SOFTWARE TOOL FOR HYDRODYNAMIC SIMULATION AND SHAPE OPTIMIZATION IN TURBOMACHINERY

Description
Presented CFD (computational fluid dynamics) software is a tool for numerical fluid flow simulation and shape optimization in turbomachinery. It is based on a new approach to modeling 3D stationary and non-stationary, inviscid and turbulent flows in turbomachines as well as one- and multi-objective optimization of hydroturbine runner. New efficient and high accuracy methods are used for solution of the problems.

The software makes it possible to simulate fluid flows in complex flow passages turbomachines (hydraulic turbines, pumps, fans, etc.) in an operative manner, and to optimize their geometry. The software can be used in the course of design, construction and exploitation of aero- and hydrodynamic units.

The software consists of the following independent codes, each provided by convenient input data preprocessor, processor (solver) and postprocessor:
CADRUN/07 is a code for calculation 3D stationary incompressible flow fields (pressure and velocity) in rotor and stator inter-blade passages using periodic statement;
CADRUN2/07 is a code for calculation 3D incompressible stationary and non-stationary flow fields using full-turbine statement;
CADRUN-opt/07 is a code for automatic choice (optimization) of runner blade curvature and runner meridian projection for Francis turbines.

Technical specifications
Computation time (for Pentium IV type computer)
- one element of a hydroturbine
  about 2 minutes
- whole hydroturbine
  about 8 hours

Time of three-objective hydroturbine runner optimization problem with 30 free geometry parameters (on a 60 processor cluster)
5 hours

Fig.1. Types of turbomachines for which computation system is applicable.
From left to right: Kaplan and Francis hydroturbines, pump stage, fan.
Fig. 2. Modeling of the precessing vortex rope behind the turbine runner in part load operating point: computation (left), experiment (right).

Fig. 3. Optimal design of hydroturbine runner: elimination of suction side cavitation in Bratsk hydro-turbine runner. Initial blade (left), and optimal blade (right).

**Technical appraisal and economic benefits**

Significant advantages of the presented software tool are: the simplicity of mastering and using, applicability to a wide class of aero-hydrodynamic fluid flow problems, fastness and low computing system requirements.

**Application areas**

The software can be used for solution of industrial and scientific hydrodynamics problems in factories and academic institutions dealing with complex fluid flows.

**Development stage**

The software is a fully completed commercial product. It is used in the design process at the Leningradsky Metallichesky Zavod (LMZ), a branch of the “Power Machines” concern.

**Patent situation**


**Commercial offers**

**Estimated cost**
From 100 000 rubles ($4000).

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