Paper ID: 76482
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Vehicles – Mechanical/Robotic/Thermal/Fluidic Systems (7)

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STUDY OF GAS FLOW BY INVERSE PROBLEMS TECHNIQUE

Abstract

Computational-experimental method of identification of the gas properties by measuring the absorbed heat flux near the critical point of the axisymmetric blunt body interacting with gas flow is considered. The transport properties of the gaseous medium are studied as an object of identification. The identification problem is formulated as optimization problem. It has been shown that the set of points, for which value of the objective function is lower than the value specified by the noise level of the heat flux measuring, has specific structure. This fact allows us to obtain a fairly accurate estimation of the identified parameters by averaging. Study the spatial distribution of the atmosphere, the gas characteristics of the environment, the meteorological situation analysis and other research in the scientific and practical purposes in interplanetary piloting are extremely urgent problem. The possibility of identifying parameters of the gaseous medium by means of specially installed sensors is obvious, however, the probability of accidents or hardware failure exists. Moreover, not every unit is equipped with these sensors. As a backup scenario or as an alternative opportunity to obtain information on the characteristics of the gas composition of the atmosphere, the problem of identification of the gaseous medium by measuring the absorbed heat flow is considered. The possibility of identifying the transport properties of a gaseous medium from measurements of the heat flow in the vicinity of the forward critical point of an axisymmetric blunt body in a supersonic flow has been demonstrated. For this purpose, the inverse problem of the boundary layer is solved. Power-law and two-parameter models of viscosity are considered. The inverse problem is formulated in an extreme setting. For optimization, the Nelder-Mead method was used in combination with random restarts. It is shown that the solution to the problem of minimizing the objective function with finite accuracy is not unique. The structure of the set of points is analyzed, the value of the objective function in which is lower than the value specified by the accuracy of measurements of the heat flux. It is shown that the set is rather compact and has symmetry with respect to the true values. Thus, it is possible to obtain a fairly accurate estimate of the identified parameters by averaging over the set of obtained solutions. The corresponded experimental equipment is developed. The results of a set of experiments with various gases approved the effectiveness of suggested approach.