IMPROVING THE EFFICIENCY OF HEAT EXCHANGE BY OPTIMIZING THE PARAMETERS OF THE HYDRODYNAMIC MODE OF SHELL-AND-TUBE HEAT EXCHANGE

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Annotation: In this article, by experimentally studying the effect of the viscosity, density and consumption of aqueous solutions of saturated and regenerated diethanolamine on the modes of flow in the pipe, the structural parameters of the heat exchanger were studied, the influence of the consumption of raw materials and the dependence of the temperature of the raw materials.

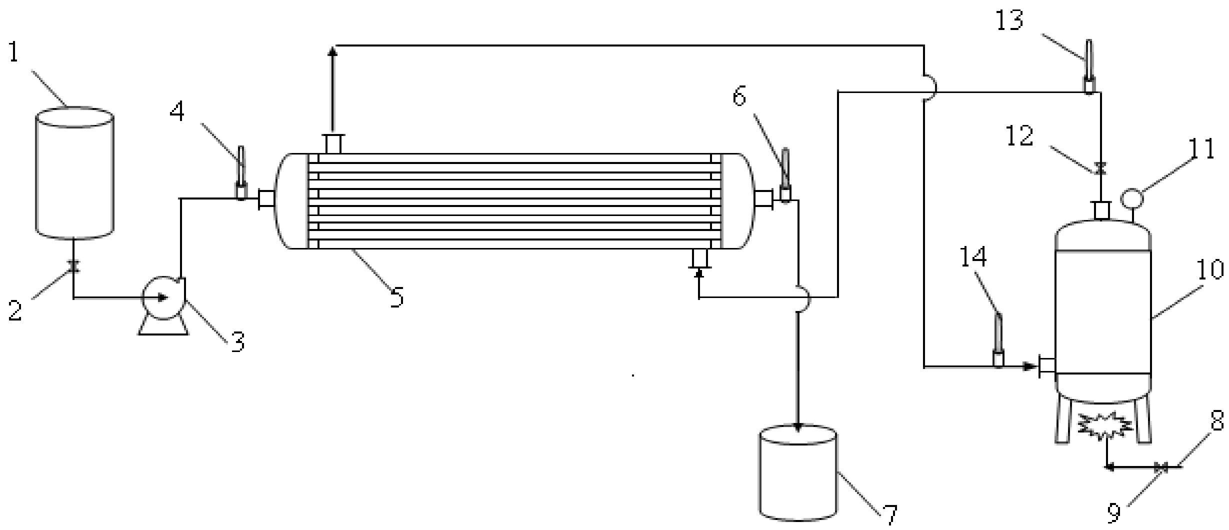
Keywords: hydrodynamic regimes, the shell-and-tube heat exchanger, raw material, consumption, heat carriers, diethanolamine, flow rate.

Today, oil and natural gas raw materials are the main source of energy production and are widely used in all industries. At the same time, in the conditions of the steady growth of natural gas and oil consumption, special attention is paid to the modernization of deep hydrocarbon processing facilities, finding optimal hydrodynamic regimes of the flow of raw materials, extending the time between repairs, and producing products that meet the requirements of international standards [1].

A shell-and-tube heat exchanger was assembled at the Shurtan Oil and Gas Production Department to study the operation of the heat exchange process in gas desulfurization using diethanolamine. In it, the dynamics of temperature change during heating of saturated diethanolamine with regenerated diethanolamine was studied (Fig. 1) [2].

The experimental device works in the following sequence. A heating agent (saturated diethanolamine) is poured into the raw material tank 1, and the raw material is fed to the centrifugal pump 3 through the tap 2, and the raw material is pumped to the shell-and-tube heat exchanger with the help of the pump 5. The raw material heated in the heat exchanger falls into the collection tank7. In this process, the initial and final temperatures of raw materials are monitored using thermometers 4 and 6. Its volumetric consumption is determined by the volume of raw materials that have entered the collecting tank over time [3,4].

The heating agent, that is, the regenerated diethanolamine is poured into the heating boiler 10, the fire is lit in the pipe 8 with the help of the faucet 9, the heating agent is heated, and the faucet 12 is opened, the shell is transferred to the shell part of the tube heat exchanger 5, and the condensed heat carrier is returned to the heating boiler 10. The initial and final temperatures of the heating agent are measured using thermometers 13 and 14, and the process pressure is measured using a monometer 11 [5,].



1- container for raw materials; 2- raw material consumption control valve; 3-centrifugal pump; 4. the temperature of the raw material at the entrance to the heat exchanger; 5-shell tube heat exchanger; 6. the temperature of the raw material at the exit to the heat exchanger; 7-volume container; 8-natural gas; 9-gas tap; 10-generator for heating agent; 11-manometer for measuring atmospheric pressure; 12-tap for adjusting the consumption of the heat carrier; 13, 14 thermometers for measuring the temperatures at the inlet and outlet of the heat exchanger of the shell and tube.

Figure 1. Schematic diagram of a shell-and-tube heat exchanger

The length of the shell-pipe experimental device is 2000 mm, the shell diameter is 76 mm, 5 pipes with a diameter of 10 mm are placed inside the shell, and the experiments were carried out at the speed of raw materials in the inner pipe of 0,5÷1,0 m/s [6].

Fractions coming out of rectification columns from heat exchange devices used in oil and gas processing enterprises, raising the temperature of primary raw materials or low-temperature streams with hot technological streams coming out of adsorption and absorption columns, on the other hand, are widely used in cooling technological streams, condensing steam. Therefore, the results of heating sulfur-saturated diethanolamine with regenerated diethanolamine using a shell-and-tube heat exchanger are presented in table 1.

The values given in the table show that the temperature of the heating agent (saturated diethanolamine) at the entrance to the inner pipe of the shell and tube device is t1=25 ºC, and the temperature of the heating agent (regenerated diethanolamine) at the exit from the heating boiler is t_4= 108 ºC. At these temperature limits, the temperature change of heated raw material at different consumption V = 1÷5 l/min was shown as follows. Consumption of heated raw materials [7].

Table 1

Dependence of the flow temperature in the shell-and-tube heat exchanger on the consumption of raw materials

Raw material consumption V l/min	The temperature of the heating agent, ºC		The temperature of the heating agent, ºC	
	t_1	t_2	t_3	t_4
1	25	87	108	81
2	25	85	108	82
3	25	82	108	84
4	25	78	108	86
5	25	71	108	89

An increase in temperature from t_1= 25 ºC to 87 ºC at 1 l/min caused a decrease in the temperature of the heating agent from t_3= 108 ºC to 81 ºC. It was found that an increase in the consumption of raw materials to 5 l/min causes the temperature of the heating agent to increase to t_2=71 ºC and the temperature of the heating agent to decrease to t_4=89 ºC [8].

From the results obtained above, it can be seen that increasing the consumption of raw materials from 1 l/min to 5 l/min causes the temperature of the heated agent to decrease to 16 ºC. However, the total volume of heated raw materials increases 5 times [9].

Figure 2 below shows the graph of the temperature of cold and hot heat carriers exiting the experimental device of the shell-and-tube heat exchange as a function of the flow rate of the raw material being heated in the device [10].

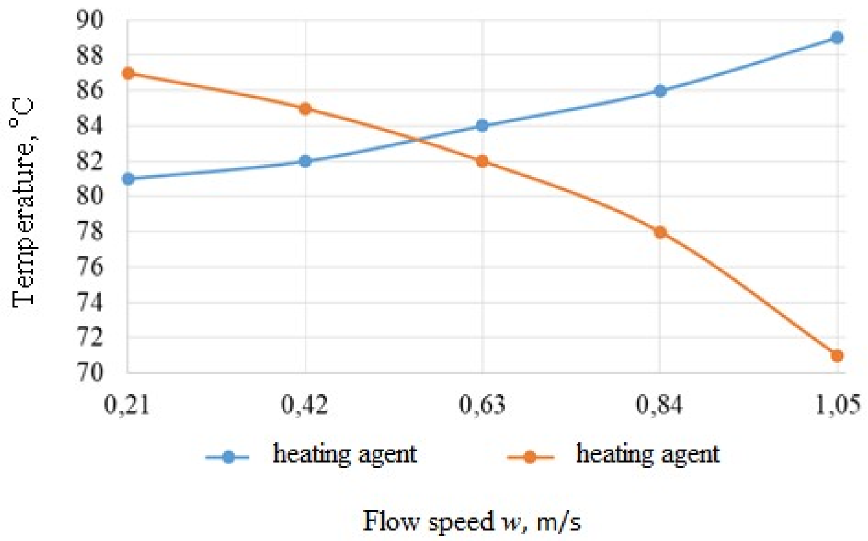


Figure 2. Dependence of the temperature of the heat carriers in the heat exchanger on the speed of the flows

From the curve graph presented in the figure, it can be seen that if the temperature of the heated raw material in the pipe is increased from 25 to 87 ºC at a flow rate of 0,21 m/s, the increase in the raw material speed leads to an increase in consumption and, as a result, the heating efficiency of the raw material decreases. According to it, if we take into account that the temperature of raw material entering the pipe is constant 25 ºC, when we increase the speed by 2 times, the temperature rises to 85 ºC, when we increase it by 3 times to 82 ºC, when we increase it by 4 times to 78 ºC, and when we increase it by 5 times (1,06 m/s) it is 71 ºC it was determined as a result of experiments. According to the given speeds, the temperature of the heating agent (the raw material to be cooled) was also found to increase to 81, 82, 84, 86 and 89 ºC [10].

It can be seen from the obtained results and the curve data presented in the graph that the heating process in tubular devices when the raw material flow rate is in the range of 0,5÷0,6 m/s allows to increase the thermal efficiency of the device[11].

A shell-and-tube heat exchanger pilot plant was assembled in the Shurtan Oil and Gas Production Department to study the operation of the heat exchange process in gas desulfurization using diethanolamine [11].

The process of heating raw materials in the device was studied depending on its consumption. According to him, the increase in raw material consumption from 1 l/min to 5 l/min causes the temperature of the heated agent to drop to 16 ºC. However, the total volume of heated raw materials increases 5 times [11].

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