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OPTIMIZATION OF HEAT EXCHANGE SURFACE GEOMETRIC PARAMETERS FOR THE WATER-TUBE PANEL HEAT RECOVERY EXCHANGER

Summary. *Based on the exergy approach, a complex methodology for optimizing a heat recovery system with a water-tube panel heat recovery exchanger has been developed. The methodology includes the canonical transformation method used in statistical theory of experiment planning. Using this technique, the heat exchange surface geometric parameters of the studied* *heat recovery exchanger, which is used in schemes for heating water in heating systems, were optimized.*

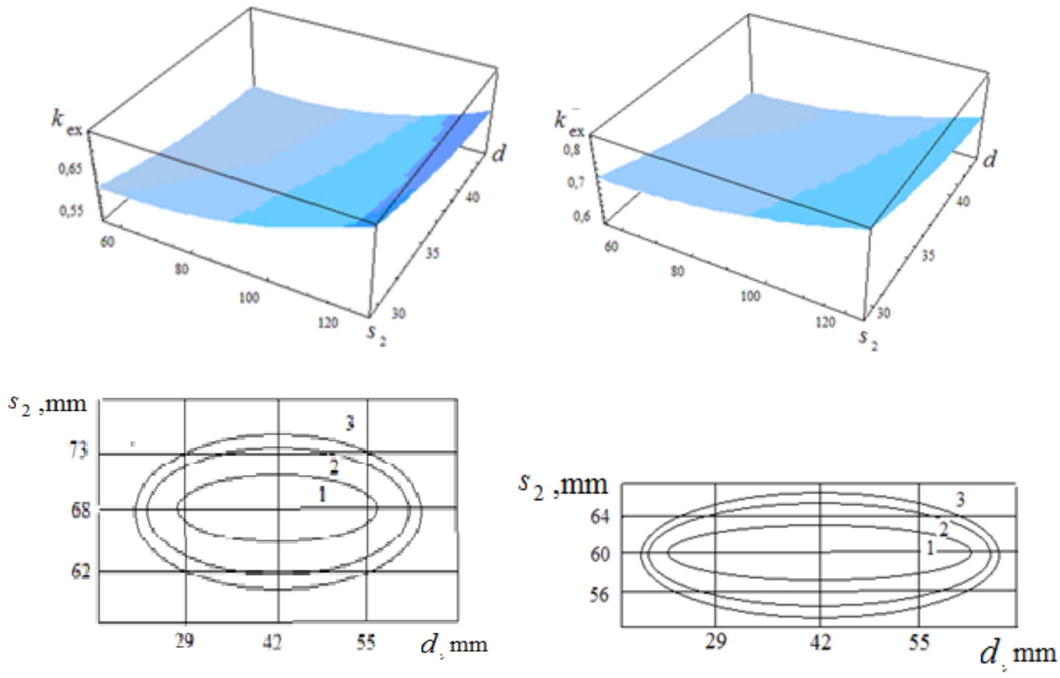
Key words: *waste heat recovery, exergy approach, complex methodology.*

Relevance. Comparative analysis of the different power installations efficiency is only possible for installations with optimal technological and design parameters. Exergy analysis is an important tool for studying the efficiency and optimization of energy installations various types. This is because exergy characteristics are highly sensitive to changes in plant parameters and can be used as their thermodynamic efficiency and target functions of optimization. In this regard, expanding research into energy installations, including heat recovery equipment, based on an exergy approach is important and relevant.

Literature review. Currently, when optimizing of various types power plants parameters, individual exergy characteristics are most often used as target optimization functions [1-3]. This does not allow taking into account the intended purpose of the process, establishing the localization of exergy losses, etc. The use of complex methods [4-8] allows assessing the installations efficiency, including heat recovery systems, from thermodynamic, thermal engineering, and technological perspectives. Therefore, it is advisable to optimize the parameters of heat recovery equipment using appropriate complex methods.

The purpose of the work is to optimize the geometric parameters of the heat exchange surface panel water-tube heat exchanger used in schemes for heating water in heating systems.

Research results. In the work, based on the exergy approach, a complex methodology has been developed that includes the canonical transformation method used in statistical theory of experiment planning. Using the developed methodology, the heat exchange surface geometric parameters of a panel water-tube heat recovery exchanger used in schemes for heating water in heating systems were optimized. The water-tube heat recovery exchanger consists of three panel-type modules arranged vertically and connected to each other by gas and water paths. The heat exchange part of each heat recovery module is composed of sections in the form of panels with collectors formed by smooth pipes connected by external membranes. Pipe bundle arrangement: staggered and corridor. The exergy criterion for evaluating efficiency k_{ex}, which includes exergy losses in the heat recovery unit, its heating capacity, and mass, is used as the optimization target function. The geometric parameters of the heat exchange surface were used as independent factors: the distance between panels s_1 in the heat exchanger, the distance between pipes in the panel s_2, and the pipe diameter d. The canonical transformation method allows obtaining a graphical interpretation of the optimum region of functional dependencies in the form of a series of contour curves on a plane. For the studied heat recovery exchanger, the functional dependencies of the efficiency criterion on the geometric parameters of the optimum region are ellipsoidal depressions. There is a minimum at the center of the depressions, and the contour curves in the optimum region are ellipses. The following are graphs the dependence of the exergy efficiency criterion on the parameters of the heat exchange surface and the corresponding contour curves for a panel water-tube heat recovery exchanger with a staggered and corridor arrangement of pipes in the bundle (Fig. 1).



a) ***b)***

Fig. 1. Dependence of the exergy efficiency criterion on the heat exchanger surface geometric parameters of heat recovery exchanger at the optimal distance between panels s_1 = 60 mm, as well as the corresponding contour curves in the minimum region, as well as the corresponding contour curves in the minimum region: *a* – for a staggered layout at 1 – k_{ex} = 0.545; 2 – k_{ex} = 0.550, 3 – k_{ex} = 0.555; *b* – for a corridor layout at 1 – k_{ex} = 0.595; 2 – k_{ex} = 0.600; 3 – k_{ex} = 0.605

The study of response functions in the minimum region and corresponding contour curves made it possible to determine the optimal values and ranges of permissible values for the heat exchange surface geometric parameters of a water-tube heat recovery exchanger (Table 1).

Table 1

Optimal values and ranges of permissible values of the heat exchange surface geometric parameters of a panel water-tube heat recovery exchanger

Parameter	Chess bundle		Corridor bundle	
	Optimal values	Ranges of permissible values	Optimal values	Ranges of permissible values
s_1, mm	60.5	59.5 - 61.5	60.0	59.0 - 61.0

s_2, mm	68.0	67.5 - 68.5	60.0	59.0 - 61.0
d, mm	42.0	41.0 - 43.0	42.0	41.5 - 42.,5

When determining the permissible values of the heat exchange surface geometric parameters of the water-tube heat recovery exchanger, the real requirements for the operational and design features of heat recovery exchangers were taken into account. Thus, using a complex methodology including the canonical transformation method, the optimal values and ranges of permissible geometric values for the parameters of the heat exchange surface of panel water-tube heat recovery exchanger were determined.

Conclusions and Prospects

1. To optimize of the heat exchange surface geometric parameters of a panel water-tube heat recovery exchanger, a complex methodology has been developed based on one of the statistical theory of experiment planning methods – the canonical transformation method.

2. Graphs of the dependence of the exergy efficiency criterion of heat recovery exchanger on the heat exchange surface geometric parameters for staggered and corridor pipe arrangements in a bundle were obtained, as well as graphical interpretations of the optimum regions in the form of a contour curves series on a plane.

3. The optimal values and ranges of permissible values of the heat exchanger surface geometric parameters have been determined, which allows for the development of highly efficient heat recovery systems.

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