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ANALYSIS OF HEAT TRANSFER RATES DURING FLOW IN SMOOTH TURBULIZER TUBES

Oybek Soliyev
Assistant, Department of Technological Machines and Equipment, Fergana Polytechnic Institute, Fergana, Uzbekistan

Islomjon Qaxxorov
Assistant, Department of Technological Machines and Equipment, Fergana Polytechnic Institute, Fergana, Uzbekistan

A B S T R A C T	K E Y W O R D S
In this article, the increase of heat transfer in convective heat exchange during fluid flow in the channels of shell-and-tube heat exchangers used in industrial enterprises is studied. Based on the analysis of existing problems, it was determined to accelerate the process of heat transfer during the movement of the heat carrier flow in smooth and convex printed channels.	In industrial enterprises, heat exchange devices, hydraulic resistance, heat exchange process.

Introduction

Heat exchange devices are widely used in the processing of products in various industries in Malumki industrial enterprises. According to the principle of operation, heat exchange devices are divided into surface regenerative and mixing devices, among these devices, surface heat exchange devices are widely used for heat exchange processes in processing and production enterprises of the chemical industry [1,2,3].

According to the design of surface heat exchangers, they are divided into shell-tube, spiral, plate, spiral, edged, casing, graphite and special heat exchangers. It is known that one of the main goals of improving heat exchange devices is to speed up the heat exchange process. Naturally, the choice of the acceleration method should be made taking into account the hydraulic resistance [3,4,5].

The versatility of the problem of accelerating convective heat exchange determines the existence of many ways to solve it. The purpose of the heat transfer acceleration process is to increase the ratio between the amount of heat released from the surface and the pressure loss to drive the heat carrier. This goal can be achieved by addressing the main problem of convective heat transfer - the softening or partial destruction of its boundary layer. The solution to this problem is influenced by the growth of energy consumption, the possibility of using a certain heat carrier, and restrictions on its technological acceptability. Therefore, the method of simple increase of the flow rate, which leads to a thinning of the boundary layer, but is associated with a rapid increase in hydrodynamic resistance, is limited [6,7,8,9].

When smooth walls without turbulizers are washed by the flow, a special phenomenon called Reynolds similarity operates, which establishes a direct relationship between the rate of heat transfer and surface friction. it will show. The relationship between the heat exchange rate achieved and the energy spent in the absorption of heat exchange surfaces with a more complex configuration than a smooth wall becomes more complicated.

For a long time, the Reynolds similarity has been a special type of constraint that sets a lower limit on the power required to drive a heat carrier to dissipate a given amount of heat. It was believed that any random change in the physical environment, which leads to a violation of the similarity in the distribution of temperature and velocity, almost always leads to a change in the ratio in question in an undesirable direction [10-16].

The possibility of practical use of one or another method of heat exchange acceleration is determined by its technical convenience and technical-economic efficiency, and the information that allows to justify the given methods of heat exchange acceleration is provided.

The problems of heat exchange and hydraulic resistance for laminar and turbulent flow of liquids in channels are studied in depth and in detail. However, heat exchange and hydrodynamics in the region of fluid flow are not sufficiently studied [15-19].

The theoretical analysis of literature data on the study of hydrodynamics and acceleration of heat exchange in coiled and straight pipes of dense bundles of pipes allows us to conclude that they are a system of concentric or straight longitudinal channels of variable cross-section. There are many studies in which the acceleration of heat exchange is carried out using the turbulation of the flow of the heat carrier inside the pipes.

A theoretical analysis of patents and literature sources showed that discretely located annular or spiral grooved pipes, coiled pipes, etc. it is considered the most optimal in terms of hydraulic resistance and heat exchange rate. As can be seen from the graph in Figure 3.1, with the increase of the flow rate Re, the value of the heat transfer rate Nu increases for both smooth and developed surface pipes. Experimental data on heat transfer in a smooth pipe agree satisfactorily with the data of other well-known authors in the field of heat transfer. The results of studies on heat transfer in liquid flow in discretely placed annular diaphragm channels with a location step t/D = 0.25-0.44 for pipes with a dimensionless diameter d/D=0.94 of the turbulator are shown in the figure.

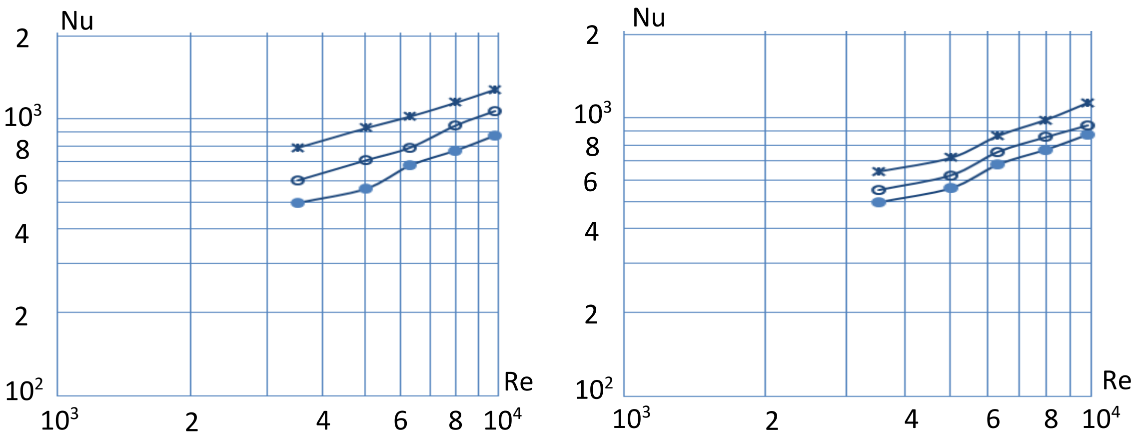

Fig. 1. The effect of *Nu* on the heat transfer rate of the placement step *t/D* and the dimensionless diameter *d/D* during heating of ethane in a shell-and-tube heat exchanger

The results obtained for a smooth pipe are as follows: at Reynolds number Re=3500, the value of the heat transfer rate for a pipe with t/D=0.44 is Nu=600, and Nu=790 for a pipe with t/D=0.25, respectively. It can be seen that the decrease in the numerical values of the location step of annular turbulizers significantly affects the heat transfer process. In the first case, the rate of heat exchange for t/D=0.44 is 10-12%, and for t/D=0.25 it is 23-29%, respectively. Similar results were obtained for a pipe with d/D=0.88, the only difference being that the heat transfer acceleration numerical values are much higher. For a pipe with t/D=0.44, the rate of smooth pipe heat transfer was 26-28%, and for t/D=0.25, it was 43-47%, respectively.

The height of the bump or the depth of the groove, together with the step of their placement, causes non-stationary accumulations and flows, as well as flow microdiscontinuities, which lead to the acceleration of heat exchange without causing a significant increase in the hydrodynamic resistance of the channel. Such channels can also be used in contaminated heat carrier streams, as they have smooth internal contours and no stagnant zones. Channels with d/D≤0.9 have the greatest efficiency, but it should be taken into account that the hydraulic resistance to drive the heat carrier increases significantly.

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