peat and even rubber can be used for their feeding. When burning the

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latter, many harmful smoke compounds are released into the atmosphere, which significantly limits their use, especially in densely populated regions. Therefore, the developers of company “Shpargeit” boilers focused on solving this problem. As a result of the search for solutions [1-7], it was established that the mentioned disadvantages of solid fuel boilers can be significantly reduced by introducing the so-called super-pyrolysis process of pumping the source gas.

2. Results and discussion

To ensure an environmentally safe, highly efficient heat generation process, “Shpargeit” boilers use a new combustion principle, namely 4-stage combustion of solid organic fuel using the following phase processes and phase transitions:

1-st stage:

- at the first stage of combustion, there is partial direct combustion of solid organic fuel on the surface of its contact with air (oxidizer) with the formation of "black smoke" in the form of gaseous combustion products which contain partially fully oxidized and partially incompletely oxidized flue gases - CO_2 and CO, and also, which is very important - water vapor, which is formed due to two components intercellular moisture, present in biomass, and chemically bound hydrogen, which is in the composition of cellulose molecules.

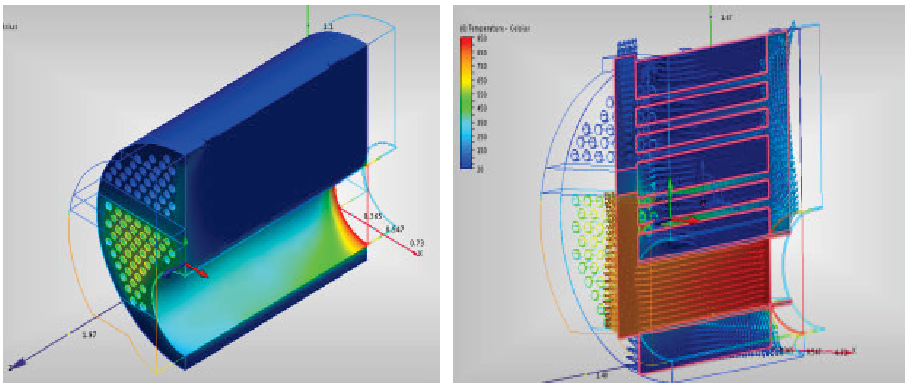

Figure 1. CAD modelling heat flow in boiler

As a result of direct combustion and after the completion of the pyrolysis process, the mineral component of the organic fuel remains in the boiler in the form of heated charcoal - practically pure carbon which is located in the lower layers of the burning fuel in the lower part of the fuel layer.

2-nd stage:

- at the second stage of partial burning - when the temperature of solid fuel reaches 500°C, pyrolysis of organic molecules (biofuel) occurs, in the process of which pyrolysis gas is formed (formed without access of air or with an insufficient amount of air). Depending on the type and humidity of the fuel (wood) and the temperature and intensity of pyrolysis, pyrolysis gas can have different shades of color.

3-rd stage:

- at the third stage of the combustion process, the combustion products formed in the first two stages, which contain water vapor, synthesis gas, methane, hydrogen, vapors of wood resins, tar, water vapor, and partially soot - are absorbed through charcoal heated to a temperature above 800 ° C , and under these conditions additional heating of pyrolysis products and chemical and mechanical underburning of direct combustion occurs to the temperature of effective oxidation and due to the contact of water vapor with red-hot charcoal, charcoal and soot are gasified by the reaction of hydrogen reduction from hydrogen oxide (water vapor) to pure hydrogen H_2 and carbon monoxide - CO.

4-th stage:

- in the fourth stage of combustion, the combustion products formed in the first three stages are sucked through an injection nozzle heated to a temperature of 1000-1200 °C (Fig.2).

Figure 2. Results of temperature measurement at the gas injection nozzle

In the injector nozzle, the optimal amount of heated air required for their complete combustion is added to the mixture of gases, resin vapors, tar, soot, and chemical and mechanical afterburning formed in the first three stages of combustion.

From the injector nozzles, the gas-air mixture formed in the form of an incandescent flame enters the high-temperature afterburning chamber, where at a temperature of 1200-1350°C (fig. 2), in the form of plasma, complete afterburning of the gasified fuel occurs and its decomposition to a transparent state in the form of plasma ions, chemical elements and stable inorganic compounds - mainly oxides of all gasified fuel products and all its components, including wood resins, tar, glues, phenols, formaldehydes, plastics, rubber and other organic compounds (Fig 3,4).

Figure 3. The final implementation of an industrial boiler with a capacity of 1 MW

Figure 4. Photo of boilers heat exchanger surface in process of operations. No carbonization of firetubes and the white color of the ash on the heat exchanger surface testifies to full and clean fuel burning.

After the afterburning chamber (Fig.6), clean, completely burned combustion products enter the heat exchanger, where they give thermal energy to the heat carriers without contaminating the heat exchanger, which helps to obtain a high efficiency of the boiler.

Figure 5. Injector of the chamber of the 4-th stage of afterburning.

Figure 6. The results of measuring the efficiency a solid fuel boiler.

3. Conclusions

Thus, the construction of a solid-fuel boiler according to a multi-stage scheme makes it possible to burn any furniture production waste in anenvironmentally safe and smoke-freeway, including chipboard, plywood, remnants of paint, varnish, fabrics, etc., as well as organic house hold waste, human and animal waste, spoiled food products, biomaterials, animal husbandry and meat processing waste and etc. The efficiency of the boiler unit is not lesst han 92% (at exhaust gas temperature of 160° C).

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