ON THE PROBLEM OF MODELING THE HEAT EXCHANGE OF CONDENSED COMBUSTION PRODUCTS OF SOLID PROPELLANT WITH A COOLING WALL

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Abstract: The physical and mathematical model describing heat and mass transfer due to the interaction of condensed combustion products of solid rocket motor (SRM) with a cooling wall was developed. The model takes into account formation of the film on the cooling wall from condensed combustion products and heat flux changing depending on the film thickness. The film may consist of either a solid layer or the solid and liquid layers. The model takes into account the dynamic changes in the thickness of both layers and the temperature profile within them. Two versions of the model were developed. In the first version, a linear temperature profile is adopted in the solid and liquid layers and in the second version, a linear temperature profile is adopted in the solid layer and a parabolic temperature profile is adopted in the liquid layer. A series of calculations using the developed model and the model based on the numerical solution of modified Stefan problem by the finite volume method were performed. Both stationary and nonstationary boundary conditions for mass and heat fluxes on the film surface and for the temperature of the cooling wall were imposed. The calculation results showed good agreement between the models on the dynamics of the film surface temperature and the heat fluxes into the cooling wall and on the film surface.

Keywords: heat and mass transfer; Stefan problem; two-phase film; solid propellant combustion products; cooling surface; alumina; theoretical model

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