CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF MECHANICAL ENGINEERING

DEPARTMENT OF FLUID MECHANICS AND THERMODYNAMICS

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Yearly Average:

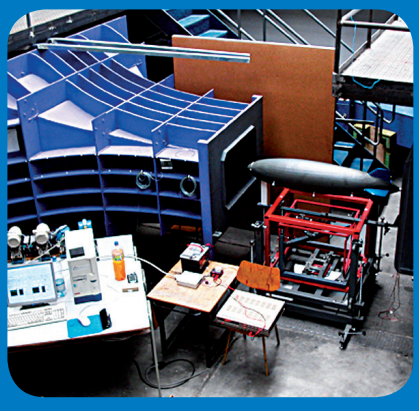
Evaluated outputs	91
RIV points	2187
Staff	27
Investigated projects	6
Cooperation with the application sphere	6
Presented and defended Bachelor theses	13
Presented and defended Master theses	10
Presented and defended Doctoral dissertations	2

World of Constant Motion

The Department of Fluid Mechanics and Thermodynamics of the Czech Technical University in Prague is one of leading Czech scientific and research institutions in the field of continuum mechanics. Besides lectures on subjects in bachelor, master and doctoral study programmes the department is engaged above all in research and development in the field of applied mechanics of fluids (typically in aeronautical and automotive applications), heat transmission (in power engineering and automotive applications), thermodynamics (namely in cooperation with the 1st Faculty of Medicine, Charles University in Prague) and in the issue of supersonic flow.

At present the capacity of the department is devoted to education (20%), cooperation with industry (40%) and activities associated with research projects funded by various grant agencies (mainly by the Technology Agency of the Czech Republic [TAČR]) (40%).

The staff of the department participated in a number of research projects funded both from public sources (namely grants from national and European programmes) and from private sources within the scope of cooperation with the application sphere. In recent years cooperation with industrial partners was elevated from a domestic level to an international one. The department thus ranks in many fields on an at least European level.

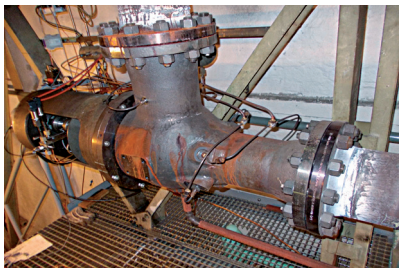


"Scientists try to get acquainted with the world whilst an engineer strives to create a new one."

Prof. Ing. Jiří Nožička, CSc.
Head of Department

Cooperation with industry

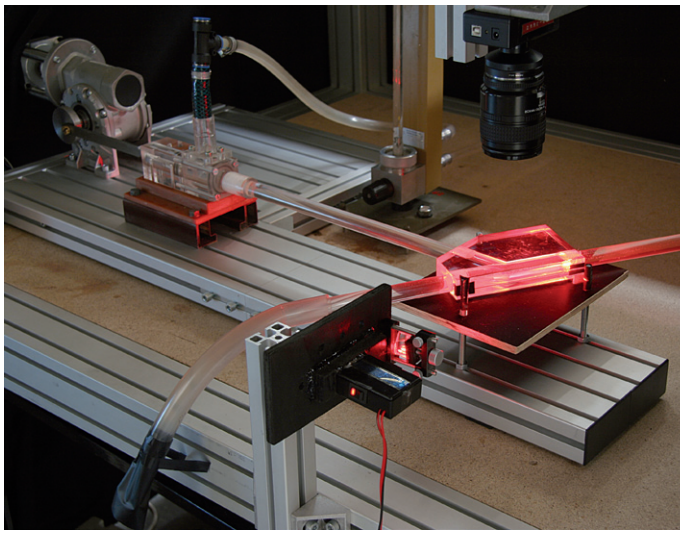
We cooperate with:
Škoda Auto, J.S.C.,
FANS, J.S.C.,
Brentwood Industries, Inc.
Intecha, Co.Ltd.,
NET4GAS, Co.Ltd.
LOM Praha s.e.
and a number of other firms.



Hemodynamics

Our department in cooperation with the 1st Faculty of Medicine, Charles University is engaged for a long period of time in research in the field of hemodynamics (blood flow dynamics). In this field the team namely focuses on research in the flow of blood in specific sections of the blood vessel (stenosis, bifurcation, vascular accesses).

The laboratory is equipped with an experimental stand for modelling transient state flow and instrumentation for the measurement of pressure losses, shear stress on walls and systems for the optical measurement of speed.



Department Inventory

From the viewpoint of instrumentation the department is equipped with several aerodynamic tunnels with a variety of parameters:

- Low-speed aerodynamic tunnel (AT) with a working space of 0.75x0.55 m
- Air-conditioned AT with a working space of 0.75x0.55 m and temperature control in the range 20°C-60°C
- Small AT for detector calibration
- AT for research in blade cascades at a maximum speed exceeding 80 ms^{-1}
- System of pressure vessels for a supersonic tunnel, etc.
- AT of the Eifell type with a 1.1 m diameter working space and speed up to 40 ms^{-1}

A number of experimental stands for research in the field of cooling of industrial systems:

- Model cooling tower (size: 1.5x1.5x4m) for the measurement of thermodynamic properties of cooling fill sheets
- Microcooler for testing finned tubes of dry exchangers
- Model hybrid cooling tower
- Air and water system with exhaust of air to the outside of the building and a heated elevated tank.

Facilities for research in water sources:

- 2 water channels 2x2x12m
- Water tank 4x4x6m with optical access (ports) from walls and bottom of tank

A number of systems for research applying state of the art experimental methods:

- Two professional PIV systems which enable 3D PIV
- TR-PIV for the measurement of nonstationary velocity patterns in fluids and gases
- System for the measurement of magnitude and speed of transparent spherical particles (IPI)
- System for measurement with a heated wire (CTA).

The department also has a small prototype workshop and several CNC machine tools which enables production of simpler but geometrically complicated units.

For numerical calculations the department has freely accessible software tools, e.g. OpenForm and also a commercially licenced programme file Fluent 13 Matlab software with a number of toolboxes, designing software Autodesk Inventor, Thermoflow programme, etc. The department also has its own computer centre with processors Intel Xeon X5680 3.33 12MB/1333, 48GB main storage memory, etc.

External and Internal Aerodynamics

In the field od external and internal aerodynamics the staff of the department is engaged mainly in applications in aeronautical and automotive industry. Attention, however, is also paid to power engineering - namely to the field of renewable sources, where issues are investigated related with concepts and optimization of rotors for water and wind power plants. Within the scope of the first of the above fields investigation is focused both on wing profiles of classical design and profiles of flexible wings (design used typically in powered parachutes – PPC). In the field of classical wing profiles in recent years a project was investigated of an aerodynamic flying test-bed. The main target of the project was to create a platform for a variety of aerodynamic measurements. An airplane with a span of 3.5m and 20kg mass is equipped with a recording device which can record flight data such as the aircraft position, speed, altitude and bank. Flight can either be controlled in a stabilized mode, when the plane is controlled by the pilot from the earth or in a fully automatic flight mode when the plane follows a pre-planned flight path. For measurement the flying test-bed is equipped with wing-end extensions and measuring technique which can measure the pressure distribution along the investigated profile.

In the field of the second of the above categories which deals with the development of flexible wings in cooperation with a leading Czech producer of powered parachutes the project was investigated of a remote controlled powered parachute which enabled testing of parachute wings up to a ratio 1:2.5.

Another sphere of research in the field of aeronautical applications in which the department is engaged for a long time is the issue of the design and optimization of airplane propellers of small up to medium sizes. A software programme was created which made it possible to design and optimize airplane propellers, and an airplane propeller test room was established for the measurement of static thrust. Optimization calculations of the shape of wind power plant blades of classical design can also be included in this category.

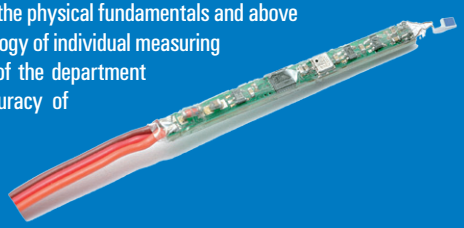
In research and development in the field of automotive industry the department cooperates for a long period of time with Škoda Auto, J.S.C. namely in the field of internal dynamics of the engine compartment.

Measurement Technology

The staff of the department is engaged for a long period of time in the development of its own measurement technologies. The essential part of every experiment is a set of tools which makes it possible to observe processes which are currently proceeding in the given experiment. Usually these tools are measuring and detecting appliances.

Since microelectric development is directly incorporated within the unit of fluid mechanics it is possible to react flexibly to topical requirements of the performed experiments. Often this requires an authorial approach (patents, etc.) and development of measuring devices based on new physical principles. During the existence of the team engaged in the development of measuring technologies at the department a number of unique measuring devices and measuring procedures were developed which are now subject to patenting.

Detailed understanding of the physical fundamentals and above all of the particular technology of individual measuring devices enabled the rest of the department staff to improve the accuracy of measurements performed in individual experiments considerably.



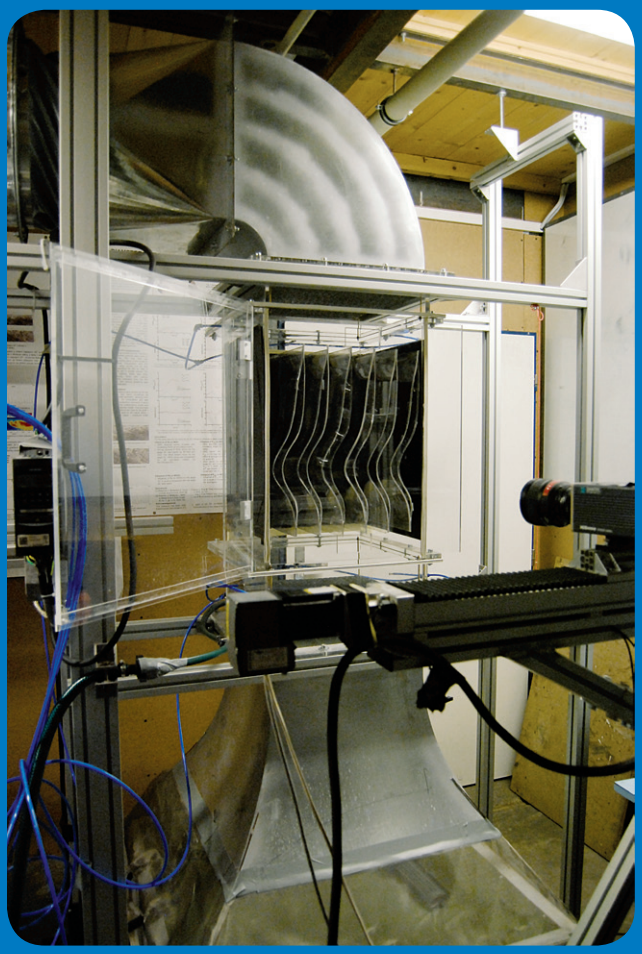
Power Engineering and Combined Heat and Power Production (HPP)

The staff of the department is also engaged in the field of power engineering and combined heat and power production.

Within the scope of these engagements in the period 2006-2012 the Department was the principal contractor of Research Centre 1M (funded by the Czech Ministry of Education, Youth and Sports) called "Advanced Technologies and Systems for Power Engineering" and in 2012 also of the Centre of Competence "Advanced Technologies for the Production of Heat and Electricity" (TPHE). Both above projects associate 4 leading Czech Technical Universities. The Centre of Competition in addition to these research and development institutions includes also 9 representatives from the application sphere.

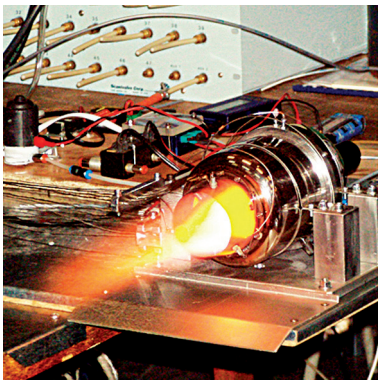
One of the main fields of research the Centre TPHE and within the scope of the Centre also the Department of Fluid Mechanics and Thermodynamics of the Faculty of Mechanical Engineering of the Czech Technical University in Prague is engaged in for a long period of time is the field of cooling namely for power engineering industry and combined heat and power production industry. The share of residual lowpotential heat due to the demand for a constantly growing amount of energy, related with the unceasing industrial development of mankind, is still growing. Effective and environmentally friendly heat removal is therefore one of the priorities of contemporary science and technology. In spite of the fact that cooling towers, as we know them now, are used since the 19th century, their efficiency can still be increased on the basis of thorough knowledge of all processes which occur in such units. The department due to its historically given orientation is exceptionally equipped both materially and theoretically and is therefore able to investigate even most complex issues from the field of cooling using its own sources. Due to previously investigated projects and extensive economic activities the department staff can use experimental stands, measuring and computer technologies necessary for the investigation of a large number of technical issues in the field of classical, so-called wet cooling, dry cooling, hybrid cooling and at present the most dynamically developing field called "Water Recovery Systems" (WRS – systems which can reduce the consumption of complementary water in classical cooling towers with forced draft and simultaneously eliminate the steam plume which is considered by the lay public to be one of the worst effects associated with the production of electric energy).

At present in the field of cooling, e.g. the issue is investigated of the rain zone in cooling towers (zone below the cooling fill sheets) which constitute in terms of performance about 20% of that of the whole cooling tower. From the results of research performed at the department it appears that thanks to numerical and experimental simulations carried out at the department, this performance can be nearly doubled whithout complicated adaptations of the cooling tower construction. At present the department also has a unique experimental stand which enables measurement of parameters of cooling fill sheets in a 1:1 geometrical scale with a thermal balance consistency accuracy of up to 3%. Parameters of classical film and splash fill sheets can be measured on this stand. The latter ones are at present used predominantly on the rapidly developinng Asian markets. At present among proceeding investigations are: optical measurement of drift eliminator efficiency in cooling towers, measurement of spray nozzle characteristics or experimental assessment of heat transmission in tube nests of exchangers of dry cooling towers.



Numerical Modelling

Owing to the high complexity of experimental research in all the mentioned fields, it is appropriate to use, besides experimental procedures, also the results of numerical simulations.

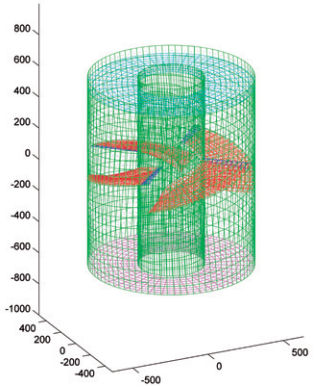


Numerical simulations of issues concerning flow, transfer of heat and mass are at present a strong and accessible tool which makes it possible to gain further insight into the investigated issues.

Numerical solutions can also serve as tools for the analysis of existing components, at present they play an irreplacable role above all in testing new concepts and also in tasks dealing with geometrical optimization.

The Department of Fluid Dynamics and Thermodynamics has long-term experience in the application of tools of computer fluid dynamics in research, both in projects of basic and applied research and direct cooperation with the application sphere.

At present mathematical models are created of evaporative cooling in context with open circuit cooling towers.



Presently Investigated Projects

- Advanced Technologies for Production of Heat and Electricity
- Research and Development of the Design of Distributing, Cooling and Transportation Systems for Data Centres
- Elimination of Steam Plumes in Cooling Towers
- Centre for Research in Multiphase Flow and Thermodynamic Phenomena in the Field of Renewable Sources and Power Engineering