EFFECT OF TURBULIZER ON HYDRODYNAMICS OF LIQUID HYDROCARBON FLOW

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ABSTRACT:

The article analyzes the energy consumption of heat exchange processes in the processing of liquid hydrocarbons, the mechanism of heat distribution in the pipes of the device, it is determined that the formation and thickening of deposits on the heat exchange surfaces significantly impedes heat transfer and turbulence. The use of passive turbulators in the form of a spiral in the form of a spiral in the formation of an oil flow containing mechanical particles in its composition has been shown to improve heat exchange performance. The results of experimental studies of the hydrodynamics of oil flow in the pipe show that with an increase in the width of the spiral strip from 6 mm to 14 mm, the hydraulic resistance increases by 30% (Re = 2000), 40% (Re = 1200). It follows from this that it is determined that it is desirable to optimize the turbulence process, taking into account the significant increase in the hydraulic resistance of the flow of liquids, especially liquids with high viscosity, such as oil.

INTRODUCTION. Hydrocarbon processing plants, in particular, oil and other liquid hydrocarbons, are industries with a high relative (specific) energy consumption. At the same time, given the large volume of oil and gas condensate raw materials processed at these plants, it is clear that they are large consumers of fuel and energy resources. The main part of the energy consumption for the processing of hydrocarbons (especially liquid hydrocarbons), approximately 70-75%, is due to heat exchange or processes related to this process. Heat exchange devices are also widely used in oil refining, petrochemical and many other related industries and sectors [1,2]. Increasing the efficiency of heat transfer is directly and indirectly dependent on a number of important factors, the main of which are accelerating heat transfer from the heating surfaces to the liquid, and subsequently to the core of the liquid flow, as well as minimizing the thickness of the laminar boundary layer, which creates the main thermal resistance, and increasing flow turbulence [3,4,5].

The purpose of the study. Theoretical analysis and experimental determination of the dependence of the hydraulic resistance of the oil flow on the shape and dimensions of the turbulator, as well as the feasibility and necessity of optimizing the parameters of the turbulence process. To achieve this goal, studies were conducted to solve such research tasks as the effect of oil flow turbulence on the sedimentation of solid particles in liquid hydrocarbons, as well as the identification of promising forms of passive turbulators.

Methods and materials. In the course of the study, and in order to solve the set research tasks, the authors used methods to improve the state of the heat exchange surface and reduce the liquid boundary layer in front of the pipe walls of the heated liquid hydrocarbon to enhance the heat transfer process. The formation of a sediment layer due to the deposition of particles from the liquid hydrocarbon composition flowing on the surface of the heating pipe had a negative effect on the heat transfer and heat transfer coefficient, while an increase in the thickness of this thermo-resistance layer was observed during the experiment. The formation of a dense layer as a result of the effect of heat on the sediment layer on the surface of the heating pipe was observed and was confirmed in practice. In turn, this layer has a very low thermal conductivity coefficient.

Efficient flow turbulators have been successfully used by the authors in experimental facilities to prevent or reduce the formation of oil-based deposits on heat exchange surfaces at low cost. The results of the research have determined the parameters for reducing the relative formation of deposits and reducing their layer thickness by using highly efficient flow turbulators.

The authors' studies of various methods of turbulization of liquid hydrocarbon flows have shown that passive turbulators are effective in increasing the turbulence of the heated oil flow, distinguished by their simple design and efficiency. This method of turbulization of heated oil in shell-and-tube heat exchanger tubes has shown the effectiveness of their use in a wide range of hydrodynamic parameters. During the experiments, it was found that the use of various-sized twisted ribbon turbulators used by the authors helps to reduce the thickness of the deposit formed by the heated oil flow. At the same time, no additional external energy is supplied to the device.

Analysis of the mechanism of flow turbulence using twisted ribbon turbulators has shown that they effectively serve to create intensive mixing between the flow center and layers, as well as to reduce the thickness of the liquid boundary layer and the resulting sediment layer on the surface of the walls of heat exchange pipes. Twisted ribbon turbulators, along with the formation of turbulent vortex circulation flows (vortex formation) in the pre-wall layer of the pipe, had a positive effect on equalizing the temperature difference in different parts of the pipe, as a result of which the heat exchange process was enhanced [6,7].

Experiments on the creation and use of heat exchangers with different turbulizer designs have shown that a 1.5-2 times reduction in the deposition of solid particles on the heat exchange surfaces of the turbulizer devices in the form of a twisting tape has been achieved.

The authors studied various designs of turbulizers to improve and enhance the processes occurring in heat exchanger tubes.

In order to improve the flow of single-phase heat carriers, the installation of spiral spiral device pipes at the entrance and along their length to accelerate the flow turbulization of various designs was emphasized. It was possible to increase the contact surface due to the organization of the turbulent circulation of the heat carrier. The effectiveness of turbulizers of this design is different, and in some samples, an increase in heat exchange parameters by 2 times or more is achieved due to the improvement of hydrodynamic parameters.

Results

The authors have studied a number of designs of turbulators that significantly slow down the formation of a layer of solid particles on the heat exchange surfaces of the apparatus. At the same time, the tasks of reducing the formation of deposits on the contact surfaces of the liquid and the heater, preventing a significant increase in the hydraulic resistance of the liquid hydrocarbon flow when using turbulators, were set and solved. The study of a number of designs of turbulators for organizing a rapid rotational movement of the liquid flow in the tubes of the heat exchange device showed that these passive turbulators in the form of a spiral effectively prevent the deposition of solid particles in the liquid on the heat exchange surfaces. These spiral and screw-shaped turbulators can be made with a smooth and ribbed surface. Another important factor taken into account in the conducted studies was the increase in hydraulic resistance created by the used turbulators. Among the turbulators studied above, it was found that turbulators with a smooth surface (without ribs) have the lowest hydraulic resistance. During the studies, the authors studied the hydraulic resistance of the flow created by ribbon-shaped spiral turbulators in laboratory conditions. These studies studied the hydrodynamics of the oil flow at different values of the Reynolds criterion (*Re*). *In laboratory* conditions , spiral ribbon-shaped turbulators of different widths (*l*) with a smooth surface and a ribbon pitch *of b* = 16· *l* were studied. The experiments were carried out in oil flow in glass tubes with an inner diameter of 25 mm and a length of 1400 mm. The experimental results are in the following picture generalized.

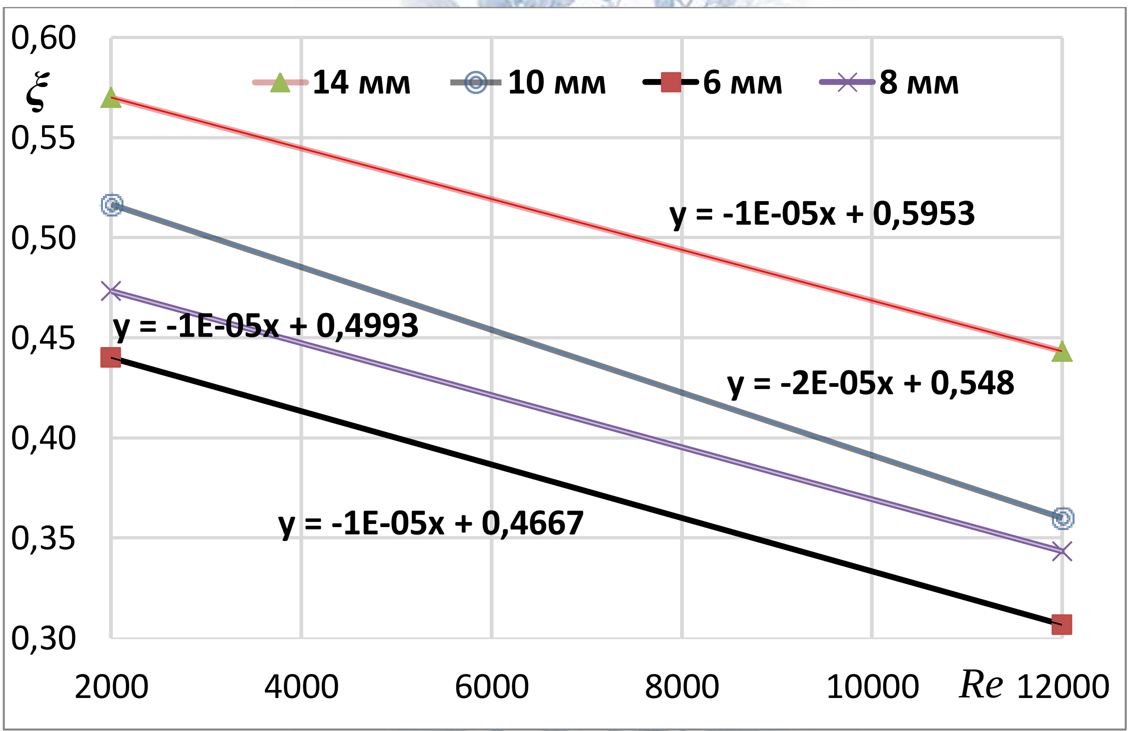

Figure 1. Dependence of the value of the hydraulic resistance coefficient of the oil flow inside the heat exchanger tube on its Reynolds number (*Re*) *criterion for a twisted ribbon turbulizer with a width of l* 6, 8, 10 and 14 mm and a pitch of *b* = 16· *l.*

Discussion. As a result of their use as criteria for evaluating the design of a ribbon screw turbulizer, the Reynolds (*Re*) *criterion and the hydraulic resistance coefficient (ξ)* of the oil flow in the heat exchanger tube affecting it were studied. Analyzing the experimental results, it can be noted that when *Re* = 2000 and the width *l of the screw ribbon* changed from 6 mm to 8 mm, the value of *ξ* increased by an average of 6.8%, from 8 mm to 10 mm by 10.6%, and from 10 mm to 14 mm by 9.6%. When *Re = 12000, the increase in the value of l* was 9.6%, 5.8%, and 22%, respectively. The figure shows the corresponding equations obtained using a computer program that fit the dependence lines of the parameters. The analysis and generalization of the research results showed that the main factors affecting the hydrodynamics of the oil flow in the pipe when using the studied turbulizers are the geometric shape and dimensions of the turbulizers. Transferred experiments based on passive turbulizer in the form of a twisted tape basic parameters and configuration was determined. Twisted tape width (i.e. turning height) of increase and it was found that the hydraulic flow value increases with decreasing screw pitch.

Conclusions. So, in the form of a twisted tape of optimal size work climbed turbulizer construction with the help of of pipe flow hydraulic resistance relatively small heat with growth fluid in the exchanger tube current turbulence to increase is reached. Research results hard of particles sinking reduction of passive turbulizers for gi in the form of a twisted ribbon using the construction showed a promising future. This , in turn, is high heat transmission parameter relatively ancient preservation provision was determined. From this except for the turbulizer in the form of a twisted tape the construction is simple, work and to release easy and Being cheap , they can be used in existing devices increase for noticeable constructive changes demand.

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