FEATURES OF HEAT TRANSFER IN A FLOW OF AIR IN A PLANE CHANNEL
WITH UNSTAGGERED HALF-CYLINDRICAL PROJECTIONS

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A study was made of local heat transfer in a flow of air with \( \text{Re} = (1.5-170) \cdot 10^3 \), \( s_1/d = 1.27 \); \( s_2/d = 5.33 \); 3.04; 2.13. It was found that heat transfer is non-symmetrical on opposite sides of the channel.

In boiler design, great importance is attached to questions related to intensifying heat exchange and ensuring the reliable operation of convective heating surfaces. Experience accumulated in the operation of such surfaces shows the significant design, processing, and operational advantages of membrane panels used as convective and shielding elements. The studies [1-5] present data from investigations of local heat transfer, this data showing that to ensure reliable operation of a membrane structure, it is necessary to consider the effect of the nonuniform distribution of heat transfer on the temperature regime of the surface.

As in normal bundles, the pipes in such systems can be arranged in staggered or unstaggered fashion. The use of a given arrangement is dictated by the flow conditions and should be substantiated by special technicoeconomic calculations for each case. For example, it was noted in [6] that several design problems are encountered in achieving "economical" flue-gas velocities, but the authors also noted that these problems can be overcome by using unstaggered membrane bundles.

Calculations performed in [7] showed that an unstaggered bundle of tubes with solid fins is more efficient than a similar bundle of smooth tubes in the range \( \text{Re} \leq 10^4 \).

Along with this, as in the case of flow over a straight double ledge [8], flow and heat transfer may be nonsymmetrical under certain conditions in the case of a membrane surface with an unstaggered tube arrangement. These effects may have a significant influence on the temperature regime of the membrane panel.

These considerations interested us in taking a closer look at membrane heating surfaces with an unstaggered tube arrangement. To do this, we reconstructed the test section described in [7]: measurements were made only for an unstaggered arrangement of the projections, with a transverse relative step \( s_1/d = 1.27 \) and three lengthwise steps \( s_2/d = 5.33 \), 3.04, and 2.13.

Heat transfer was measured on a flat wall and on semicylindrical calorimeters for both sides of the channel. Although realization of this reconstruction required many design
changes, heat release conditions remained the same as before. The study [7] presented results of an evaluation of heat transfer in plane and semicylindrical surfaces. There was no redistribution of the warming electric current due to the temperature dependence of electrical resistivity for the plate. For the half-cylinders, the redistribution was estimated as being no more than 1%. For the semicylindrical calorimeters, \( q_{pot} = f(\Delta t = t_c - t_{bse}) = (\lambda/\delta)\Delta t \), where \( \Delta t \) is the temperature difference between the heater \( t_c \) and textolite base \( t_{bse} \). Thermal conductivity \( \lambda/\delta \) was determined from special calibration tests in which a semicylindrical calorimeter was located in the plane temperature field of the heating plate. In this case, for a half-cylinder at \( \varphi^o = 90^o \), we can determine the