

Czech Society for the Properties of Water and Steam

Annual Report 2022

Submitted to IAPWS Executive Committee, November 2022

Steering board of CZPWS

Chair: Tomáš Němec (Institute of Thermomechanics of the Czech Academy of Sciences - IT CAS, nemec@it.cas.cz), Vice-Chair: Josef Šedlbauer (Technical University of Liberec), Secretary: Jan Hrubý (IT CAS), Member: Radim Mareš (University of West Bohemia), Member: Milan Sedlář (SIGMA Research and Development Institute).

CZPWS Meetings

Annual meeting of the CZPWS was held on June 15, 2022. The form of the meeting was hybrid. CZPWS members were informed about the activities of CZPWS Chair and approved CZPWS Financial Statements. Until 2021, payment of CZPWS Member Due to IAPWS was provided from a national grant led by T. Němec. This grant ended. CZPWS became a member of the Council of Scientific Societies of the Czech Republic (CSSCR). Member fee for 2022 and future CZPWS Member Dues to IAPWS will be paid based on the CZPWS membership in CSSCR.

New steering board of CZPWS was elected for period 2023-2027: Jan Hrubý (chair), Milan Sedlář (vice-chair), Ondřej Bartoš (scientific secretary), Vladimír Majer (member), Adam Nový (member).

RESEARCH ACTIVITIES

Calibration of vibrating tube densimeters using the IAPWS standards

Experimentalists from IT CAS in Prague continued in measurement of density of various fluids using accurate vibrating tube densimeters (VTD). A calibration technique for highly sensitive commercial instrument Anton Paar DMA 5000 M operated at 0.1 MPa was developed based on the comparison with the IAPWS-95 equation of state for water and the IAPWS G8-10 guideline for humid air [1]. The uncertainty of the liquid density was thoroughly analyzed together with other aspects influencing the quality of obtained data such as the relation between fluid viscosity and damping, the isotopic composition of the calibration water, the measurement procedure covering VTD cleaning and filling, and the effect of water contained in samples. The high-pressure VTD Anton Paar DMA HP is currently being brought into operation [7]. Both densimeters are intended for accurate measurement of density of aqueous solutions.

Surface tension and vapor pressure of supercooled water

Recent work on surface tension of supercooled water at University of West Bohemia in Pilsen was reported by R. Mareš and J. Kalová [5]. J. Kalová also published a study of the vapor pressure of supercooled water [6].

Cavitation

The problems studied in the SIGMA Research and Development Institute and the Centre of Hydraulic Research in the period of June 2021 – June 2022 have been related mainly to the modelling of cavitation erosion during the hydrodynamic cavitation and models of cavitation instabilities. In cooperation with the Institute of Physics of the Czech Academy of Sciences, a new cavitation erosion stand has been used to test cavitation resistance of steel samples treated with LSP. In cooperation with the Moscow Power Engineering Institute, the Technical University of Liberec and the Wuhan University, the experimental and numerical modelling of unsteady cavitation phenomena in water has continued in the framework of internal grant projects. The experiments and numerical simulations have concentrated on the thermal effects of cavitation and on the influence of surface hydrophobicity on cavitation phenomena [2]. The Centre of Hydraulic Research in cooperation with the Palacky University in Olomouc finished a new hot-water stand for testing high-performance pumps at the temperatures up to 190 °C, maximum pressure up to 40 bar and power input up to 11 MW. In cooperation with the Institute of Thermomechanics of the Czech Academy of Sciences and the Czech Technical University in Prague, experimental and numerical modelling of unsteady multiphase flow has continued, taking into account the interface of water and air [3], [4].

Publications

1. Prokopová O., Blahut A., Čenský M., Součková M., Vinš V.: Comments on temperature calibration and uncertainty estimate of the vibrating tube densimeter operated at atmospheric pressure, *J. Chem. Thermodynamics* 173 (2022) 106855.
2. Sedlář M., Komárek M., Šoukal J., Volkov A.V., Ryzhenkov A.V., Druzhinin A.A., Grigoriev S.V., Kachalin G.V, Kalakutskaya O.V.: Experimental and Numerical Studies into the Cavitation Impact of the Hydrofoil Surface with Different Treatments. *Thermal Engineering*, 69 (2022), 418-428. doi: 10.1134/S0040601522060064
3. Furst J., Halada T., Sedlář M., Krátký T., Procházka P., Komárek M.: Numerical analysis of flow phenomena in discharge object with siphon using lattice-Boltzmann method and CFD. *Mathematics*, 9 (2021), 1734. doi: 10.3390/math9151734
4. Uruba V., Procházka P., Sedlář M., Komárek M., Duda D.: Experimental and Numerical Study on Vortical Structures and their Dynamics in a Pump Sump. *Water* 2022, 14(13), 2039; doi.org/10.3390/w14132039
5. Kalová J., Mareš R., Temperature Dependence of the Surface Tension of Water, Including the Supercooled Region, *Int. J. Thermophysics*, 43, 10 (2022), doi.org/10.1007/s10765-022-03077-
6. Kalová J, Vapor Pressure of Supercooled Water, *Int. J. Thermophysics*, s (2022) 43: 165, doi.org/10.1007/s10765-022-03095-w

Conference Proceedings

7. Olga Prokopová, Miroslav Čenský, Aleš Blahut, Václav Vinš: *Design and testing of the supporting setup for the high-pressure vibrating tube densimeter*, EPJ Web of Conferences 264 (2022) 01033.

Ing. Jan Hrubý, CSc.
Scientific secretary of CZPWS