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MAIN WAYS OF IMPROVING THE EFFICIENCY OF FUEL AND ENERGY RESOURCES UTILIZATION IN ENERGY PRODUCTION

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The paper analyzes the main ways of improving the energy efficiency of boiler plants that provide thermal energy to industrial enterprises and housing and utilities sectors. The paper also presents the methodology for evaluating the effectiveness of energy-saving measures. The authors point out the main measures to save boiler and furnace fuel, heat and electric energy.

One of the main sectors of the national economy of the Republic of Belarus is the power industry. The economic potential of the state and the welfare of the population mainly depend on it. However, it also has the most powerful effect on the environment, ecosystems and the biosphere as a whole. The most acute environmental problems (climate change, acid rain, general environmental pollution) are directly or indirectly related to either production or use and consumption of energy.

In this regard, the urgent goal of the development of the fuel and energy sector is to satisfy the needs of the country's economy and population in energy resources on the basis of their most efficient use while reducing the environmental load.

The State program "Energy Saving" for 2016-2020 envisages within the framework of the subprogramme "Improving Energy Efficiency" to ensure the saving of fuel and energy resources (FER) as a result of the implementation of energy-saving measures of about 5 million tons of equivalent fuel, and also reduce by 2020, the consumption rate of fuel and energy resources for the production of goods (works, services) by 2% [1].

The paper analyzes the main ways of improving the energy efficiency of boiler plants that provide thermal energy to industrial enterprises, housing and utilities sector. As a result, the main measures to save boiler and furnace fuel, heat and electric energy were identified.

Thus, saving boiler oil can be obtained by implementing the following measures:

– improving the efficiency of existing energy facilities through the use of innovative and energy-efficient technologies with phased decommissioning of obsolete equipment;

– introduction of low power boilers instead of unloaded high power boilers. This leads to an increase in the efficiency of the small boiler when operating at rated load; reduce electricity consumption; for steam boilers, an_additional effect is achieved by reducing their own needs for heat production (reducing the volume of blowing and losses through thermal insulation).

– optimization of heat supply networks of populated areas and at the same time the elimination of inefficient heat sources or decentralization of heat supply systems;

– changing the working mode of steam boilers into hot water mode. When changing to the hot water mode, the economic effect is achieved due to the following: reducing heat loss with flue gases by 1.5–2%, due to a decrease in the temperature of flue gases; reducing heat consumption for own needs (heat loss with purging boilers; heat loss in steam pipelines and steam-water heat exchangers; heat loss with loss of condensate; reducing energy consumption for industrial needs: for feed pumps; for condensate pumps; lower costs for chemical water treatment).

Reducing thermal energy consumption can be achieved by:

– reduction of energy losses in heat networks;

– the introduction of efficient heat exchangers (plate-type heat exchanger instead of shell and tube exchanger). Heat energy is saved as a result of the following: reducing the outer surface of the heat exchanger (at equal heat load) and more complete use of heat in the heat transfer process by increasing the heat transfer coefficient; reduce coolant consumption and energy costs for its transmission.

The main measures to save electric energy include:

– replacement of pumping equipment with more energy efficient one;

– introduction of a controlled electric drive of pumping equipment (reduction of electric energy consumption is achieved by eliminating the influence of idling of the electric motor; optimizing the operating mode of the installation depending on operating parameters);

– introduction of a controlled electric drive of a blower fan or a boiler exhaust fan.

Currently, a significant part of the fixed assets of energy production facilities requires modernization. This is primarily due to the fact that the boiler plants have depleted their resources and do not meet modern operating standards and energy efficiency standards.

Therefore, among the main measures ensuring an increase in the efficiency of the use of fuel and energy resources, it is possible to single out the replacement of low efficiency boiler equipment with highly efficient boilers. When implementing this measure, saving fuel and energy resources is achieved by reducing fuel consumption with a more efficient process of burning it to produce thermal energy. Efficiency analysis is performed according to the following method [2]:

1. Evaluation of the specific fuel consumption for heat supply after replacing the boiler (the decrease in specific fuel consumption for heat supply is caused by an increase in boiler plant efficiency):

$$b_{тэ}^{н} = (142{,}86/\eta_{нетто}^{н}) \cdot 100, \text{ kg h.c./Gcal};$$

where $\eta_{нетто}^{н}$ – efficiency of a new boiler, %.

Evaluation of equivalent fuel economy from changes in the boiler efficiency netto:

$$\Delta Вт = Q_{ч} \cdot Т_{г} \cdot (b_{тэ}^{ф} - b_{тэ}^{н}) \cdot 10^{-3}, \text{ т у.т.},$$

where $b_{тэ}^{ф}$ – specific fuel consumption for thermal energy output, actual, kg / tce / Gcal;

$Q_{ч}$ – average hourly heat load of the boiler plant, Gcal / h;

$Т_{г}$ – the number of operating hours of the boiler plant in a year.

Among boiler plants having a higher efficiency compared to conventional solid fuel boilers and allowing to obtain a greater amount of thermal energy from a similar volume of solid fuel, pyrolysis boilers can be distinguished. The principle of operation of the pyrolysis boiler is based on burning solid fuel at high temperature and lack of oxygen. Under such conditions, it is not the usual combustion process that occurs, but the decomposition of dry wood or another type of solid fuel with the release of combustible pyrolysis gas, which is then used to generate thermal energy and to heat the heat carrier in the heat exchanger. A solid fuel pyrolysis boiler consists of two main chambers: a combustion chamber (gas generator chamber) and a combustion chamber (gas combustion chamber).

In the combustion chamber, the process of pyrolysis of firewood occurs. In the combustion chamber, gas that is released from the wood due to pyrolysis is burned.

When using pyrolysis boilers, the specific fuel consumption for the production of thermal energy is reduced, and also, due to the combustion of the fuel, less emissions of harmful substances into the atmospheric air are released. When analyzing the energy balance of housing and utilities enterprises, an important way of the consumption of thermal energy is losses during the transportation of thermal energy in heating networks.

In this regard, as a measure to save fuel and energy resources, a gradual replacement of existing heating networks with pre-insulated pipes is proposed. When using pre-insulated pipes, saving of fuel and energy resources is achieved due to: reduction of heat losses in heating mains, as well as reduction of electricity consumption for heat energy transport. Analysis of the effectiveness of the event is performed according to the following technique [2].

According to the test results or by calculation, the losses $\Delta Q_{пот}$ along the heating main are determined. To calculate the heat loss, you can use the "Methodology for the determination of heat energy losses in heat supply networks taking into account wear, tear and operating conditions", approved by Resolution No. 2 of the Committee on Energy Efficiency under the Council of Ministers of the Republic of Belarus of September 29, 2006.

Evaluation of the excessive fuel consumption obtained by using this heat pipe is made according to the formula:

$$\Delta B_{тэ} = (Q + \Delta Q_{пот}) \cdot b_{тэ}/1000 - (Q + Q_{пот}^{ПИ}) \cdot b_{тэ}/1000,\ т\ у.т.,$$

where Q – amount of received thermal energy, Gcal;

$\Delta Q_{пот}$ – losses on the existing heating main, Gcal;

$Q_{пот}^{ПИ}$ – heat losses from pre-insulated pipes;

$b_{тэ}$ – specific fuel consumption of the existing heat source, kg of equivalent fuel / Gcal.

Evaluation of the energy consumption required to transfer thermal energy from the existing heating main:

$$Э_{п} = (Q + \Delta Q_{пот}) \cdot Э_{сн\ тэ},\ кВт\ ч;$$

where Q – amount of received thermal energy, Gcal;

$\Delta Q_{пот}$ – losses on the heating main, Gcal;

$Э_{сн\ тэ}$ – specific energy consumption necessary to transport and produce of 1 Gcal of thermal energy, kWh / Gcal.

Evaluation of the amount of electricity required to produce and transport thermal energy through a heating main from pre-insulated pipes:

$$Э_{пи} = (Q + Q_{пот}^{ПИ}) \cdot Э_{сн\ тэ},\ кВт\ ч,$$

where Q – amount of received thermal energy, Gcal;

$Q_{пот}^{ПИ}$ – losses on the heating main from pre-insulated pipes, Gcal,

$Э_{сн\ тэ}$ – specific energy consumption necessary to transport and produce of 1 Gcal of thermal energy, kWh / Gcal.

Evaluation of the fuel consumption that is necessary to cover the excessive energy consumption to produce and transport thermal energy, taking into account losses in the electrical grids:

$$\Delta B_{э} = (Э_{п} - Э_{пи}) \cdot k_{пот}/100 \cdot b_{ээ} \cdot 10^{-6}, \text{ т у.т.},$$

where $Э_{п}$ – energy consumption that is necessary to transfer thermal energy through the existing heating main, kWh;

$Э_{пи}$ – energy consumption that is necessary to produce and transport thermal energy through a heating main from pre-insulated pipes, kWh;

$k_{пот}$ – coefficient taking into account losses in electrical grids;

$b_{ээ}$ – specific fuel consumption for electricity supply is taken to be equal to the actual fuel consumption at the closing station in the power system (Lukoml state district power station) per year preceding the calculation, year equivalent / kWh.

$$\Delta B = \Delta B_{тэ} + \Delta B_{э}, \text{ т у.т.}$$

The total fuel economy from the use of pre-insulated pipes is determined by:

$$\Delta B = \Delta B_{тэ} + \Delta B_{э}, \text{ т у.т.}$$

Thus, the measures considered contribute to increasing the efficiency of using fuel and energy resources (boiler-furnace fuel, heat and electric energy) at energy production facilities.

Reference

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