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MINIMIZATION EXERGY LOSSES OF THE COMBINED HEAT RECOVERY SYSTEM OF BOILER PLANT

Summary. *A complex heat recovery system designed to heat return heat-network water and boiler blown air was investigated using a comprehensive* *methodology based on exergy analysis methods and graph theory. The optimal parameters of the heat recovery system that provide the necessary reduction in the exhaust gases temperature with minimal exergy losses are determined*

Key words: *exergy analysis, graph theory, exergy losses.*

Relevance. Currently, Ukraine has a fairly high potential for implementing modern, efficient waste heat recovery technologies. Such technologies allow solving problems of saving fuel and energy resources in the field of industrial and municipal heat and power engineering and are now affecting more and more production facilities in the country. This necessitates the expansion of work aimed at improving the efficiency of heat recovery technologies and determines the importance and relevance of developments in this area.

Analysis of the latest research and publications. In Ukraine and the world, the exergy efficiency of plants is often assessed by the amount of exergy losses [1-9]. Thus, in work [1], exergy studies of individual components of a nuclear power plant characterized by high exergy losses, were performed. The following works are devoted to the study of heat recovery technologies using complex exergy analysis methods [2-9]. These methods allow to increase the efficiency of heat recovery technologies of various power plants.

Purpose of the work and research tasks. The purpose of the work is to rationalize the parameters of heat exchangers in the combined heat recovery system of boiler plant to ensure the required values of technological and exergy parameters. The following tasks were set: - to analyze the possibility of applying a comprehensive methodology based on exergy analysis methods and graph theory to study exergy losses; to determine the optimal parameters of the heat recovery system to ensure the necessary reduction in the heat-transfer agent temperature and the lowest exergy losses in the heat recovery system.

Materials and methods of research. Comprehensive studies of the combined heat recovery system of a boiler plant designed to heat return heat-network water and blown air were carried out. A complex research methodology developed on the basis of exergy analysis and graph theory was used.

Research results. Heating of several heat-transfer agents in a combined heat recovery system can provide an overall increase in the boiler plant efficiency by up to 12%. The choice of heat exchangers in a heat recovery system, their number and location in the system is determined by many factors, in particular the need to reduce the temperature of the heating heat-transfer agent to a given value by heating different heated heat-transfer agents. It seems advisable to ensure the lowest level of exergy losses in the heat recovery exchangers of the heat recovery system. The minimum level of exergy losses is possible when the heat recovery exchangers parameter values are closest to optimal. A comprehensive research methodology is proposed, developed on the basis of exergy analysis methods and graph theory. The exergy losses graph was considered using the graph theory methods. The set of vertices in the graph corresponds to the heating and heated flows. The many arcs correspond to the possible distribution of exergy losses in the respective elements of the heat recovery system. A gas heating boiler with a heating capacity of 2 MW was considered, equipped with a combined heat recovery system, which included a water-heating and air-heating heat recovery exchangers and a cooled gas heater (to prevent condensation in the exhaust gas duct) placed in series along the exhaust gas flow. The heating heat-transfer agent is the boiler exhaust gases, and the heated heat-transfer agents are the return heat-network water and blown air. The boiler's efficiency in nominal mode, calculated using the lower heat value of fuel, was 92%. The heat recovery system ensured a decrease in the exhaust gas temperature from 170-180 °C to 30-40 °C. Under the conditions of minimizing exergy losses, the optimal values of the geometric parameters of the water heater and air heater of the heat recovery system were calculated. In the case of optimal parameter values, the exergy losses in the system were maintained at a minimum and amounted to: for the water-heating recovery exchanger E_{los} = 0.75 kW, for the air-heating recovery exchanger – E_{los} = 0.96 kW (Table 1, Fig. 1).

Table 1

Optimal parameters of heat recovery units

Heat recovery	Parameters	Optimal parameter values
Water heater	Fin height, *mm*	10,0 ÷ 11,0
	Fin thickness, *mm*	4,0 ÷ 6,0
	Interfin pitch, *mm*	3,0 ÷ 3,5
Contact air heater	Plate width, *mm*	1350÷1550
	Plate height, *mm*	1500÷2000
	Distance between plates, *mm*	5÷6

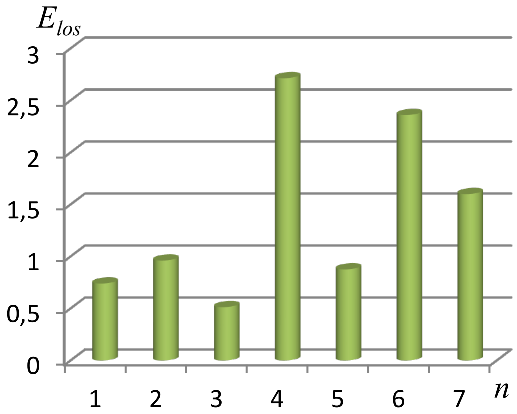

Fig. 1. Exergy losses E_{los} (kW) in the elements of the combined heat recovery system of the boiler plant: 1,2 –water-heating and air-heating heat recovery exchangers; 3 – gas heater; 4 – smoke exhauster; 5 – fan; 6,7 – pumps

Conclusions.

1. The possibility of using a comprehensive methodology based on the methods of exergy analysis and graph theory to study a combined heat recovery system designed to return heat-network water and boiler blown air is analyzed.

2. The optimal parameters of the heat recovery system were determined, ensuring the necessary reduction in the exhaust gas temperature with minimal

exergy losses, which in the water-heating heat recovery exchanger were E_{los} = 0.75 kW, and in the air-heating heat recovery exchanger - E_{los} = 0.96 kW.

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