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COMPARATIVE ANALYSIS OF THE EFFICIENCY CRITERIA FOR HEAT UTILIZERS OF EXHAUST GAS

Summary. *The paper presents the results of a comparative analysis of criteria for evaluating the efficiency of waste heat utilizers of waste gases based on studying the degree of sensitivity of the criteria to changes in the parameters*

of heat exchangers. The data are given for five efficiency criteria; some operating parameters and geometrical parameters of the heat exchange surface are selected as parameters. It is indicated that the energy and exergo-technological efficiency criteria have the highest degree of sensitivity to changes in the operating parameters of heat utilizers. The exergy and heat-exergy criteria of efficiency are more sensitive to changes in the geometric parameters of the heat exchange surface.

Key words: *exergy analysis, efficiency criterion, heat recovery unit parameters.*

Introduction. Modern comprehensive approaches to the analysis of the efficiency of heat recovery equipment involve the use of criteria that should take into account the features of the specified equipment, have a high degree of sensitivity to changes in its parameters and serve as target optimization functions when solving optimization problems. This allows you to more deeply study the operation of heat recovery systems and evaluate their perfection from various positions.

Problem statement and research method. In Ukraine and in the world, the methods of exergy analysis are increasingly used to assess the efficiency of power plants. However, in general, the efficiency of power plants is estimated either by losses of exergy or by exergy efficiency [1-4]. In works [5-11], an integrated approach is proposed that allows analyzing the efficiency and optimization of heat recovery equipment using exergy criteria that take into account the thermodynamic, heat engineering and technological features of the specified equipment. The purpose of this study is a comparative analysis of the criteria for evaluating the efficiency of waste heat exchangers based on studying the degree of sensitivity of the criteria to changes in the parameters of heat exchangers. The studies were carried out using balance methods of exergy analysis.

Research results and their discussion

On the examples of hot-water and hot-water heat recovery units of boiler units and glass furnaces, a comparative analysis of the sensitivity of various efficiency criteria to changes in the operating and geometric parameters of heat recovery units is carried out. The following efficiency criteria were investigated: heat-exergy $\varepsilon=E/Q$, exergy-technological $k_{\text{ò}}=Em/Q^2$, technological $m_0=m/Q$, exergy $k_{ex}=\eta_{ex}/\eta_{ex}^{\text{id}}$, energy $k = Q/N$. Here E is exergy losses, Q is thermal power, m is mass, η_{ex} is exergy efficiency, and η_{ex}^{id} is efficiency of a heat exchanger with a high degree of ideality. The following were chosen as independent variable parameters: the ratio of the Reynolds numbers of flue gases and air, the ratio of the initial and final moisture content of flue gases, the temperature of flue gases and air at the inlet to the heat exchanger, the geometric parameters of the heat exchange surface, etc. The dependences of these efficiency criteria on the parameters of the heat exchangers were obtained. The degree of sensitivity of the efficiency criteria to changes in the operating and geometric parameters of the heat exchangers was determined by the proposed sensitivity coefficient $k_s=\delta_{\text{cr}}/\delta_{\text{par}}$, where, $\delta_{\text{cr}}, \delta_{\text{par}}$ are the relative changes in the efficiency criterion and the corresponding parameter (Table 1).

Table 1

Degree of sensitivity of efficiency criteria to changes in the parameters of heat exchangers

Criterion efficiency	Designation	Sensitivity factor k_s	
		Regime parameters	Geometric parameters
Heat-exergy	ε	0,5…1,6	1,0…1,8
Esergo-technological	$k_{\text{ò}}$	1,0…2,6	0,5…0,8
Technological	m_0	0,1…0,3	0,1…0,3
Exergetic	k_{ex}	1,0…1,5	1,0…1,5
Energetic	k	1,5…2,5	1,5…2,5

As can be seen from the table, the energy and exergy-technological criteria are sensitive to changes in operating parameters, on average, 1.7 times greater than the heat-exergy and exergy criteria. The latter are more sensitive to changes in the geometric parameters of the heat transfer surface. Thus, when optimizing the operating parameters of heat utilizers, it is preferable to use the energy and exergy-technological criteria, and when optimizing the geometric parameters of the heat exchange surface - exergy heat-exergy criteria of efficiency.

Conclusions

1. A coefficient of sensitivity of efficiency criteria to changes in the parameters of waste heat utilizers is proposed.

2. With the help of the proposed sensitivity coefficient, a comparative analysis of the degree of sensitivity of some efficiency criteria to changes in the operating and design parameters of waste heat utilizers was carried out.

3. It has been established that the highest degree of sensitivity to changes in the operating parameters of heat utilizers is possessed by the energy and exergo-technological efficiency criteria. The exergy and heat-exergy credentials are more sensitive to changes in the geometric parameters of the heat exchange surface.

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