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**ANALYSIS OF ENERGY EFFICIENCY OF THERMAL SCHEME OF
INDUSTRIAL HEATING BOILER HOUSE WITH COGENERATION HEAT
PUMP INSTALLATION**

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Abstract. The study analyzes the energy efficiency of the thermal scheme of an industrial heating boiler house with a cogeneration heat pump installation (CHPI). It is determined that the use of CHPI in the thermal scheme will provide high values of indicators of energy efficiency and savings of natural gas.

Key words: energy efficiency, cogeneration-heat pump installation.

The aim of the proposed study is to analyze the energy efficiency of the thermal scheme of an industrial heating boiler house with cogeneration heat pump installation (CHPI), which is an energy module based on steam compression heat pump and gas piston engine-generator.

The study was performed on the example of the thermal scheme of an industrial heating steam boiler house of an enterprise specializing in the production of frozen berries and fruits, as well as juices, purees and fruit fillers. According to the results of our previous research [1 – 9], proposed CHPI to modernize the thermal scheme of the boiler house can be widely used in thermal schemes of industrial heating boiler houses to replace part of the heat capacity of the boiler house to provide heat to consumers and meet their own needs of electric energy.

We have analyzed a number of indicators of energy efficiency of the thermal scheme of the boiler house with CHPI, using the methodological basis and research results from [10 – 13]. To increase the energy efficiency of the thermal scheme of the industrial heating boiler house, in our study it is proposed to use CHPI on low-temperature heat of industrial low-temperature source (heat from the condensers of refrigeration machines of the enterprise).

Studies [3 – 9] substantiate the energy, environmental and economic efficiency of CHPI application for thermal schemes of industrial heating boiler houses.

In this study, we evaluated the energy efficiency of CHPI application in the thermal scheme of the industrial heating boiler house of the enterprise when working in the mode of providing the load of the heat consumer; the results of the research are summarized in Table 1.

Based on the analysis of energy efficiency indicators from Table 1 we determined that the use of CHPI on industrial low-temperature heat source in the thermal scheme of industrial heating boiler house of enterprise will generate heat and electricity in CHPI with high energy conversion efficiency with $\varphi = 4,88$ and provide savings of working fuel (natural gas) on boiler house in volume 43,8% compared to the same heat capacity produced by the boiler house.

Based on the analysis of the research results, it is proposed that a heat pump with a capacity of 3000 kW will be installed in the thermal scheme of the boiler house. The source of low-temperature heat for CHPI will be the heat from condensers of refrigeration machines of the enterprise. A gas-piston engine-generator with a nominal power of the electric generator of 1000 kW is selected for the drive of the compressor of the heat pump.

Table 1

**Indicators of energy efficiency of CHPI for the thermal scheme
of the industrial heating boiler house of the enterprise**

Indicator	Value
The water temperature at the outlet of the evaporator, °C	27
Coefficient of performance of CHPI without taking into account the thermal capacity of the cogeneration drive	3,49
Coefficient of performance of CHPI with taking into account the thermal capacity of the cogeneration drive	4,88
The increase in the value of the coefficient of performance of CHPI due to the use of heat of the cogeneration drive	1,39
Specific consumption of electric energy for the production of a unit of thermal energy in CHPI, kWh / GJ	79,43
Specific consumption of electric energy for the production of a unit of thermal energy in CHPI with taking into account the heat of the cogeneration drive, kWh / GJ	56,94
Saving of working fuel by the boiler house from the use of CHPI (compared to the same heat capacity produced by the boiler house),%	43,8

Application of CHPI based on this equipment with the use of low-temperature heat in the thermal scheme of industrial-heating boiler house of the enterprise will provide generation of thermal and electric energy in CHPI with high energy efficiency and economy of working fuel (natural gas).

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