NUMERICAL SOLUTION OF THE PROBLEM OF FLOW AND HEAT EXCHANGE IN MODEL CHAMBERS OF COMBUSTION OF HIGH-SPEED DIRECT AIR-REACTOR ENGINES ON HYDROGEN FUEL

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The development of technologies and materials used for high-speed ramjets makes it possible to significantly increase the life of the engine. In this regard, an obligatory element of the combustion chamber design is an active cooling system that provides acceptable values of the temperature of the fire walls. Numerical simulation of the conjugate heat exchange problem allows to predict the thermal state of the walls of the combustion chamber and to reveal physical features.

In the present study, the object of the study was a flat two-dimensional combustion chamber model operating on hydrogen fuel. The calculated area of the combustion chamber can be conditionally divided into two parts. Flow section of the combustion chamber with hydrogen pylons installed in it and a flowing cooling system. The wall thickness was set at 1 mm, the thermal conductivity of the wall material depended on temperature and varied in the range from 18 W / (m * K) to 30 W / (m * K). In the flow path of the combustion chamber, a viscous, turbulent flow of chemically reacting gas was considered. At the entrance to the combustion chamber, a supersonic boundary condition was used, i.e. the pressure, temperature, and Mach number were set. Supply of hydrogen through the pylons inside the flow path of the combustion chamber. In the channels of the cooling system, the flow of hydrogen in a supercritical state with thermophysical properties that depend on temperature was considered.

The first series of calculations was carried out on the assumption that the flow rate and temperature of hydrogen at the outlet from the cooling system are in no way related to the flow and temperature of hydrogen in the fuel pylons. For different values of the excess air factor in the combustion chamber, such a hydrogen flow in the cooling system was selected so that the temperature of the hot wall did not exceed 1000 K, which is the criterion for the permissible thermal state. The second series of calculations was carried out taking into account the fact that the input boundary conditions for the fuel pylons correspond to the parameters at the exit from the combustion system of the combustion chamber.

As a result of the numerical simulation it was established that to ensure the permissible thermal state of the wall, it is necessary that the flow through the cooling system be greater than the flow through the combustion chamber. In the case of a regenerative cooling system, the permissible thermal state is ensured only when the combustion chamber operates with an excess air ratio of 0.5.