



Saint-Petersburg Polytechnic University
Joint scientific – technological Institute

R &D Laboratory
«GAS DYNAMICS OF TURBO-MACHINES»

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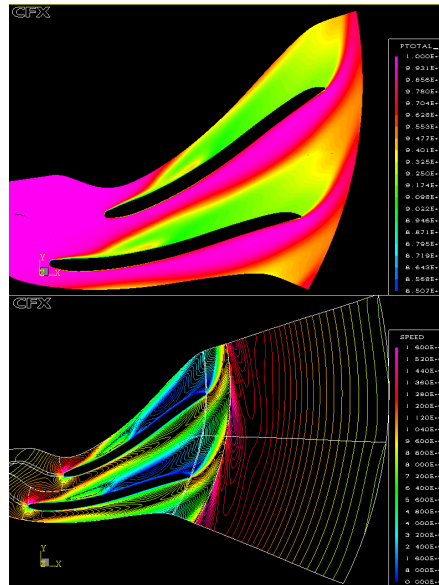
The head of the laboratory Dr-Ing. Hab., Prof
Yuri B. Galerkin, Chairman Compressors &
Pneumatics Association, Head editor “Compressors
& Pneumatics”

Directions of the activity:

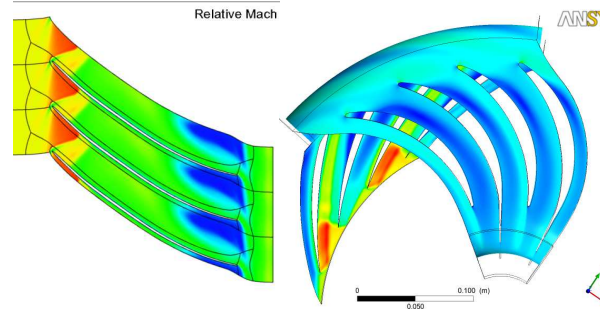
- field-type methods of gas-dynamic design development;
- CFD methods application in gas-dynamic design;
- general research for advanced turbo machines;
- gas-dynamic design of new turbo machines for Russian and foreign manufacturers;
- post-graduate and doctoral studies;
- compressor society organizational work through the Compressor & Pneumatic association (25 companies and Universities of Russia and Ukraine).

Gas-dynamic research

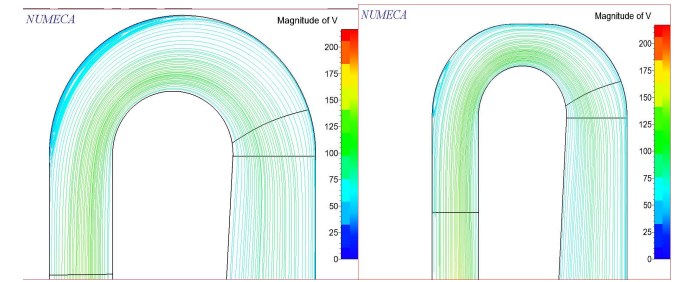
Information collected for decades’ long and profound physical experiments in the Laboratory of compressor problems TU SPb still in 1960 – 1990 and later obtained information is used for CFD calculations verification. Physical models generalize information on flow behavior. Math models describe it by algebraic equations. Standard recommendations on flow path configuration choice are checked by CFD calculations and are corrected when necessary.



Flow field in a radial impeller – pre-surge flow rate



Mach number field in the supersonic compressor stage elements. Design flow rate



Crossover shape correction. Standard and after CFD analysis. Stage efficiency increase 0,15% (NUMECA FINE TURBO, ANSYS CFX)

Gas–dynamic design general rules and modeling technology

TU SPb compressor school has developed classical Russian methodology of the second part of 20th century (Y. Galerkin, Turbo-compressors. Compressor and Chemical technology publishing house, Moscow, 2010 – in Russian). Gas dynamic parameters are prior to geometry ones. In case of a centrifugal stage:

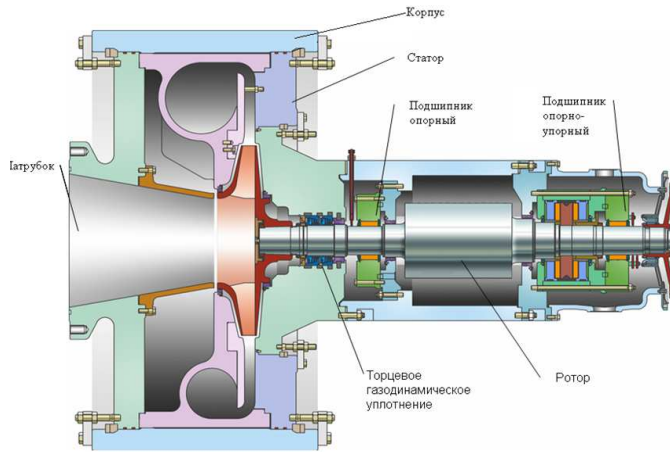
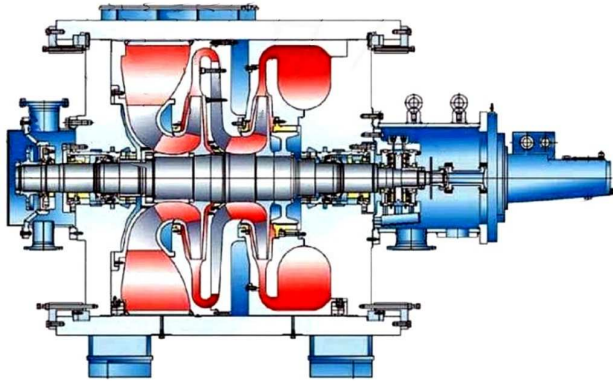
- normalized design parameter flow rate coefficient is prior to normalized impeller blade width,
- Euler work coefficient is prior to impeller blade exit angle, etc.

The decisive step was the creation of the Universal modeling method – the set of computer programs on the base of the math model for efficiency of a stage and a compressor calculation. Up to 2010 the 4th version of the model was applied.



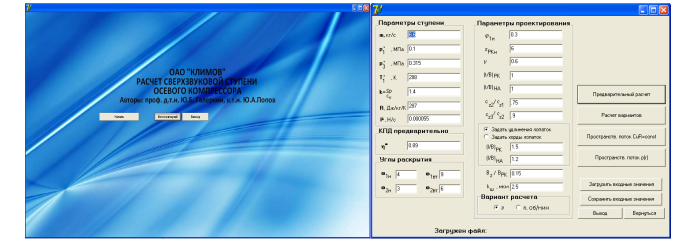
Titles of computer programs NCCO-G4E and CCPM-G4E

Several dozens of compressors (2000 – 25 000 KWt, 1- 8 stages, delivery pressure up to 12,5 MPa) were designed for Russian and foreign manufacturers – about 400 compressors are manufactured with total power more than 5000 000 KWt.



Single stage pipe-line compressor 32 MWt. The design for SMPO (Sumi, Ukraine). Test of the model 1:2 (industrial partner, May 2014) verified predicted efficiency 90%

Several computer programs for axial compressors and stages and developed and applied for industrial partners benefits.



Title and input parameters of the program for supersonic axial compressor stage analysis

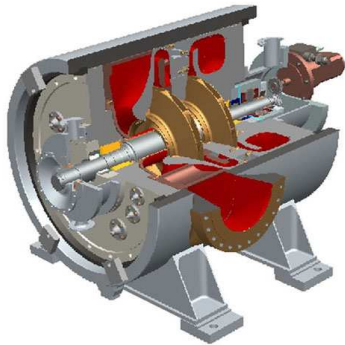
Compressor & Pneumatic association (25 companies and Universities of Russia and Ukraine).

The Chairman of the Compressors & Pneumatics Association and its executive office staff are members of the R &D Laboratory «Gas dynamics of turbo-machines».

The association publishes the magazine “Compressors & Pneumatics” (Specialists from Russia, Ukraine, Poland< Germany, Great Britain, USA are presented in the editorial staff), organizes several international compressor conferences and is the place to discuss scientific and organizational problems.

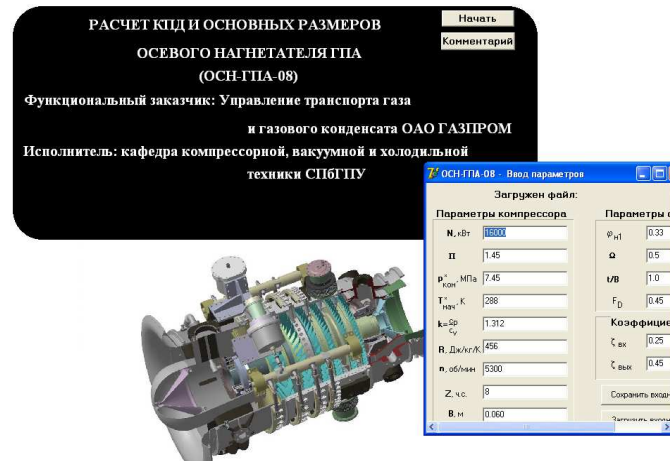
The international conferences:

- “Compressor Users-Manufacturers Symposium” – the meeting of industrial specialists. Annually from 1994 in June, TU SPb. All leading world companies participate.
- International Compressor conference – once in 3 years. The last one – September 2014 on the base of known manufacturing company “Newsky plant”.
- The annual conference inside the Forum “Pumps and Compressors”, Moscow, October.



Typical two-stage pipe-line compressor of TU design in mid-90th

Predicted design point parameter accuracy satisfies manufacturers. The usual practice to check designs by model tests is abandoned completely now. Some “weak points” of the 4th generation were eliminated and some new abilities added in 4th and 6th versions of the Method that are used now.



Title and input parameters of the program OCH-ГПА-08 oriented on small flow rate high pressure axial compressors