COMPUTATIONAL METHODS OF DESIGN AND IDENTIFICATION OF THERMAL PROTECTION OF SPACECRAFT

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ABSTRACT Methods of Inverse Heat Transfer Problems (IHTP) were developed to increase the amount of information from thermal experiments and tests, to improve the accuracy and reliability of experimental data processing and interpretation, and also for investigating and control of Heat Transfer in production processes. In the majority of cases this methodology is used for optimization but in a number of practical situations it is the sole technique available , as, for example, in measuring the transient heat fluxes and heat transfer coefficients. This methodology is based on the mathematical theory of ill-posed problems of mathematical physics.

One of the most important directions of studies where the application of methods of inverse problems is necessary is the design of thermal protection and identification of the heat transfer processes of spacecrafts. Under development is a new approach to the thermal design of high temperature thermal protection, based on the identification of nonlinear systems with distributed parameters. Proceeding from this approach modern experimental-computational methods have been developed to determine thermal, thermokinetic, radiative and other properties of various materials of complex composition, as well as corresponded methods of design.

Depending on the type and mission of the material the considered mathematical models of heat transfer can be divided into four groups:

1. Models of a solid opaque materials with effective thermal characteristics depending on temperature, on temperature and time;
2. Models with a highly porosity of the materials or semitransparent fibers etc.;
3. Models including the kinetics of destruction of composite materials and related processes;
4. Models of multilayer thermal insulation with applications to orbital spacecrafts.