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Promising methods for enhancing the performance of boiler plants of centralized, decentralized and individual type of heat supply

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Promising methods for enhancing the performance of boiler plants of centralized, decentralized and individual type of heat supply

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Abstract. The paper covers the methods of how to enhance boiler plants for centralized, decentralized and individual type of heat supply. The performance analysis uses technical and economic efficiency indicators, fuel and other types of energy resources saving.

Boiler plants in our country are used as sources of thermal energy to provide heating, ventilation and hot water supply. Most often, such a source supplies heat to various groups of consumers distributed over long distances and connected by means of extensive heating networks. In the last 10-15 years, individual heat supply systems designed to provide heat to a single consumer have become more popular, as well as decentralized systems that supply heat to several consumers united geographically on a fairly small area (for example, skid-mounted boiler plants).

The challenge of how to enhance the performance of boiler plants in terms of energy efficiency is actual and significant for the economy of our country due to the fact that they share 60% of total energy saving sector, while their fuel consumption is 80% [1-3]. Its solution requires actions that will contribute to energy conservation and can give a significant effect on fuel economy in the whole country.

Centralized boiler plants.

The main items of energy consumption at centralized boiler plants are:

- heat supply to consumers as steam of industrial characteristics and hot network water providing the heating, ventilation and hot water supply to the consumers;
- discharge of heat to the atmosphere along with fuel combustion products (exhaust gases);
- loss of heat energy due to external cooling of heat exchange hardware and incomplete combustion of fuel in the boiler;
- heat release to the atmosphere with gases removed during the process of deaeration.

Actions that will reduce dead outlay at boiler plants are primarily aimed at reducing heat release to the atmosphere with gases discharged to the atmosphere (exhaust and deaeration gases). Below are two actions:

1. Heat recovery of the discharged gases in condensation heat exchangers [4].
2. The use of heat pump plants [5-8]. This is one of the most successfully promoted actions for the recovery of low-grade secondary energy resources in the energy sector, industry facilities and housing and utility infrastructure. The heat pump plants can be used in boiler plants to increase the



potential of secondary energy resources to a higher temperature level at which their recovery becomes most efficient [14,15].

Both of these actions are competing with each other, because they are able to displace the heat load of the same units, so a special study is required to select one of them or optimize the combined solutions. The method of temperature matching is the most descriptive approach to determining the allowable loads of heat recovery units (Fig. 1) [1, 5, 10].

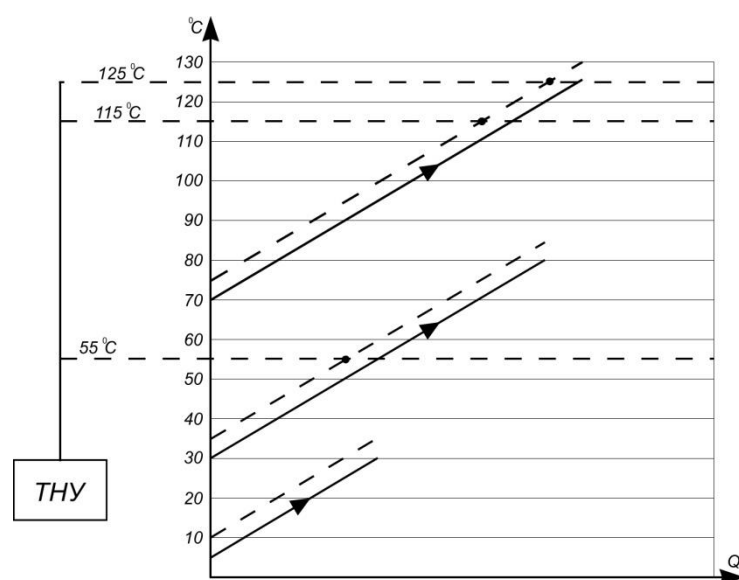
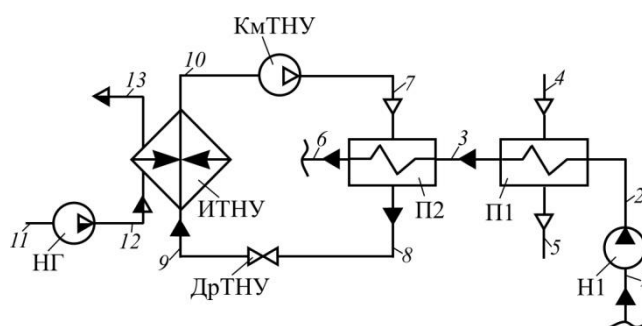


Fig. 1 Determination of allowable loads of heat recovery units using the method of temperature matching

The recovery of secondary energy resources is possible for the following processes [5]:

- 1) heating of raw water for the makeup system of the boiler plant (Fig. 2, a);
- 2) heating of chemically purified water upstream of the deaerator (Fig. 2, b);
- 3) heating of network water (Fig. 2, c).



a)

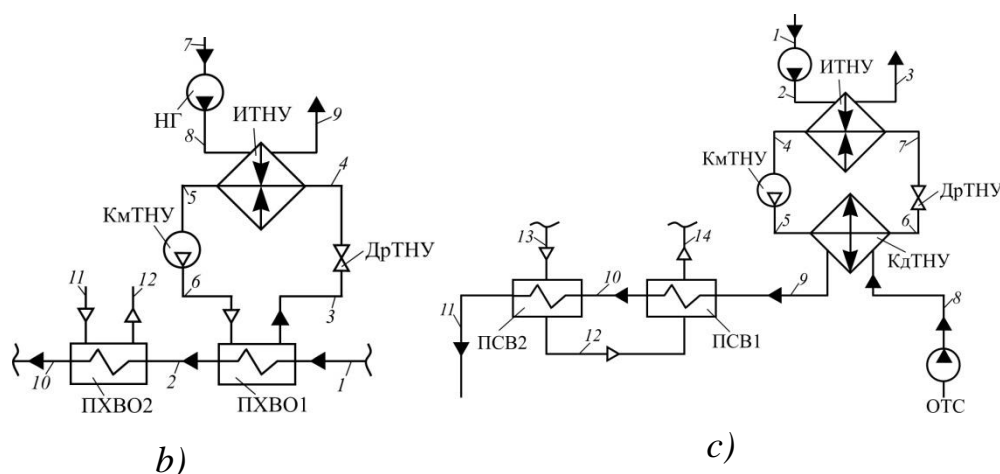


Fig. 2 Possible options of heat recovery of secondary energy resources included in the revised layout of the boiler plant

a) raw water heating; b) chemically purified water heating;
c) network water heating

The acronyms on Fig. 2 have the following meaning: КмТНУ, ИТНУ, КдТНУ, ДрТНУ stand for respectively, compressor, evaporator, condenser, throttle of heat pump plant; П1, П2 stand for make-up heat exchangers; ПХВО1, ПХВО2 stand for preheaters of chemically purified water; ПСВ1, ПСВ2 stand for raw water heaters, Н1, НГ stand for pumps; ОТС stands for return line of heat network.

In addition to the above actions, the recovery of secondary energy resources for heating the deaerator could be an option.

Boiler plants of decentralized and individual type of heat supply.

For decentralized boiler plants and individual heat supply, the choice of actions is narrower. In this case, heat pump plants have no competitors. Moreover, using of solar collecting panels and batteries in the installations makes it possible to synthesize hybrid plants [8].

Analysis of decision effectiveness

The most important technical and economic indicators of the performance of boiler plants are the cost and profitability of the heat energy produced (with regard to environmental requirements) and, as a result, minimization of the payback periods of power plants.

The main criteria for meeting these requirements are [7, 9-12]:

- 1) achieving the maximum possible fuel utilization efficiency in a power plant (the ratio of net energy to fuel energy) [13];
- 2) the maximum possible reduction in capital costs and timelines of construction of power plants.

Based on the calculation of these indicators, the fuel utilization efficiency can be increased for boiler plants by 5-7% with a payback period of 1-2 years.

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