Numerical Modeling of Film Cooling of the Surface at Non-Uniform Heat Flux Distributions on the Wall

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Abstract : The problem of heat transfer at thin laminar liquid film is solved numerically. A thin film of liquid flows down an inclined surface under conditions of variable heat flux on the wall. The use of thin films of liquid allows to create the effective technologies for cooling surfaces. However, it is important to investigate the most suitable cooling regimes from a safety point of view, in order, for example, to avoid overheating caused by the ruptures of the liquid film, and also to study the most effective cooling regimes depending on the character of the distribution of the heat flux on the wall, as well as the character of the blowing of the film surface, i.e., the external shear stress on its surface. In the statement of the problem on the film surface, the heat transfer coefficient between the liquid and gas is set, as well as a variable external shear stress - the intensity of blowing. It is shown that the combination of these factors - the degree of uniformity of the distribution of heat flux on the wall and the intensity of blowing, affects the efficiency of heat transfer. In this case, with an increase in the intensity of blowing, the cooling efficiency increases, reaching a maximum, and then decreases. It is also shown that the more uniform the heating of the wall, the more efficient the heat sink. A separate study was made for the flow regime along the horizontal surface when the liquid film moves solely due to external stress influence. For this mode, the analytical solution is used for the temperature at the entrance region for further numerical calculations downstream. Also the influence of the degree of uniformity of the heat flux distribution on the wall and the intensity of blowing of the film surface on the heat transfer efficiency was also studied. This work was carried out at the Kutateladze Institute of Thermophysics SB RAS (Russia) and supported by FASO Russia.

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