HEAT-TRANSFER TESTS*

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Heat- and mass-transfer processes are rapid and complex in many technical applications, particularly in aviation, nuclear power, chemical technology, and metallurgy; on the other hand, the general appearance of plant, the design parameters, and the working characteristics are largely determined by such processes. This gives particular importance to heat tests, heat engineering, and processing of measurement data. In some cases such as nonstationary interaction between a decomposing heat shield and a very hot gas flow, experiment is the main means of solving the problem.

Many such tests involve considerable consumption of resources, quite apart from the development preceding the test proper, in the production, installation, and commissioning of the test system. It is therefore very important to maximize the output data from the test, and also ensure high reliability. Methods have to be devised for processing and analyzing the output data to extract the maximum information about the phenomenon subject to restricted accuracy in the systems for measuring, recording, and interpreting the data. This aspect is of particular importance for full-scale tests on machines and plant. It is extremely important to plan tests on full-scale plant properly, and also to process the data to best advantage.

Computer-aided data processing is necessary in tests on models and in full-scale tests; this not only accelerates evaluation and reduces the processing labor but also enables one to formulate essentially new experiments, which can substantially improve the reliability of the conclusions. The algorithmic support to such systems must be based on efficient computerized data-processing methods.

Very often, the basic mathematical support in nonstationary heat tests must come from methods of solving inverse heat-transfer problems (determination of limiting thermal conditions, identification of heat- and mass-transfer processes, recovery of external temperature distributions, and so on). Inverse problems differ from direct ones in heat and mass transfer in being incorrect in the classical sense (small changes in the working functionals correspond to large changes in the desired solutions). This major feature of inverse problems makes them difficult to handle and requires special techniques to provide stable results from adequate mathematical models for real processes.

Research workers in this country have devised numerous efficient methods of simulating heat conditions and of processing heat-test data; in particular, extensive studies on this topic have been performed at Moscow Aviation Institute, where suites of algorithms and associated programs have been written for primary processing of input data and for handling inverse problems in thermal conduction, as in nonstationary heat tests. Also, major advances in handling incorrectly formulated processing and interpretation problems have been made by a team of mathematicians at Moscow University under the direction of A. N. Tikhonov, as well as by workers at other organizations.

One may thus say that at present we have available advanced design methods and analysis algorithms for heat experiments, together with an ongoing research program for handling inverse problems. Some of these topics are considered in the papers at the seminar that appear in this issue of the journal.

*Opening address by Professor Vasil'ev at the All-Union Seminar "Inverse Problems in Heat Conduction and Processing Heat-Test Data" (see notes on the Seminar in this issue).

Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 29, No. 1, pp. 5-6, July, 1975.