REPORT

on IAPWS-related activities: August 2012 – August 2013

submitted by the

Czech National Committee for the Properties of Water and Steam (CZ NC PWS)

to the Executive Committee Meeting of 2013 IAPWS Meeting, London, United Kingdom in September 2013

National Committee Contacts

CZ NC PWS
Institute of Thermomechanics AS CR, v. v. i.
Dolejškova 1402/5, 182 00 Praha
Czech Republic
Fax: +420 2858 4695
E-mail: secr.czncpws@it.cas.cz
Committee Chairman: Dr. Jan Hrubý (hruby@it.cas.cz)

Participating institutions

The following Czech Institutions have participated in the research of thermophysical properties and chemical processes between August 2012 and August 2013:

Institute of Thermomechanics AS CR, v. v. i., ("IT ASCR"), Department of Thermodynamics, Dolejškova 1402/5, CZ-182 00 Praha 8

Czech Technical University in Prague ("CTU"), Faculty of Mechanical Engineering, Department of Fluid Mechanics and Thermodynamics, and Department of Power Engineering, Technická 4, CZ-166 07 Praha

Institute of Chemical Technology, Prague ("ICT"), Department of Power Engineering ("ICT-DPE") and Department of Physical Chemistry ("ICT-DPC"), Technická 5, CZ-166 28 Praha 6

University of West Bohemia ("UWB"), Faculty of Mechanical Engineering, Department of Power System Engineering, Univerzitní 8, CZ-306 14 Plzeň

DOOSAN ŠKODA POWER, Plzeň, Inc., Tylova 57, CZ-316 00 Plzeň

Technical University of Liberec ("TUL"), Department of Chemistry, CZ-461 19 Liberec

SIGMA Research and Development Institute Ltd. ("SIGMA"), Jana Sigmunda 79, CZ-783 50 Lutín

---

Funding

The activities described below were sponsored by the Grant Agency of the Academy of Sciences of the Czech Republic (GAAV ČR), the Czech Science Foundation (GAČR), DOOSAN ŠKODA POWER, Ministry of Education, Youth and Sport of the Czech Republic (MŠMT), and Ministry of Industry and Trade of the Czech Republic (MPO).

Board of CZ NC PWS for 2010-2013:

Dr. J. Hrubý
Prof. R. Mareš
Dr. T. Němec
Prof. P. Šafařík
Prof. J. Šedlbauer

List of IAPWS-Related Activities

Information about new documents adopted and authorized by IAPWS have been published on the CZ NC PWS website.

The joint project of IT ASCR and UWB sponsored by the Ministry of Education, Youth and Sports of the Czech Republic provided financial support for international collaboration with IAPWS since 2009. The project support ended on 31/12/2012.

The joint project of IT ASCR and TUL sponsored by the Ministry of Education, Youth and Sports of the Czech Republic provided financial support for international collaboration with IAPWS since 2013. The project support will end on 31/12/2016.

The team around Dr. Hrubý and Dr. Vinš (IT ASCR) focused on the development of thermodynamic models for gas hydrates (in joint cooperation with the team of prof. Roland Span from the Ruhr-University Bochum), experimentally investigated surface tension of supercooled water, developed of an experimental apparatus for the measurement of density of supercooled water and developed thermodynamic formulations suitable for computational fluid dynamics [1-7].

Prof. Mareš (UWB) and Dr. Kalová studied thermophysical properties of supercooled water [8]. Dr. Kalová has a research project entitled Thermodynamic modeling of supercooled water.

Prof. Maršík (IT ASCR) and his research team studied problems of the efficiency of hydrogen fuel cells [9-12] and a new hydraulic turbine [13, 14].

Prof. Šedlbauer (TUL) and his collaborators investigated thermodynamic properties of hydration for selected organic solutes and gases [15, 16].

Assoc. Prof. Kolovratník (CTU) and his collaborators investigated wet steam energy losses in LP steam turbines and determined heterogeneous particles in the superheated steam in turbines [17, 18].

Mr. Nový (DOOSAN ŠKODA POWER) and his collaborators studied parameters of shock waves in saturated steam [19-21].

Dr. Sedlář (SIGMA) and his collaborators studied the problems of modelling cavitation erosion in hydrodynamic cavitation [22], [23], and modelling of cavitation instabilities in hydrodynamic pumps [24]. The team collaborates on the project entitled "Experimental research and mathematical modelling of unsteady phenomena induced by hydrodynamic cavitation" funded by the Czech Science Foundation

In September 2012, the Institute of Chemical Technology in Prague, the Faculty of Environmental Technology and the Department of Power Engineering (ICT-DPE) organized the 10th International Power Cycle Chemistry Conference (CHEO-10) focused on water treatment for power and environment, corrosion in power engineering and renewable energy sources [25-31].

Dr. Hnědkovský (ICT-IPC) and his collaborators studied the properties of organic solutes in water [32-36].

Prof. Šťastný (UWB) and his co-workers tested and applied a numerical model of steam flow with and without chemical impurity in nozzles and turbine blades [37-39].

IAPWS Young Scientist Fellowships

In 2012, **Dr. Holten** completed his IAPWS Young Scientist Fellowship Project (exchange between the Czech Republic and USA) entitled "Towards an IAPWS Guideline for the Thermodynamic Properties of Supercooled Water" jointly supervised by Dr. Hrubý, Prof. Anisimov, and Dr. Sengers. The preliminary results were presented and discussed during the 2012 IAPWS Meeting in Boulder. The final Project Report will be presented during the 2013 IAPWS Meeting in London.

References

[1] Jäger, A., Vinš, V., Gernert, J., Span, R., Hrubý, J.: Phase Equilibria with Hydrate Formation in H_2O + CO_2 Mixtures Modeled with Reference Equations of State, Fluid Phase Equilibria, 338, pp. 100-113, 2013

[2] Vinš, V., Hrubý, J., Hykl, J., Blaha, J., Šmíd, B.: Design of an Experimental Apparatus for Measurement of the Surface Tension of Metastable Fluids, EPJ Web of Conferences 45, 01094, 2013

[3] Duška, M., Hrubý, J.: Re-Evaluation of Experimental Data on the Second Virial Coefficient for Steam and Development of Its Analytical Representation as a Function of the Internal Energy, EPJ Web of Conferences. 45, 1024, 2013

[4] Jäger, A., Vinš, V., Gernert, J., Span, R., Hrubý, J.: Phase Equilibria with Hydrate Formation in H_2O + CO_2 Mixtures Modeled with Reference Equations of State, In : 18th Symposium on Thermophysical Properties, Boulder, 2012

[5] Jäger, A., Vinš, V., Gernert, J., Span, R., Hrubý, J.: An Accurate and Consistent Description of Hydrates in H_2O + CO_2 Mixtures, In : Thermodynamik-Kolloquium, Potsdam, 2012

[6] Vinš, V., Hrubý, V., Hykl, J., Blaha, J., Šmíd, B.: *Design of an Experimental Apparatus for Measurement of the Surface Tension of Metastable Fluids*, In : Experimental Fluid Mechanics, Proceedings of Conference, Hradec Králové, 2012

[7] Duška, M., Hrubý, J.: *Re-Evaluation of Experimental Data on the Second Virial Coefficient for Steam and Development of Its Analytical Representation as a Function of the Internal Energy*, In : Experimental Fluid Mechanics, Proceedings of Conference, Hradec Králové, 2012

[8] Kalová, J., Mareš, R.: Vapor Pressure of Supercooled Water. In : 12th conference on Power System Engineering, Thermodynamics and Fluid Flow – ES 2013, Pilsen, 2013

[9] Pavelka, M., Maršík, F.: Detailed Thermodynamic Analysis of Polymer Electrolyte Membrane Fuel Cell Efficiency, International Journal of Hydrogen Energy, Vol. 38, pp. 7102-7113, 2013

[10] Maršík, F., Novotný, P., Pavelka, M.: Role of Water Diffusivity in PEM for the Hydrogen Fuel Cell Efficiency. In : 2013 Zing International Hydrogen & Fuel Cells Conference, Silverado Resort, 2013

[11] Pavelka, M., Maršík, F.: Detailed Thermodynamic Analysis of Polymer Electrolyte Membrane Fuel Cell Efficiency. In : 12th Joint European Thermodynamics Conference, Brescia, 2013

[12] Maršík, F., Němec, T., Pavelka, M.: Enhancement of Hydrogen Fuel Cell Efficiency by the Control a Water, IAPWS Meetings 2012, Boulder, 2012

[13] Beran, V., Sedláček, M., Maršík, F.: A New Bladeless Hydraulic Turbine, Applied Energy 104, pp. 978–983, 2013

[14] Falta, J., Maršík, F.: A Rolling Turbine SETUR – Theoretical Analysis. (in Czech) In : Contemporary Trends of Pumping Technology Development, Scientific-Technology Conference, Lutín, 2013

[15] Pourtier, E., Ballerat-Busserolles, K., Majer, V., Sedlbauer, J.: Standard Molar Volumes and Heat Capacities of Aqueous Solutions of Sodium Trifluormethanesulfonate at Temperatures up to 573 K and Pressures to 28 MPa, Journal of Chemical Thermodynamics, Vol. 57, pp. 416-429, 2013

[16] Sedlbauer, J.: Group Additivity in High-Temperature Aqueous Solutions : How to Account for Proximity Effects?, presentation at the IAPWS Meeting 2012, Boulder, Colorado, 2012

[17] Petr, V., Kolovratník, M.: Wet Steam Energy Loss and related Baumann Rule in the 1000 MW Nuclear and 210 MW Fossil LP Steam Turbines. In : Baumann Centenary Conference, Cambridge, 2012.

[18] Kolovratník, M., Hrubý, J., Ždímal, V., Bartoš, O., Jiříček, I., Moravec, P., Zíková, N.: Measurements of Heterogeneous Particles in Superheated Steam in Turbines. In : Baumann Centenary Conference, Cambridge, 2012.

[19] Nový, A., Jícha, D., Šafařík, P., Hajšman, M.: On Parameters of Shock Waves in Saturated Steam, pp. 43-43. In : Topical Problems of Fluid Mechanics 2013, Proceedings, Praha, 2013

[20] Nový, A., Šafařík, P., Jícha, D., Hajšman, M.: On Flow Parameters of Normal Shock Waves in Saturated Steam. In : 12th conference on Power System Engineering, Thermodynamics and Fluid Flow – ES 2013, Pilsen, 2013

[21] Jícha, D., Nový, A., Šafařík, P., Hajšman, M.: Entropy Analysis of Theory of Normal Shock Waves in Saturated Steam, pp. 211-214. In : SKMTaT, Proceedings of Conference, Tatranská Lomnica, 2013

[22] Zima, P., Sedlář, M.: Modelling Bubble Collapse Aggressiveness in Traveling Bubble Cavitation Using Bubble Breakup Model, In : Proceedings of 8th International Symposium on Cavitation (CAV2012), #209, Singapore, 2012.

[23] Sedlář, M., Komárek, M., Vyroubal, M., Müller, M.: Experimental and Numerical Analysis of Cavitation Flow around a Hydrofoil. EPJ Web of Conferences, 25, 01084, DOI: 10.1051/epjconf/20122501084, 2012.

[24] Sedlář, M., Zima, P., Bajorek, M., Krátký, T.: CFD Analysis of Unsteady Cavitation Phenomena in Multistage Pump with Inducer. IOP Conferene Series: Earth and Environmental Science, 15, 062024, DOI:10.1088/1755-1315/15/6/062024, 2012.

[25] Vošta, J., Janda, V.: Power Engineering Should Use Environment-Friendly Energy, pp. 148-150. In : CHEO09, Proceedings (CD-ROM), Prague, 2012 (in Czech)

[26] Hásl, T., Žemlová, T., Jiříček, I.: Influence of Structure of Organic Substances with Phase Change on Their Termoacumulative Properties, pp. 156-161. In : CHEO09, Proceedings (CD-ROM), Prague, 2012 (in Czech)

[27] Vošta, J., Janda, V.: Corosion and Anticorosion Protection of Metals in Aqueous Surrounding, pp. 177-185. In : CHEO09, Proceedings (CD-ROM), Prague, 2012 (in Czech)

[28] Jiříček, I., Rudasová, P., Žemlová, T., Hrubý, J.: Less Known Components of Layers and Seats of Steam-Liquid Water Cycles, pp. 186-191. In : CHEO09, Proceedings (CD-ROM), Prague, 2012 (in Czech)

[29] Chalabala, J., Sajdl, P., Stodola, J., Vošta, J., Macák, J.: Influence of Hydrogen Carbonate Ion on Oxygen Corrosion of Steel, pp. 254-259. In : CHEO09, Proceedings (CD-ROM), Prague, 2012 (in Czech)

[30] Renčiuková, V., Macák, J., Sajdl, P., Novotný, R., Vrtílková, V.: Corosion of Zirconium Alloys in VVER Setting, pp. 278-285. In : CHEO09, Proceedings (CD-ROM), Prague, 2012 (in Czech)

[31] Dzurus, M., Petrů, J., Sajdl, P.: Dependence of Properties of Oxide Layers on Zirconium Alloys, pp. 294-301. In : CHEO09, Proceedings (CD-ROM), Prague, 2012

[32] Katrinak, T., Hnedkovsky, L., Cibulka, I.: Partial Molar Volumes and Partial Molar Isentropic Compressions of Three Polyhydric Alcohols Derived from Propane at Infinite Dilution in Water at Temperatures T = (278 to 318) K and Atmospheric Pressure, Journal of Chemical and Engineering Data, Vol. 57, No. 4, pp. 1152-1159, 2012

[33] Simurka, L., Cibulka, I., Hnedkovsky, L.: Partial Molar Isentropic Compressions and Partial Molar Volumes of Selected Branched Aliphati Alcohols at Infinite Dilution in Water at Temperatures from T = (278 to 318) K and Atmospheric Pressure, Journal of Chemical and Engineering Data, Vol. 57, No. 5, pp. 1570-1580, 2012

[34] Dohnal, V., Rehak, K.: Thermal and Volumetric Properties of Four Aqueous Aroma Compounds at Infinite Dilution, Journal of Chemical and Engineering Data, Vol. 57, No. 6, pp. 1822-1828, 2012

[35] Hollas, D., Svoboda, O., Chmela, J., Slavicek, P.: Photodynamics of water Elicited by Ionizing Radiation : a Molecular View, Chemicke listy, Vol. 106, No. 10, pp. 936-944, 2012

[36] Rehak, K., Moravek, P., Strejc, M.: Determination of Mutual Solubilities of Ionic Liquids and Water, Fluid Phase Equilibria, Vol. 316, pp. 17-25, 2012

[37] Šťastný, M., Šejna M.: Condensation of Steam with Sodium Chloride Impurity in a Turbine Cascade, In : Baumann Centenary Wet Steam Conference, CD-ROM, Cambridge, 2012

[38] Šťastný, M., Šejna, M., Synáč, J., Šimka, Z.: Condensation of Steam with Chemical Impurity in a Turbine, In : Turbomachinery, Fluid Dynamics and Thermodynamics, Conference Proceedings, Lappeenranta, 2013

[39] Šťastný, M., Šejna, M.: Condensation of Water Steam with and without Chemical Impurity in a Nozzle, Journal of Physical Science and Application, No. 3, 2013