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DEVELOPMENT OF A METHODS FOR MULTILEVEL OPTIMIZATION OF HEAT RECOVERY SYSTEMS

Summary. *The work is devoted to the optimization of complex heat recovery systems for which it is not possible to establish general analytical dependencies of the optimization objective functions on the system parameters. For such systems, a comprehensive multilevel optimization technique is proposed and the basic principles of its development are outlined. A diagram illustrating the main stages of the methodology is provided. For heat recovery systems the criteria for evaluation of their exergy efficiency have been developed, which have*

high sensitivity to changes in mode and design parameters and serve as objective optimization functions. The proposed methodology improves the optimization efficiency and exergy efficiency of the system.

***Key words*:** *heat recovery systems; complex techniques; efficiency; optimization.*

Introduction. Currently, Ukraine has the necessary potential to implement effective energy-saving technologies for heat recovery. In this regard, the problem of their development and implementation is relevant for the country's energy sector. The solution to this problem is associated with the need for systematic research into the efficiency and optimization of heat recovery plants from the standpoint of modern methodological approaches.

Problem statement and research method. Modern approaches to analyzing the efficiency and optimization of heat recovery systems include methods of exergy analysis, statistical methods of experiment planning, methods of the theory of linear systems, thermodynamics of irreversible processes, structural, structural-variant methods, etc. [1–6]. To increase the effectiveness of optimization and increase the efficiency of the heat recovery system, it is necessary to use an integrated methodology that combines these methods. The use of this technique allows, when developing the heat-recovery exchangers design of the system, to use parameters that are as close as possible to the optimal ones.

Purpose of the work is to develop a methodology for multilevel optimization of heat recovery systems. Research tasks:

– develop the main stages of the multi-level optimization methodology;

– develop a block diagram and a scheme for recursive traversal of optimization levels, which allows you to reduce a complex multi-criteria and multi-parameter optimization problem to simpler local mutually agreed upon optimization problems of each level.

Materials and methods of research. To analyze the efficiency and optimize heat recovery systems, a comprehensive methodology has been developed, based on the principles of multilevel optimization. The methodology includes methods of exergy analysis, statistical methods of experiment planning, structural-variant methods, methods of functional analysis. The work provides an example of a developed block diagram of multilevel optimization of a heat recovery system designed for heating return water of boiler plants.

Research results. The creation of new integrated methods for assessing the efficiency and optimization of heat recovery systems includes, as a necessary stage, the development and use of exergy efficiency criteria, which would be the target optimization functions. The proposed heat-exergy and exergy-technological efficiency criteria are highly sensitive to changes in the operating and design parameters of heat recovery systems. This occurs due to the inclusion in them, in addition to thermal characteristics: mass m and thermal performance Q, the magnitude of exergy losses. The developed criteria also serve as target optimization functions. The technique, based on the principles of multilevel optimization, allows one to reduce a complex multi-criteria and multi-parameter optimization problem to simpler local mutually agreed upon optimization problems of each level. The main stages of this method:

• divide the heat recovery system into several optimization levels;

• develop a block diagram and a recursive bypass scheme for optimization levels,

which allows for constant information exchange between optimization levels (Fig. 1);

• when constructing a mathematical model of a given level, use variable parameters of an object of a given level as variable parameters, and optimal parameters, which are the results of solving local optimization problems of other levels, as constants;

• for the mathematical models constructed in this way, at each optimization level, solve the corresponding optimization problem and determine the optimal values of the parameters;

• refine the resulting optimal parameters using additional iterations.

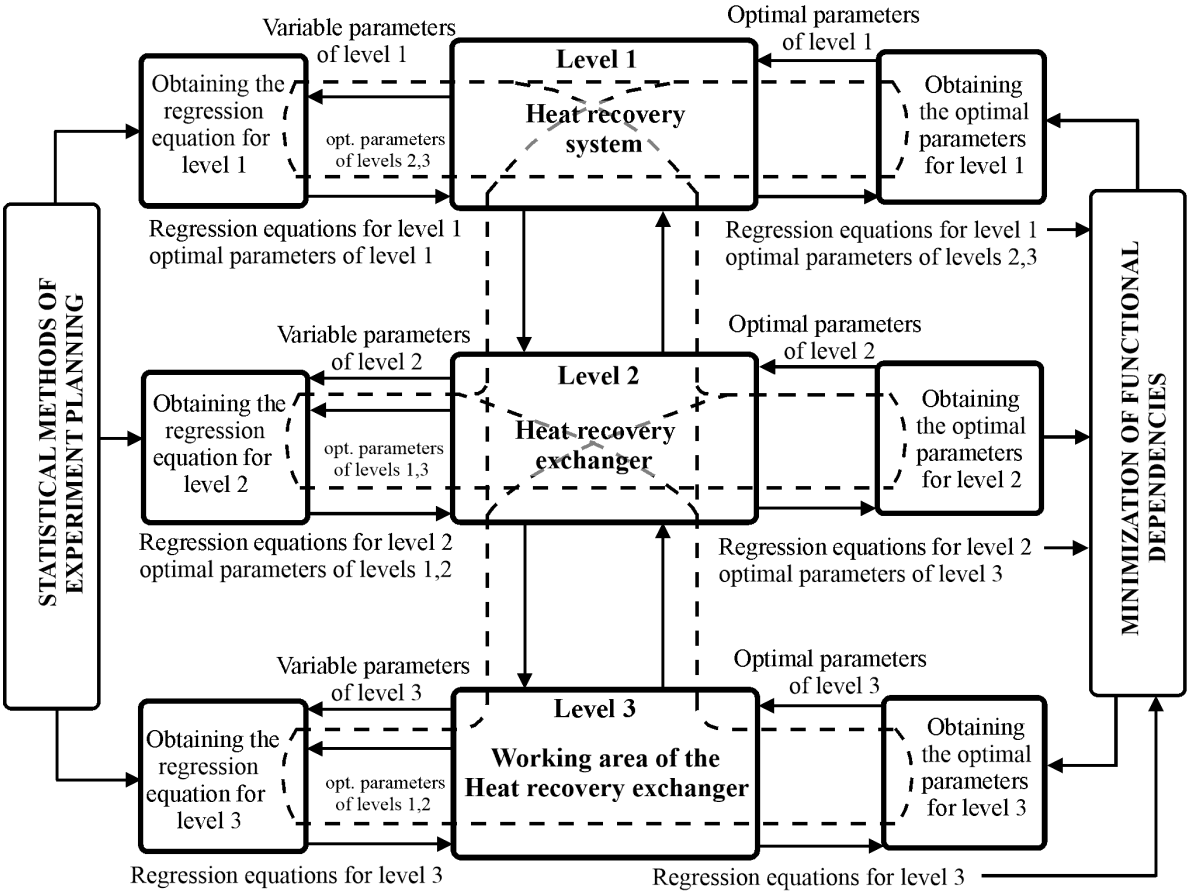

Fig. 1. Block diagram of multilevel optimization of heat recovery system designed for heating return water from boiler houses (the dotted line indicates a recursive bypass scheme for optimization levels)

The developed methodology increases the effectiveness of optimization, since it allows, when developing the heat-recovery exchangers design of the system, to use parameters that are as close as possible to the optimal ones. This, in turn, increases the exergy efficiency of the system.

Conclusions.

1. A comprehensive methodology for assessing the efficiency and optimization of heat recovery systems has been developed, based on the principles of multilevel optimization.

2. The developed methodology allows you to set the parameters of heat recovery systems as close as possible to optimal ones. This increases the exergy efficiency of heat recovery systems.

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