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USING THE "COMPARATIVE TEST METHOD" TO DETERMINE THE HEAT STATUSES FOR THE HEAT SHIELDS OF SPACECRAFT

Abstract

The study of the unsteady heat transfer process in a hypersonic speed flight condition is essential for the entire design of the spacecraft and its Thermal Protection System (TPS). During the experimental research of such processes, it becomes necessary to determine the surface unsteady heat fluxes and heat transfer coefficients in an experiment, especially in the case of flight tests. Practice shows that, in many cases, the only way to find these time dependent parameters is to solve the inverse problems of heat transfer from the results of temperature measurements inside structural elements or sensitive sensors integrated into these elements. In this paper, based on the solution of the "Boundary Inverse Heat Conduction Problem", the application of the "Comparative Test Method" for restoring the unsteady heat flux and heat transfer coefficients for the frontal surface of the Thermal Protection System with high lift-drag ratio during entry into Earth's atmosphere is discussed. To achieve this goal, gages with sensitive elements of various heat-resistant metallic and non-metallic materials were tested. The paper also discusses the problem of restoring the field of continuous thermal parameters based on solving the two-dimensional and three-dimensional inverse heat transfer problem. It is shown that the "Comparative Test Method" is sufficiently effective for processing the measurement of data and can be useful for the diagnostics of the complex heat transfer process, especially where the non-equilibrium flow, flow separation on the surface, local shock waves, transition of the laminar flow to turbulent flow take place.