METHODOLOGY OF CONSTRUCTION AND RESEARCH OF HEAT EXCHANGERS IN NTOP PLATFORM AND ANSYS SYSTEMS

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Introduction. Many industries use processes involving temperature changes, such as the chemical, oil, food and other industries. To ensure efficient operation and improve product quality, these industries use heat exchangers to regulate the temperature of the working media and transfer heat between them.

Such processes can be of great importance for production efficiency and equipment durability, so studying the principles of heat exchangers and optimising their operation is an important task for specialists in the heat and power industry and other related fields.

A heat exchanger is an equipment with a working unit that provides heat exchange between elements, usually liquids with different temperatures. Such equipment is used in heating systems, cooling systems, swimming pools, and in various industries: mechanical engineering, chemical industry, pharmaceuticals and food production, etc.

Intensification of the heat transfer process is an important task for many industries, as it allows to increase the efficiency of heat transfer and reduce energy consumption. Some of the main ways to intensify the heat exchange process are: increasing the flow rate, using finned heat exchangers, using surfactants, changing the design, etc.

There are several ways to design heat exchangers, including traditional and computer-aided design (CAD). Traditional design involves the use of empirical formulas and expert judgement to determine the geometry of the heat exchanger and its parameters, such as heat output and temperature conditions. CAD is based on the use of software to create 3-D models of heat exchangers and analyse their properties. One example of such software is nTop Platform, which is based on topological optimisation technology [1].

The study of the designed heat exchangers and their efficiency is an important step in the process of their development. Modelling of processes in heat exchangers allows determining the optimal design parameters, evaluating its efficiency and accuracy before it is manufactured and put into operation.

The main tasks of heat exchanger modelling include determining the heat flow, temperature and pressure distribution, and design requirements for the heat exchanger. In general, heat exchanger modelling reduces the time and cost of heat exchanger development and increases heat transfer efficiency. Various software tools are used for this purpose, including ANSYS, Comsol, SimScale and SolidWorks. Each of these tools has its own advantages and capabilities, so choose the one that best meets the needs and objectives of a particular project.

However, the sequence of actions in modelling is roughly the same and follows a similar plan: building the geometry; breaking it down into a set of finite elements; setting physical laws of the process; defining boundary and initial conditions; performing calculations; processing the results.

Materials and methods. To create a 3-D model of a heat exchanger with a developed heat transfer surface, it is advisable to use the nTop Platform. This is a software for designing and optimising complex mechanical systems. nTop Platform allows you to create lightweight and durable structures with high accuracy and efficiency. The main principles on which the system is based include a generative approach to design, optimisation technologies to increase efficiency and an automated problem-solving process. To build geometry, nTop Platform uses the meshing method, which allows for the creation of parts of complex shapes.

To model the processes in the heat exchanger, ANSYS was chosen - a numerical modelling software that allows analysing various physical processes, including heat transfer, hydraulics, and mechanics [2]. To solve the problems, ANSYS uses the finite element method, which allows you to divide the structure under study into a finite number of elements and model their interaction.

The finite element method allows us to calculate the distribution of stresses and strains in the body, as well as determine the temperature regime and the relevant heat transfer parameters.

For the physical implementation of the designed structures of complex geometric shapes, 3D printers are used to create parts with high precision and detail, to produce structures of any shape and complexity, including those that cannot be manufactured using traditional methods.

Results and discussion. The technology for designing heat exchangers in the nTop Platform using ANSYS involves the following steps:

1. Creating a 3D model of the heat exchanger in nTop Platform using various tools, including topology development and parameter optimisation tools.
2. Transfer the model to ANSYS for numerical heat transfer simulations and design parameter optimisation.
3. Analysing the results of modelling and design optimisation.
4. Development of the final version of the heat exchanger and its transfer for manufacturing.

The shell-and-tube heat exchanger can be replaced by developing a new design that has a higher heat transfer efficiency. For example, a heat exchanger with blade inserts could be considered, which provides a more intensive heat exchange due to a special surface design. Once the new design is developed, it can also be tested using numerical simulations in ANSYS and compared to the shell-and-tube heat exchanger [3-4].

The analysis of the literature shows that many heat exchanger designs designed using the nTop Platform are more efficient than standard shell-and-tube heat exchangers not only in terms of heat transfer coefficient, but also in terms of metal consumption and energy losses. According to research [5], the design of the heat exchange surface is the most balanced in terms of the heat flow - metal consumption ratio (Fig. 1).

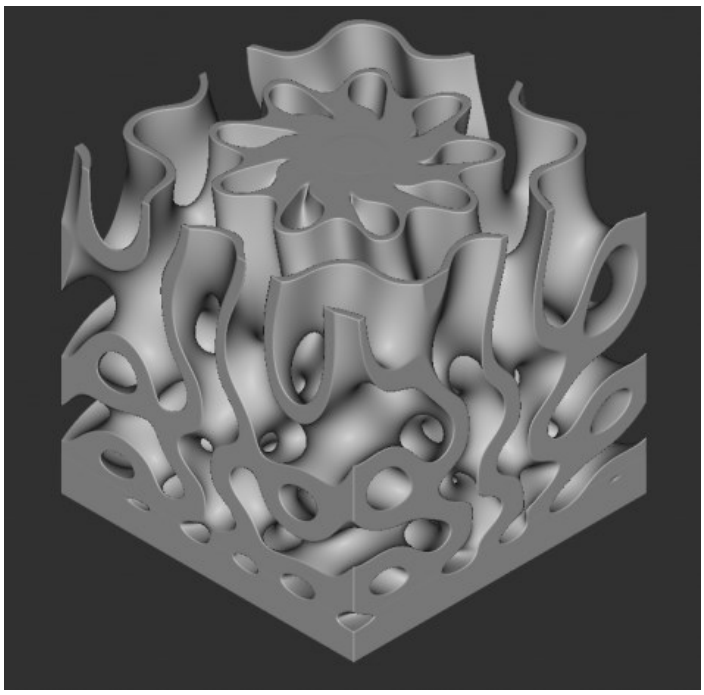

Fig. 1 Design of a high-performance heat exchange surface

Conclusions. The study considers an approach to the construction of heat exchangers based on the use of nTopology software. It is proposed to use a technology that allows creating topologically optimised models.

The importance of determining the optimal configuration of the heat exchanger, which ensures maximum efficiency at given parameters, is highlighted. To achieve this result, it is proposed to use nTopology software.

Also, the importance of using 3D printers to implement complex heat exchanger geometry is emphasised, which ensures increased modelling accuracy and efficiency in the development of new heat exchangers. Also, this design method does not require the use of additional supports, which saves materials.

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