

Multipurpose software package LOGOS to solve CFD and heat-and-mass transport problems on supercomputers

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Designing of high-tech products is unfeasible without the use of numerical methods for the simulation of physical processes in a complex geometric configuration. Expertise in solving CFD problems has been acquired and understanding of the nature of many physical processes has been achieved by the present time and, therefore, with the currently available numerical methods, growing computer power, lowering price of computers, and available software it becomes possible to introduce in practice multipurpose engineering software packages. These software packages include catalogs of mathematical models of physical processes, finite difference schemes oriented to simulations with a variety of discrete grid models, as well as computational modules for algebraic equation systems.

Common use of commercial engineering software gives appearance that they allow solving problems of any complexity level in each field of industry. However, the applicability of physico-mathematical models implemented in the available software to solve complex production problems may be the subject for a special study, because studies of the capabilities of such models have not yet been completed. The foresaid concerns, to a significant extent, the problem of implementation and application in practice of turbulence models using arbitrarily-shaped unstructured grids which are the dominant grids in the discretization of regions of a complex geometry typical for industrial production objects.

FSUE "RFNC-VNIIEF" has been developing LOGOS software package within the project "Development of supercomputer and GRID technologies", which allows simulating processes in aero-, hydro-, and gas- dynamics using effective numerical methods on unstructured grids of arbitrarily-shaped polyhedrons.

The paper describes the LOGOS functional capabilities for solving CFD and heat and mass transport problems. It describes the physico-mathematical models of physical processes that allow simulating incompressible and low-compressibility viscous turbulent flows, coupled problems with heat transport, gas flows with particles and moving systems of immiscible liquids. The organization structure of modules for solving problems of internal and external aerodynamics and heat transport, a module for simulating flows in anisotropic porous media is presented.

The paper gives solutions to the problems of great importance in industry obtained jointly with experts of the leading Russian enterprises in aircraft building, nuclear power engineering, motor car building and astronautics. The software package validation results are presented, which allow estimating errors and uncertainties in computational models used for the simultaneous simulation of multidiscipline physical phenomena with account for the processes determined by geometry and physics.