DEVELOPMENT OF A METHOD TO DETERMINE THE COEFFICIENT VALUES OF HEAT TRANSFER AND EQUIVALENT THERMAL CONDUCTIVITY FOR SIMULATION OF A THERMAL FLOW THROUGH THE IN-STRUCTURE GAS CAVITIES USING THE RESULTS OF PRELIMINARY AND DESIGN CALCULATIONS OF THE TEMPERATURE FIELDS IN DIFFERENT STRUCTURES

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The study is intended to develop a method for determination of the coefficient values of heat transfer and the equivalent thermal conductivity. The obtained coefficient values are used in the simulation of a thermal flow through horizontal and vertical gas cavities in different structures. The calculation results are validated against the experimental data.

In calculations to determine the temperature fields, aside to thermal conductivity through the solid parts of the structure, it is important to consider heat transfer through the numerous in-structure gaps and cavities. To obtain the value of the thermal flow through an air cavity/gap, one should determine the coefficient of heat transfer to an in-structure (internal) cavity (by Newton–Richmann law) or the equivalent thermal conductivity coefficient (if the process of heat transfer is referred to as the phenomena of thermal conductivity into slits).

Calculation of the heat transfer reduces to determination of the Nusselt number using Grashof and Prandtl criteria equations depending on the fluid flow mode and the channel shape. The Grashof number characterizes relative efficiency of buoyancy, which is responsible for the buoyancy flow in the media. The Prandtl number is the thermal characteristic of the reactor coolant. In the general case, the heat transfer coefficient is a function of the body shape and size, velocity, temperature, and thermal characteristics of the media [1].

To simplify the calculations of complicated convection heat-transfer processes, these processes are assumed as a thermal conductivity phenomena considering the notion of the equivalent thermal conductivity coefficient [2].

Calculations to determine the coefficients of heat transfer to an internal air cavity and the equivalent thermal conductivity were made for the air gaps 5-60 mm thick and 230-300 mm high. The calculation results showed that in the specified range of the air gap thickness, the thermal transfer coefficient equals to 1.5–8 Wt/m2K and the equivalent thermal conductivity coefficient is from 0.08 to 0.19 Wt/m·K (depending on the temperature gradient value).

Dependences of the heat transfer and the equivalent thermal conductivity coefficients on the gap thickness and the thermal gradient value can be used in preliminary and design calculations to obtain the temperature distribution (close-to-real conditions) throughout the structural elements.

With this method, we calculated the temperature fields of the system of bodies comprising pipes of circular and rectangular cross-sections. The pipes were inserted one inside the other and shifted from the axis of symmetry relative to each other. The heating elements were installed in the internal pipe. To reduce the heat losses, the pipe ends were blanked off by non-heat conducting glass textolite square caps. The system of bodies was horizontally and vertically mounted.

The experimental results were compared to the ones obtained in the calculations. The difference between the results is less than 5 %.

References

1. **Mikheev, M. A.** Fundamentals of heat transfer [Text]. – M. : Energiya, 1973 (in Russian).
2. **Isachenko, V. P.** Heat transfer [Text]. – M. : Energiya, 1975 (in Russian).