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## **TECHNICAL AND ECONOMIC SUBSTANTIATION OF THE USING A HEAT PUMP INSTALLATION FOR THE THERMAL SCHEME OF THE INDUSTRIAL-HEATING BOILER HOUSE IN VINNYTSIA**

**Ostapenko Olga,**  
Ph.D., Associate Professor  
Vinnytsia National Technical University

The aim of our study was to develop a feasibility study (FS) on the feasibility of using a heat pump installation (HPI) for the thermal scheme of industrial-heating and steam-water heated boiler house located in Vinnytsia, the study used scientific results from our study [1].

The study [1] was aimed at determining the effectiveness of HPI in the thermal scheme of the industrial-heating boiler house in Vinnytsia. This industrial-heating boiler house works to meet the technological needs of production and heating. As mentioned in [1], this boiler house is equipped with one VITOMAX 200 HS 0,5-3,8 steam boiler and two Vitoplex 100 hot water boilers, the working fuel for these boilers is natural gas.

In the study [1], it was proposed, in order to utilize the heat of secondary energy resources of the boiler house (exhaust gases) and increase the energy, environmental and economic efficiency of the boiler house, to install cogeneration heat pump on the basis of steam-compression HPI and gas engine-generator, based on the results of research [2 – 14].

In the study [1] it was noted that according to the results of the analysis of indicators was selected for design the variant of cogeneration HPI on the heat of secondary energy and surface water, which was the most acceptable for this thermal scheme of the boiler house. Installation of HPI in the thermal scheme of this boiler house will partially displace the load of the water-heating boiler and ensure the generation of displaced thermal capacity of the boiler in HPI with high energy conversion.

In [1] the savings of working fuel in the industrial heating boiler house due to the modernization of the thermal scheme for the two modes are determined, as well as the average annual savings of working fuel are determined.

It is determined that for the heating period the saving of working fuel in the modernized boiler house will be 27,6% (for the water heating part of the boiler house). In order to modernize the thermal scheme of the boiler house, the installation of a heat pump with a capacity of 300 kW was chosen, which operates in two seasons (medium heating mode and hot water supply mode). The source of low-temperature heat for HPI in the modernized thermal scheme of the boiler house will be heat from the contact recycler and surface water. The drive of the heat pump compressor will be provided by the gas-piston engine-generator of the Generac SG 160 brand with a nominal power of the electric generator of 160 kW.

In our investigation, a feasibility study was proposed to determine the effectiveness of HPI with cogeneration drive in the thermal scheme of steam-water heated and industrial-heating boiler house in Vinnytsia, based on the results of previous studies [1] and developed by the author methodological fundamentals for assessing energy, economic and ecological efficiency of energy supply systems with cogeneration HPIs, covered in publications [2 – 14].

The expected economic effect from the introduction of cogeneration HPI in the thermal scheme of the steam-water industrial-heating boiler house in Vinnytsia is confirmed by the economic efficiency of investment compared to the basic version of the heat supply source (HSS) – the existing boiler house. Estimation of indicators of economic efficiency for basic and alternative (with HPI) variants of heat supply sources is executed on the basis of researches [1 – 14], results are summarized in Table 1.

Table 1

Results of technical and economic analysis of basic and alternative variants for steam-water industrial-heating boiler house in Vinnytsia

Indicator	Unit	Variant of HSS	
		Basic variant of HSS	Alternative variant with HPI of HSS
Operational expenses	UAH million / year	8,953	6,106
Economic efficiency	UAH million / year	---	2,847
The cost of heat	UAH / GJ	386,26	279,55
Investment in the new cogeneration HPI equipment (considering installation costs)	UAH million	---	5,073
Payback period	year	---	1,78

### Conclusions

The investigation developed a feasibility study for the feasibility of using a heat pump installation for the thermal scheme of industrial-heating and steam-water-heating boiler house, located in Vinnytsia.

According to the results of the technical and economic analysis of the efficiency of cogeneration HPI in the thermal scheme of industrial-heating steam-water-heating boiler house, it is determined that:

- saving of working fuel will be provided by the boiler house in the amount of 27,6% (for the water-heating part of the boiler house);
- will reduce the operating costs (economic efficiency) of the boiler house in the amount of UAH 2,847 million / year;
- investment in new equipment for modernization of the boiler house, including installation costs, will amount to UAH 5,073 million;
- payback period of new equipment for the modernized thermal scheme of boiler house will be 1,78 years.

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