Czech Society for the Properties of Water and Steam

2018 Annual Report

Submitted to IAPWS Executive Committee in Prague, Czech Republic, September 2018

Because of a change of legislation, the Czech National Committee for the Properties of Water and Steam (CZNCPWS) was replaced by the Czech Society for the Properties of Water and Steam (CZPWS) by the end of 2017. On the contrary to CZNCPWS, which has been one of numerous committees embedded in the structure of the Czech Academy of Sciences, CZPWS is a standalone legal entity (Registered Association). All active members of the former CZNCPWS became CZPWS members. The seat of CZPWS is again the Institute of Thermomechanics of the Academy of Sciences of the Czech Republic (IT CAS) in Prague.

Steering board of CZPWS

Chair: Tomáš Němec (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

CZPWS was established at a constituent meeting on October 27, 2017, at IT CAS. Here, the CZPWS Statutes have been adopted. Consequently, the legal status of a Registered Association has been approved on December 4, 2017.

The first annual meeting of the CZPWS was held on June 20, 2018. Strategies to ensure CZPWS funding have been adopted. Activities of IAPWS WGs have been discussed. A significant activity was organizing the 17th ICPWS in Prague.

RESEARCH ACTIVITES

Surface tension of supercooled water was studied at IT CAS in Prague and at the University of West Bohemia (UWB) in Pilsen.

Measurements of pure water under supercooled conditions conducted at IT CAS were finalized [1]. The measurements with the horizontal capillary tube imitating original method employed by P.T. Hacker [NACA TN 2510 (1951)] did not confirm the second inflection point anomaly down to -23 °C. The new data are in good agreement with the previous measurements conducted with the capillary rise technique employed in the extrapolation of the IAPWS standard [Hrubý et al., J. Phys. Chem. Lett. 5 (2014) 425 and Vinš et al., J. Phys. Chem. B 119 (2015) 5567]. The experimental apparatus has been further modified and is being used for the measurements of supercooled aqueous mixtures. Preliminary data for the surface tension of binary mixtures of water with methanol, ethanol, and propanol were presented at the international conference EFM 2017 [6]. Currently, the new measurements with supercooled seawater are carried out in order to verify extrapolation of the seawater correlation by

Nayar et al. [J. Phys. Chem. Ref. Data 43 (2014)] in the supercooled region. For the needs of the task group, V. Vinš wrote an internal report “Surface tension of seawater at low temperatures including supercooled region down to −25 °C”.

At UWB, R. Mareš continued in surface tension measurements in the supercooled region down to -32°C (mentioned in Kyoto 2017). J. Kalová and R. Mareš tested a new equation for the surface tension of water (results will be presented in Prague, ICPWS17th in Prague). J. Kalová and R. Mareš also published a work on the mean field equation of state for supercooled water [7].

At IT CAS, additional measurements for the density of supercooled water have been performed and a new data set on the density of supercooled seawater has been recorded [8].

In an international collaboration of the Ruhr-Universität Bochum, the Technische Universität Dresden and IT CAS, a thermodynamic model for eight pure gas hydrates relevant mostly for CCS (Carbon Capture and Storage) applications was successfully extended to hydrate mixtures. The complex phase equilibrium algorithms developed for various fluid phases, gas hydrates, and pure solid phases (ices) were thoroughly revised in order to model multicomponent systems with mixed hydrates. The results were published in Fluid Phase Equilibria [5] and presented at a German national conference [9].

Researchers from IT CAS (J. Hrubý, M. Duška, T. Němec) and M. Kolovratník from the Czech Technical University in Prague published a study on nucleation in steam and water vapor – carrier gas mixtures, including data from steam nozzles, turbines, classical nucleation data, and molecular simulations, including own simulations with TIP4P/2005 force field [2]. A team from the Institute of Chemical Process Fundamentals and IT CAS finalized a study of nucleation in mixtures of sulfuric acid and water vapors using a new experimental method [3].

At SIGMA Research and Development Institute and the Centre of Hydraulic Research, M. Sedlář and coworkers were developing models of cavitation erosion during the hydrodynamic cavitation and models of cavitation instabilities in hydrodynamic pumps [10]. In cooperation with ITCAS, the Moscow Power Engineering Institute, the Technical University of Liberec, and the Wuhan University, experimental and numerical modelling of unsteady cavitation phenomena in water has continued in the framework of internal grant projects. Recent research is devoted to the influence of real water properties including the content of undissolved air on the pressure pulses excited by cavitation [4].

At Doosan Škoda Power, P. Rudasová was concerned with the implementation of IAPWS guidelines for operating blocks. The implementation of IAPWS Technical Guidance Documents in Czech power plants is difficult, most personnel adhere to outdated national technical standards.

Publications

1. Vinš V., Hošek J., Hykl J., Hrubý J.: *Surface tension of supercooled water: Inflection point-free course down to 250 K confirmed using a horizontal capillary tube*, J Chem Eng Data 62 (2017) 3823-3832.
2. Hrubý J., Duška M., Němec T., Kolovratník T.: *Nucleation rates of droplets in supersaturated steam and water vapour–carrier gas mixtures between 200 and 450K.* J Power and Energy 232 (2018) 536–549.
3. Trávníčková T., Škrabalová L., Havlica J., Krejčí P, Hrubý J., Ždímal V. *Laboratory study of H2SO4/H2O nucleation using a new technique – a laminar co-flow tube*, Tellus B Chem Phys Meteorol 70 (2018) 1446643.

4. Sedlar, M., Soukal, J., Komarek, M., Volkov, A.V. and Ryzhenkov, A.V.: *Numerical Simulation of Interaction between Fluid and Vapor Structures in Multiphase Flow around Hydrofoil*. Journal of Applied Mathematics and Physics, 2018, under review
5. Hielscher S., Vinš V., Jäger A., Hrubý J. Breitkopf C., Span R.: *A new approach to model mixed hydrates*, Fluid Phase Equilibria 459 (2018) 170-185.

Conference Presentations

6. Vinš V., Hykl J., Nikl Z., Čenský M., Hrubý J.: *Surface tension of aqueous binary mixtures under the supercooled conditions – Development of the measuring technique and preliminary data for water + lower alcohols*, international conference Experimental Fluid Mechanics 2017, Mikulov (Czech Rep.), November 21-24, 2017.
7. Kalová J., Mareš R.: *Mean-Field Equation of State of Supercooled Water and Vapor Pressure Approximations*, AIP Conference Proceedings 1889, 020016 (2017)
8. A. Blahut, M. Duška, J. Hykl, P. Peukert, V. Vinš, M. Čenský, J. Hrubý, *Dual-Capillary Apparatus for Accurate Density Measurements of Supercooled Water*, Twentieth Symposium on Thermophysical Properties, Boulder (CO, USA), June 24-29, 2018.
9. Hielscher S., Jäger A., Vinš V., Breitkopf C., Hrubý J., Span R.: *Modellierung gemischter Gashydrate konsistent zu vielparametrigen Zustandsgleichungen*, Thermodynamik Kolloquium 2017, Dresden (Germany), September 27-29, 2017.
10. Sedlář, M.: *Cavitation phenomena in balancing drums of high-performance feed pumps.* PCC/PCAS/IRS Joint WG Meeting and Workshop, IAPWS Meeting, Kyoto, 2017.