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ANALYSIS OF PROCESS INTENSIFICATION METHODS IN SHELL TUBE HEAT EXCHANGERS

B.J. Khursanov
Acting Associate Professor, Fergana Polytechnic Institute, Fergana, Republic of Uzbekistan
E-mail: *boyqozi.xursanov@mail.ru.,b.xursanov@ferpi.uz,*

Abstract
The article describes the problems of heat exchange processes and devices and their solutions. Methods of intensification of processes in shell and tube heat exchangers are analyzed. Different turbulizers are used to speed up heat exchange. Turbulizers make the boundary layer of the heat-carrying medium on the surface of the pipes into a vortex or absorb it, as a result, the thermal resistance decreases and the heat transfer process is accelerated.
Keywords: Heat exchange, shell and tube device, internal and external surface, heat transfer coefficient, heat transfer coefficient, intensification method.

Introduction
In shell-and-tube heat exchangers, the cross-section between the inter-tube space is two or three times larger than the cross-section of the inside of the tube. Therefore, when the consumption of heat carriers and the condition of the unit are the same, the heat transfer coefficient on the surface of the inter-tube space is much lower, which reduces the overall heat transfer coefficient of the device. In addition, during the use of the device, the inner and outer surfaces of the pipe become dirty, as a result of which the overall heat transfer coefficient of the device decreases [1,2].

The purpose of the study
The main purpose of speeding up the operation of shell-and-tube heat exchangers is to equalize the thermal resistance on both sides of the heat exchange surface. In addition, the most effective and reasonable way to solve problems is to intensify the heat exchange in the pipes of heat exchangers and to clean the surfaces of the pipes [3,4,5].

Research methods
To intensify heat exchange processes, the following methods and operations are performed [6,7,8].

– Forced turbulization of the flow. At small values of the Reynolds number Re, i.e., in non-turbulent regimes, the values of the heat transfer coefficient are reached to the values of the advanced turbulent regime by creating artificial turbulizer grids, convexity, pulsation generation and twisting flows.

- By installing ribs on the surfaces of the pipes, the heat exchange surface is increased several times;
- Prevention of pollution (sludge, salts, corrosion products) by systematic cleaning of pipes, coating of pipe surfaces with special coatings, cleaning of heat-carrying agents;
- Treating the inside of the pipe and the inter-pipe environment with inert gases before condensing the vapors [9,10,11,12]. .
- Intensification of the heat exchange process gives the following positive results:
- the size of the heat exchange surfaces is reduced to deliver the same amount of heat;
- reliability and service life of heating surfaces increases;
- the mass of the heat exchanger is reduced and the external dimensions are smaller;
- formation of pollution on heat exchange surfaces is reduced;
- device productivity and operating time increases.

Currently, there are the following ways to intensify heat exchange [13,14,15]:

- transfer the heat carrier tangentially to the pipe;
- increase the artificial curvature of the pipe;
- internal longitudinal and transverse ribbing of the pipe;
- installation of auger rammers inside the pipe;
- installation of a spiral spring in the pipe;
- pipe internal and external nicking;
- making the pipe a spiral point;
- use of disc and puck turbulizers;
- installation of tapes twisted into the pipe;
- impact of electrostatic field on liquid flow;
- use of diffuser-confuser type tubulizers;
- vibration of the pipe and the device;
- use of composite methods of intensification, etc.

Application of one of the methods of heat exchange intensification in a heat exchanger increases heat exchange by 1.5-2 times, reduces the rate of formation of layers on heat exchange surfaces up to 2 times, and increases hydraulic resistance of the device by 2-3 times [16,17,18].

Results

Various additions and modifications have been made to the shell and tube heat exchangers to intensify the processes. For example, in the author's certificate No. 345336, the apparatus consists of a shell, a grid of pipes with pipes, covers, and transverse barriers are made in the form of a screw to intensify heat exchange processes in the space between the pipes [19,20,21,22].

In the author's certificate No. 840662, in order to intensify the heat exchange processes, the tubes are turned helically. Disadvantages of this test construction: it is difficult to prepare,

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vibration starts in the apparatus at a high speed of liquids. Screw pipes are difficult to repair and prepare [23,24,25,26].

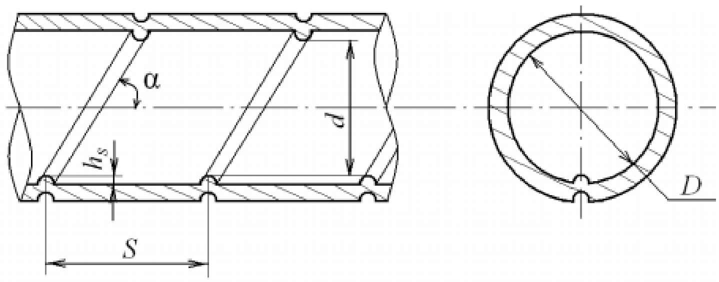
In the patent of the Russian Federation (patent RF 2299089, published in 2005), the pipes are arranged in a pipe network in a circle inside the shell. The presence of the medium in the pipe around the perimeter increases the turbulence of the fluid movement and, as a result, heat exchange processes are intensified. The disadvantage of this device is that the heat exchange coefficient is different in the central part and the periphery of the device. Second, the working volume within the shell is not uniformly used [27,28,29].

In patent No. 2372572 (patent RF 2372572, published in 2009) to improve the use of the working environment, the shell is made as a truncated cone, and the twisted pipes are placed in this truncated cone. The disadvantage of this construction: the construction is complicated, and it is difficult to prepare and repair such devices [30,31,32.33].

In the heat exchanger of V.M. Gureev (patent RF 2457415, published in 2012), in order to intensify the process and reduce metal consumption, the tubes inside the truncated cone are arranged by rotating along the axis of the cone [34,35,36,37,38].

In addition, in order to increase the intensity of heat exchange processes, the tubes inside the shell are made without forming, corrugated (item No. 868302), confusor and diffuser parts (item No. 1062500).

In G.A. Dreitser's design, there are small turbulizers inside the tubes and channels on the outside [2,3,5,39,40] (Fig. 1).



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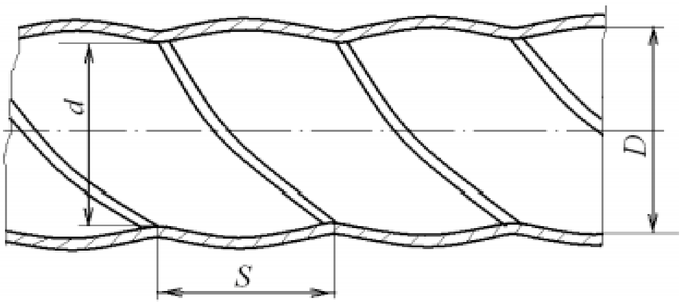

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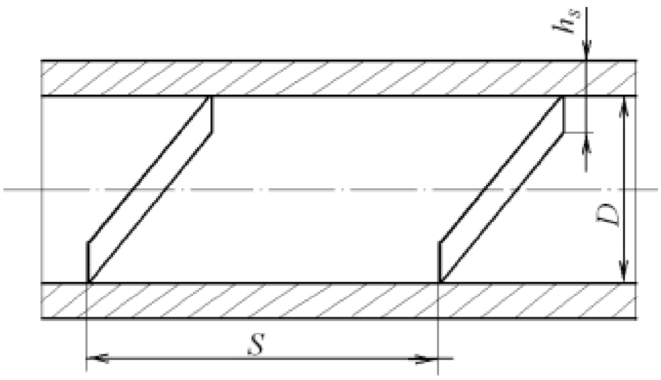

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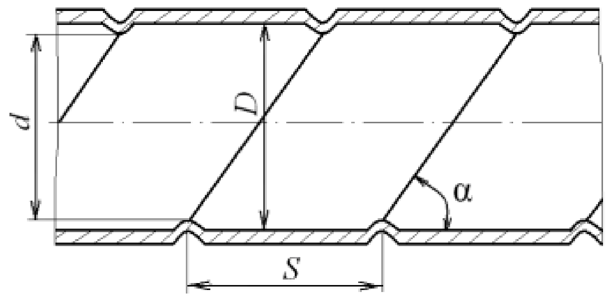

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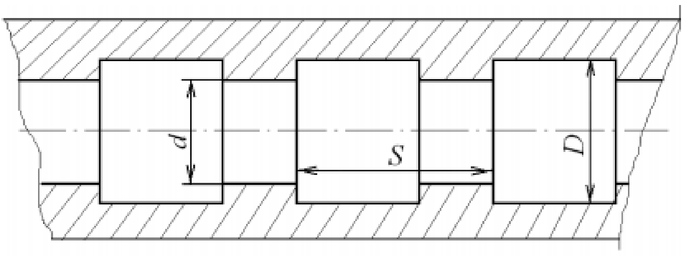

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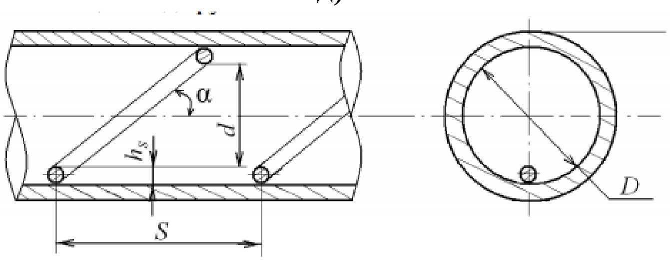

е)

Figure 1. Pipes with a turbulator: a - a pipe with spiral grooves, b - a spirally profiled pipe, v - tube with plate-like internal spiral, g - triangular grooved tube, d - tube with rectangular grooves, e - a groove in which a spiral wire is installed.

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In R.A. Amerkhanov's apparatus (patent RF 2200289, 2008) there are turbulizers in the pipes, and film electric heaters are installed in these turbulizers [1,2,41,42,43,44].

Conclusions

New designs of heat exchangers should have a higher heat transfer coefficient than similar devices used in industry, be corrosion resistant, have less metal retention, and consume less energy to pass heat transfer agents through the device. One of the promising ways to create heat exchangers is to use surfaces where the working medium erodes the boundary layer. Turbulizer heat exchangers proposed by scientists are noteworthy in this regard.

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