HEAT TRANSFER ENHANCEMENT

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1. Introduction

The problem of decreasing a mass and size of heat exchangers is urgent. Enhancement of convective heat transfer processes is a promising means for solving this problem. It should be noted that use of heat transfer enhancement enables solving some other, no less important problem, such as lowering maximum temperatures of heat exchanger working surfaces, improving the operational reliability, and reducing the fouling and other contamination.

At present, different methods of convective heat transfer enhancement in heat transfer channels have been proposed and studied These include flow turbulators on a surface, a rough surface, a developed surface due to fining, flow swirling by spiral fins, worm devices, swirlers mounted at the channel entrance, gas bubble mixing in the liquid flow, mixing of particles or liquid drops in the gas flow, rotation of a heat transfer surface, surface vibration, heat carrier pulsation, action of an electrostatic field on the flow, flow suction from the boundary layer. Use of jet cooling systems is a means for heat transfer enhancement in single-phase heat carrier flow.

2. Statement of the problem

At the Moscow Aviation Institute (Russia) the high-effective method was developed to enhance heat transfer in tubular heat exchangers, and comprehensive studies were made of the efficiency of this method when applied to gas and liquid flow in tubes, circular channels, and in tube bundles over a wide range of performance parameters. The essence of the method proposed is as follows. Equidistant annular grooves are rolled on an outer surface of a heat transfer tube. In this case, the annular smooth-wall diaphragms are formed over on an inner tube surface. Annular grooves and diaphragms swirl the flow in a wall layer and provide heat transfer enhancement outside and inside the tubes (Figure 1).

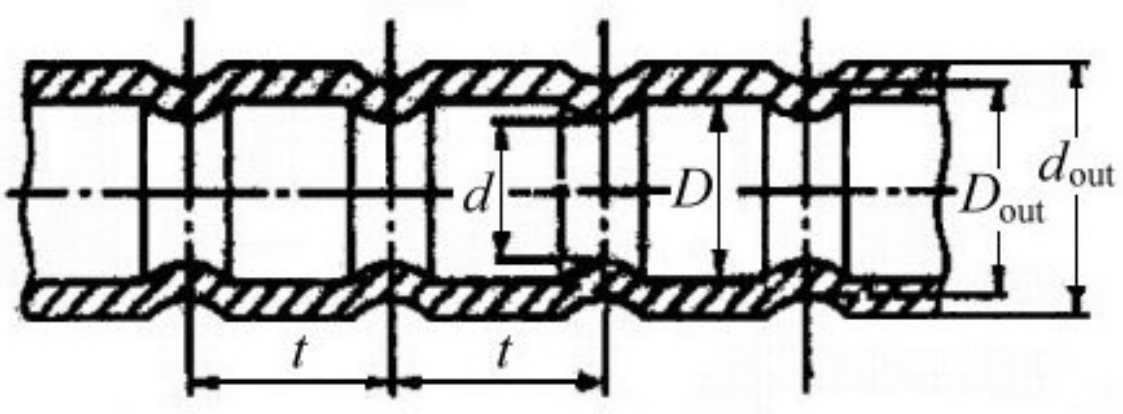

Figure 1. A tube with annular turbulators

The outer diameter of the tubes does not increase, which permits their use in compact bundles and does not require change in the existing way of assembling heat exchangers. The technology worked out for manufacturing knurled tubes is not complicated and makes use of standard equipment. The knurling cost is not more than several percent of that of the tubes. Knurling can be done at a rate of one to two meters per minute using a facility installed on a lathe. A special facility provides knurling at a rate of 9 m/min.

The tubes with annular turbulators can be installed in heat exchangers using gases and liquids with boiling and condensation of heat carriers; that is, they possess the versatility required for practical applications. Moreover, as shown below, these tubes are less susceptible to fouling. Thus, tubes with annular turbulators satisfy virtually all of the requirements necessary for their widespread practical application. Use of the developed method for heat transfer enhancement permitted both the 1.5÷2.5 –fold reduction of a heating surface, at present heat power and pumping power of heat carriers as well as the improvement of the performance parameters of heat exchangers due to reducing fouling.

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Biographical Sketch

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Date of birth- 14.06.1934. Engineer (Moscow Power Engineering Institute) - 1958. Doctor of Philosophy (Moscow Aviation Institute)- 1964. Doctor of Technical Sciences (Moscow Aviation Institute) - 1978. Titled Professor (Moscow Aviation Institute) - 1981. USSR State Prize Laureate -1985. Russian Federation State Prize Laureate - 1990. Honored Scientist of Russian Federation - 1996. Two Gold Medals of USSR State Industrial Exhibition-1983, 1985. Three Silver MAI Prize Laureate - 1996, 2000.

He is a well known specialist on heat and mass transfer and aerospace thermal techniques. He executed fundamental researches or unsteady heat transfer hydrodynamics in single-phase and two-phase cryogenic fluids in channels and tanks with reference to aerospace engines and power installations. His work has led to the development new engineering methods of calculation unsteady and emergency regimes in engines and power installations, methods of calculation of turbulent two phase flows. He developed and investigated an effective method of heat transfer enhancement in tubular heat exchangers. He for the first time found out the law of remarkable increase of heat transfer in channels with discrete turbulizers in comparison with similar smooth channels concerning increase of hydraulic resistance. This law was registered by USSR State Committee Inventions and Discoveries in 1981 as scientific discovery. Professor G.A. Dreitser – author more than 450 published works, including 24 monographs (Books), among which 6 were translated in the USA.