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WAYS TO IMPROVE THE EFFICIENCY OF HEAT EXCHANGE UNITS IN THE INDUSTRIAL ENTERPRISES

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Annotation: This article analyzes the technological significance of heat exchange devices used in industrial enterprises, their role in energy efficiency improvement and modern modernization methods. The principles of operation of heat exchangers, the possibility of reducing energy losses at industrial enterprises and cost efficiency of waste heat recovery technologies are studied on the basis of scientific sources. The results of the study show that the introduction of highly efficient heat exchange systems in industrial enterprises makes it possible to reduce energy consumption by up to 15–30%.

Key words: heat exchanger, energy efficiency, industrial processes, waste heat, recuperation, technological devices, energy efficiency.

Introduction. The steady development of the world economy and the increasing volume of industrial production are making the issue of rational use of energy resources one of the global problems. Modern industrial enterprises are considered to be highly energy-intensive systems, because a lot of heat energy is spent in production processes. According to the International Energy Agency (IEA), in 2022, the industrial sector accounted for nearly 37% of global energy consumption, making the industry one of the world's largest energy-consuming industries. Notably, in the metallurgical, chemical, oil and gas, food and power industries, the bulk of energy consumption goes to processes of heat generation, transfer and processing.

In recent years, rising energy prices, limited natural resources, and increasing environmental concerns have further fueled the need for energy efficiency improvement in the industry. According to statistics, industrial sectors account for about 30% of carbon dioxide (CO_2) emissions released into the atmosphere worldwide. For today, the development and practical introduction of energy-saving technologies is considered one of the most pressing scientific and technical tasks.

According to the study, up to 20–50% of the thermal energy generated by industrial enterprises is lost in the form of waste heat. In some high-temperature technological processes, these losses can reach up to 60%. Recovery of waste heat and its use as a secondary energy source allows to reduce fuel consumption at the enterprises, reduce production costs and ensure environmental safety. Experts estimate that technologies based on the reuse of waste heat can reduce overall energy consumption at industrial enterprises by an average of 15–30%.

Heat exchange devices used today in technological processes are considered as one of the most important energy saving tools. Heat exchangers ensure the uninterrupted and efficient operation of technological processes by transferring heat energy from one medium to another. Scientific sources note that more than 90% of the total thermal energy in the industry is transmitted through heat exchangers at least once. This shows the strategic importance of these devices in the technological system.

Currently, more modern constructions of plate, shell-pipe, spiral and microchannel heat exchangers are widely used in industry. In particular, microchannel heat exchangers are characterized by a high coefficient of heat transfer, compact construction, and energy efficiency.

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Automation of modern heat exchange systems, use of artificial intelligence-based control and digital monitoring technologies allow to further increase energy efficiency.

Improving the efficiency of heat exchangers in the industry is important not only in saving energy resources, but also in improving product quality, increasing production efficiency and reducing environmental impact. In this study, the technological properties of heat exchangers, methods of energy efficiency improvement, modern innovative solutions used in industrial enterprises are scientifically analyzed.

Research methodology Throughout the study: International Energy Agency (IEA) data; scientific articles on energy efficiency; Information about heat exchangers used at enterprises of chemical and food industry; Statistical reports on modern heat recovery technologies were analyzed.

The methods of comparative analysis, statistical estimation and feasibility study were used in the study.

Role of heat exchangers in the industry Heat exchangers are used in almost all branches of the industry: chemical industry; Oil and gas industry; Food Industry; Metallurgy; Energy; Pharmaceuticals.

Their main task is to ensure that technological processes run at an optimum temperature by transferring heat energy from one medium to another.

According to international studies, two-thirds of industrial energy consumption is associated with technological heat, and it is precisely heat exchange systems that ensure the efficient use of this energy.

Advantages of modern heat exchangers In recent years, the application of modern heat exchangers in order to increase energy efficiency in the industrial enterprises has been widely developing. The complication of technological processes, rising cost of energy resources and increasing environmental requirements have significantly increased the need for heat exchangers with high efficiency. Currently, plate, shell-pipe, spiral and microchannel heat exchangers are among the most widely used devices in various industries of industry.

One of the main advantages of modern heat exchangers is its high coefficient of heat transfer. Especially in plate heat exchangers due to the larger heat exchange surface size and the turbulent behavior of the streams, the intensity of heat transfer is significantly higher than with conventional devices. Studies have shown that the heat transfer efficiency of plate heat exchangers can in some cases be 2–4 times higher than that of shell-tube devices. This serves to accelerate technological processes and reduce energy consumption.

Shell-tubing heat exchangers are characterized by the possibility of working under conditions of high pressure and high temperature. Therefore, they are widely used in the oil and gas, chemical and power industries. These devices have a durable construction and are one of the reliable technological equipment at industrial enterprises with stable operation over a long period of time.

Microchannel heat exchangers are one of the most promising directions of modern thermal engineering. Due to the use of very small channels of diameter in their construction, the heat exchange surface increases dramatically and the heat transfer process takes place with high efficiency. Statistically, microchannel heat exchangers provide an increase in energy efficiency by 25–40%. Moreover, they are distinguished by a compact construction, light weight and low material consumption.

Another significant advantage of modern heat exchangers is the ability to reduce energy costs. Heat exchange systems based on the reuse of waste heat will significantly reduce fuel and electricity consumption in industrial plants. The analysis shows that as a result of the introduction of such systems, the total energy consumption in some enterprises has been reduced by 8–30%. Especially in the metallurgical and chemical industry, the recuperation of the waste heat provides great cost-effectiveness.

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Also, modern heat exchangers are environmentally friendly. As a result of reduced energy expenditure, the amount of carbon dioxide (CO_2) emitted into the atmosphere also decreases. According to international environmental studies, the application of energy-efficient heat exchange systems can reduce CO_2 emissions in industrial enterprises by an average of 10–20%. This is one of the key factors in mitigating the challenges of global climate change.

In addition, modern heat exchangers have a compact structure, which allows you to use the production space efficiently. The modular structure of units simplifies the processes of their assembly, maintenance and modernization. And the reduction of operating costs increases the cost efficiency of the enterprises.

Nowadays, the possibilities of managing and monitoring heat exchange systems based on digital technologies are also expanding. The use of artificial intelligence and of the automated control systems allows to control heat exchange processes in real time, detect energy losses and ensure optimal mode of operation of the devices. For this reason modern heat exchangers are considered to be one of the technological equipment, which plays a strategic role in terms of energy efficiency of industrial enterprises.

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