OPPONENT'S REVIEW

on doctoral thesis of Ing. Erik Bartuli
"Optimization of heat transfer surfaces of heat exchangers",
submitted for obtaining a Doctor of Philosophy degree

This doctoral thesis is devoted to the optimization of heat exchangers in order to increase their thermal performance. Metal and polymeric heat exchangers intended for operation in air-water and water-water systems are considered. Heat exchangers based on non-metallic surfaces have a number of interesting applications. With a very compact arrangement, they make it possible to greatly increase the heat transfer surface and to use aggressive media such as seawater, acids and aggressive gases as a heat-exchange medium.

Doctoral thesis is divided into six main chapters. In the first part theoretical aspects of heat transfer during convective heat exchange are considered. Chapter 1 presents the features of the mathematical description of particular cases of heat exchange on such heat transfer surfaces as a plane, a tube and a bundle of tubes. Chapter 2 describes the main ways and methods of intensification of the heat exchange process, which are used for heat transfer devices.

The second part of the work is devoted to experimental studies of heat exchangers from various materials and to optimizing of their geometry in order to increase the intensity of heat exchange processes. Chapter 3 presents the tests of a metal heat exchanger of the fancoil type, consisting of a copper tube with aluminum fins. Carried out thermocyclic tests that simulate the real operating conditions of the heat exchanger showed a reliability of a contact between the tube and pressed fins.

Chapter 4 demonstrates the potential of polymeric hollow fiber heat exchangers (PFEHE) of the water-air type using in air-conditioning systems. These heat exchangers consist of hundreds, and sometimes of thousands thin-walled fibers with an outer diameter of about 0.8 mm. Such a lack of polymeric materials as low thermal conductivity in these devices is compensated by a large heat transfer surface, which allows to obtain sufficiently high heat transfer characteristics of the devices. Obtained results show that PFEHE can be successfully used in air conditioning systems.

Chapter 5 is dedicated to optimization the PFEHE of shell-and-tube type operating in water-water systems. The search for the optimal arrangement of the hollow fibers inside the heat exchanger was carried out using computer simulation. The computer simulation data were then confirmed experimentally.

Chapter 6 describes a unique technology for the manufacture of polymeric heat exchangers of a new type – the cross-wound hollow fiber heat exchangers. The tests carried out by static and cyclic pressure stresses demonstrated the reliability and mechanical strength of the heat exchanger produced using the developed technology. The tests of the prototype showed high thermal characteristics, the total heat transfer coefficient of the heat exchanger reaches

1950 W/m²K with a power of 38 kW. Along with a relative compactness and resistance to aggressive media, it makes this type of heat exchangers promising for use in various industries.

There are several questions and comments concerning thesis, as follows:

1. It would be interesting to compare the efficiency of heat transfer, obtained using polymeric heat exchangers and metal one of the same heat transfer area.
2. The thesis does not clearly specify the range of PFEHE operating temperatures.
3. It is interesting to evaluate the effect of change in the finished assembly's geometry on the efficiency of the heat exchanger, for example, from cylindrical to flat.
4. Only one type of plastic is used in the work. How will the use of composite material affect the cost and efficiency of the heat exchanger?

The main part of the Erik Bartuli's doctoral thesis is devoted to relatively new types of heat exchangers - PFEHE and the possibilities of their use in water-air and water-water systems. The work has of great practical importance and is a good example of the use of computer simulation methods for solving problems of optimizing the geometry of heat exchangers. The newly created PFEHE type and the developed technology with the ability to adapt for mass production makes a significant contribution to the development of heat transfer devices. The results obtained in the frame of the work can be applied in practice in the near future. It is also worth noting the large number of developed and created stands used in this work (Ch. 3, 6).

The doctoral thesis was done on 92 pages. The work is well structured, the material is presented logically, in accessible language. The data are presented in visual form with a large number of figures and graphs. The thesis is written in English, which is advantage in terms of availability of thesis at the international level.

The above comments do not reduce the high quality of the performed work and are only advisory in nature for further research in this area.

The thesis was done on a good scientific level and its author Ing. Erik Bartuli deserves an award of Doctor of Philosophy.

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