EQUIPMENT

HIGH-EFFICIENCY BEARING-BUSHING HEAT EXCHANGER

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Increasing the rated capacity of process plants by modernizing tower equipment usually makes it necessary to increase heat-exchange surface areas. This problem is frequently solved by installing additional heat-exchange equipment in available space or enhancing heat exchange on existing equipment when there is no free space. A similar problem also arises when it is necessary to economize on heat carriers in operation of heat-exchange systems.

In studying the experience in updating heat-exchange equipment, we isolated the following basic trends in enhancing heat exchange:

- replacing the tube bank by a plate bank (the most efficient, but also the most expensive method with important restrictions on use in oil refining) [1];
- changing the bank tube configuration to undulating, spiral, etc. (complicates the technology for manufacturing and servicing the equipment) [2];
- incorporating additional elements in the design of the heat exchanger [3].

Of these trends, we prefer the last one, since the production unit does not become much more expensive when additional elements are introduced in standard shell and tube heat exchangers and the indexes of the increased heat-transfer efficiency remain relatively good. According to the data in [4], the efficiency of heat exchange in a shell and tube rod heat exchanger with a horizontal insulating wall is on average 20% higher and

![Diagram of the bearing-bushing heat exchanger](image)

Fig. 1. Diagram of the bearing-bushing heat exchanger: 1-4) connection; 5) body of heat exchanger; 6) heat-exchange tubes; 7) bearing bushings; 8) plates with turbo elements; 9) horizontal wall.

in many cases with a small temperature difference in the heat carriers (streams), 33-49% higher than in a typical heat exchanger.

Based on the recent development of the horizontal-wall rod heat exchanger, we proposed vertical and horizontal rod turbulizers to replace the bearing bushing that simulate the vertical walls of a typical shell and tube heat exchanger. Directed turbulization of the heat carrier stream in the intertube space is executed by two methods: either as a result of installing plates with tongues directly behind the bushings (in the path of the heat carrier in the intertube space) or as a result of making a variable cross-section area of the bushings themselves, positioned in vertical planes simulating the vertical walls of a typical shell and tube heat exchanger.

The principal design of the bearing-bushing heat exchanger is shown in Fig. 1. This heat exchanger operates as follows. The heat carrier passes through connection 4 to the intertube space and moves in the horizontal plane by countercurrent relative to the movement of the heat carrier in the tube space.

The intertube heat carrier is uniformly distributed by passing through bearing bushings positioned at defined distances apart in the vertical plane of the tube space. In passing through the bearing bushings, the intertube heat carrier is deflected by plates with turbo elements installed behind them, and the plates simultaneously play the role of mounting hardware for the bushings.

Using calculated or model data on the distribution density (existence of stagnant zones) of the heat carrier along its path in different sections of the heat exchanger and use of bearing bushings of different cross section in the given heat exchanger design, it is possible to maximally eliminate the negative effect of stagnant zones and thus increase the heat exchange efficiency.

Heat exchangers 9 of this design are manufactured at Prokhimapparat IA CJS (Ozersk, Chelyabinsk Obl.) and have passed industrial tests in the process plants at Novo-Ufa Refinery OJSC.

The described design of the bearing-bushing heat exchanger nevertheless has drawbacks:

the necessity of renovating connecting pipe 1 (see Fig. 1) in replacing the standard bank with a bearing-bushing bank and consequently reconnecting the corresponding intertube heat carrier input line;

the existence of by-pass flows of the intertube heat carrier — “blank” flow through the gaps between the tube bank and heat exchanger body.

To eliminate these drawbacks, we designed and manufactured a bearing-bushing heat exchanger with a corset on the tube bank [5]. A diagram of this heat exchanger is shown in Fig. 2. The high efficiency of this design is due to the fact that the tube bank is enclosed in special corset 6 which tightly surrounds its surface and closely adjoins the tube grids. There are two ports in the corset: inlet 2 for introducing the heat carrier directly into the intertube space of the bank, and this port is equipped with a sealing collar that eliminates heat carrier leaks; outlet 1 for removing “spent” intertube heat carrier into the gap between the bank corset and heat exchanger body. As Fig. 2 shows, in a heat exchanger of this design, the probability of bypass streams of intertube heat carrier is almost eliminated, while according to the data in [6], the existence of leaks in standard heat exchangers reduces the efficiency of heat transfer by 30-40%.