DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

The thermomechanical analysis plays an important role in the design and operation of equipment operating at high temperature differences. Such analyses are carried out in microelectronics, construction, drilling, power industry and in research on nuclear fusion. The fundamental problem of calculating the temperature and stress distributions in newly designed and operated components is the difficulty in determining some of the thermal boundary conditions. In the case of the power unit elements, an unknown boundary condition usually occurs on the internal surface of components which are in contact with the fluid. In order to define this convection boundary condition, it is necessary to determine the heat transfer coefficient and the temperature of the fluid in the boundary layer close to the element internal surface. The measurement of the two quantities is very difficult because they vary not only over time but also in space. An interesting way to determine the distribution of temperatures and stresses is finding a solution to the inverse problem of heat conduction in the device under analysis.

The survey of the up-to-date state of knowledge indicates that despite the great number of works devoted to the issue in question, it has so far been impossible to develop a method of rapid identification of the thermal and strength state in elements with a simple or complex shape that are subjected to substantial changes in temperature. There are also very few works presenting experimental verification of the developed inverse methods.

The scientific aim of the project is to develop methods of identification of the transient-state temperature and stress fields in solids. The identification is to be carried out despite the lack of some boundary conditions on the solid surface. In order to supplement the missing data, histories of temperature measured in certain points on the body surface or inside it will be introduced. A problem posed in this manner is poorly conditioned and difficult to solve. The errors that the measured temperature histories are burdened with make the computational method rather unstable. The problem is especially difficult to solve in elements with complex shapes. The project anticipates the development of inverse methods that will make it possible to identify the transient-state temperature and stress fields in solid bodies with both simple and complex shapes. The methods will allow stable computations also in the case of measurement data disturbed by random errors. Another aim of the project is to verify the worked out methods both numerically and experimentally. A research stand will be built within this project. The most important elements will be two thick-walled pipes. An extra connector pipe will be mounted on one of them to create an area with a complex geometry. Experimental verification will consist in comparing the histories of temperature values measured in selected points on the element wall thickness to the histories obtained using inverse methods. Next, a comparison will be made between measured histories of strains and the histories identified by means of inverse methods. Similar experimental verification will be carried out for the pipe weakened by the connector pipe.

The development of new methods of the thermal and strength state identification in devices with various shapes will certainly widen the present state of knowledge in the area under analysis. The use of the balance finite element method will make it possible to use them for bodies with a complex geometry. Owing to the application of smoothing filters and future steps, the methods will also be stable in respect of measuring data burdened with errors. The proposed methods will allow calculation of the temperature and stress distributions in areas in which it is impossible to specify all boundary conditions. They will also be useful in analyses of physical phenomena occurring for example in microelectronics, construction, drilling and power engineering.