BIAPWS Annual Report to IAPWS for 2008

BIAPWS Committee

The BIAPWS Committee has continued to develop in 2008. Three BIAPWS committee meetings have been held since the IAPWS Meeting in Lucerne, with typical attendance of around fifteen members. The number of BIAPWS sponsors now stands at seventeen - an increase of one, Camlab Ltd, in the last year.

Following on from its introduction in 2007, BIAPWS has continued to host technical presentations and discussions immediately prior to BIAPWS committee meetings. There has been a noticeable increase in attendance at committee meetings as a result. The discussions provide a useful forum for updating information and exchanging views on a number of topics. In the last year, these have included the conversion and application of oxygenated treatment to drum boilers, methods and procedures for water/steam circuit storage, and decomposition of ion exchange resins. The opportunity is also taken for sponsors to bring members other than their BIAPWS representative to the meeting to benefit from and contribute to the discussions.

The BIAPWS committee is looking into ways that it can improve its representation in areas of interest to TPWS, IRS and PCAS whilst still maintaining its important role as a representative body for Power Plant Chemistry in the UK and Ireland.

Finally, there has been an election of officers in 2008, and BIAPWS would like to express its gratitude to Dr. Richard Harries and Mr. Malcolm Ball, who have stepped down from their roles as Chairman and Secretary respectively, for their time and dedication to the organisation of BIAPWS.

BIAPWS Award

The BIAPWS Award is given annually by BIAPWS to qualifying students as a means of promoting awareness of the topics of interest to BIAPWS. In 2008 the BIAPWS award is co-sponsored by E.ON Engineering. The award recipient is Joe Hook, who is currently studying for a Masters Degree in Physics at the University of York. The Award is given in the form of contributory funding by BIAPWS for a work experience placement for the student. Joe is spending three months working on a range of projects at E.ON's Technology Centre at Ratcliffe-on-Soar near Nottingham.

The BIAPWS Award recipient from 2007, Rochelle Green, gave an excellent presentation of her Award placement at Barking Power Station, entitled "Biocide induced corrosion in closed circuit cooling systems", at the 10th BIAPWS Symposium. Rochelle has since gone on to full time employment in power plant chemistry with one of the BIAPWS sponsors, demonstrating a significant success for the Award.
BIAPWS has also supported a further educational initiative in 2008, sponsoring and judging prizes for energy related projects at a schools science fair in Hinckley, Leicestershire.

BIAPWS Symposium

The 10th BIAPWS Symposium, 'Progress in Environmental and Cycle Chemistry', took place at the Village Hotel, Nottingham, on April 10th 2008. This was preceded by a half day

workshop on April 9th. Two sessions were held in the Symposium: 'Environmental Issues in Power Plants' and 'Flexibility in Cycle Chemistry', whilst two sessions were also held in the workshop, on cycle chemistry instrumentation and waste water in power cycles. This proved to be another successful meeting, with sixty delegates attending the Symposium and thirty delegates attending the workshop. A summary report of the meeting was published in Power Plant Chemistry **10** (May 2008) 274-277. In response to feedback from delegates, BIAPWS aims to host the Symposium on an annual basis commencing in 2009, compared to the current frequency of approximately every eighteen months.

BSI Representation

BIAPWS continues to represent the power industry on the BSI committee dealing with standards for power cycle chemistry, ie BS-EN 12952: 12 and BS-EN12953:10. Through its original initiative to review these standards BIAPWS has engaged the European members of IAPWS to make representations to CEN via their own national committees.

In 2008, BIAPWS has also joined the BSI committee with responsibility for the administration of ISO 5667 – Water Quality, Sampling. BSI has joined this committee with the aim of supporting a revision to Part 7 of this standard: 'Guidance on sampling water and steam in boiler plants'. BIAPWS is liaising with IAPWS PCC working group in this activity.

Canadian National Committee of IAPWS

2008 Annual Report
IAPWS Meeting, Berlin, September 7-12, 2008

Executive: *Peter Tremaine (Chair); David Guzonas (Secretary Treasurer); Igor Svischev (Past Chair); Derek Lister (Member at Large); CANDU Owners Group Representative (Ian Hey).*

1. Canadian National Committee: Dues for the Canadian National Committee of IAPWS are supported by the National Research Council of Canada. This arrangement requires support and participation by a national association representing industry. For the past three years, this role has been taken on by the CANDU Owner's Group ("COG"), on a trial basis. We are pleased to report that COG has agreed to accept this responsibility for a five year term, which began in 2007 and includes travel support for the CNC and organization of an annual meeting to provide liaison with the electric power industry. COG has been supportive and proactive in supporting the CNC since this arrangement was put in place. The COG member of the Canadian National Committee is Ian Hey.

2. University Network of Excellence in Nuclear Engineering (UNENE). Since 2004, the Canadian government and nuclear industry have co-funded an initiative to create a number of NSERC University Research Chairs which will form a research network, and a common postgraduate MSc program in nuclear engineering. Companies are: Atomic Energy of Canada Ltd., Ontario Power Generation, Bruce Power, and the CANDU Owners Group. The first chairs come up for renewal next year. The Chairs relevant to IAPWS are listed below, along with related NSERC Industrial Chairs that form part of the network, with one-on-one funding by companies:

$ **Roger Newman (University of Toronto):** Corrosion, materials performance, electrochemistry in primary and secondary coolant

$ **Dave Shoesmith (University of Western Ontario):** Electrochemistry, materials performance and corrosion for high-level nuclear waste repositories.

$ **Clara Wren (University of Western Ontario):** Radiolysis and radiation chemistry under nuclear reactor primary-coolant conditions and reactor accident scenarios.

$ **Derek Lister: (University of New Brunswick, Associate Member of UNENE)** Primary and secondary coolant chemistry, activity transport, corrosion.

Canadian researchers are also involved with UNENE as members of universities who are associate members in UNENE. In water-chemistry, the faculty member is:

$ **Peter Tremaine: (University of Guelph, Associate Member):** Solution thermodynamics, phase relations, and solubility in sub-critical and super-critical water; also D_2O isotope effects under CANDU-PHW conditions.

3. Atomic Energy of Canada Limited (AECL)

AECL provides the major Canadian Government R&D capabilities for CANDU reactor development, most of which takes place at Chalk River Laboratories. Water chemistry support for the CANDU 6 and other CANDU designs, and R&D for the new Generation III Advanced CANDU Reactor (ACR) 1000 reactor is carried out by the Reactor Chemistry and Corrosion, and Component Life Technology Branches (CRL):

$ **Dave Guzonas (Atomic Energy of Canada Ltd.)** Section Head, Heat Transport System and Core Chemistry. Materials performance and chemistry control in primary side circuits.

A new program to develop the Generation IV Supercritical-Water-Cooled Reactor concept was announced in July. This includes funding for 10-15 university research projects by Natural Resources Canada, NSERC and AECL, some of which are expected to be of direct interest to IAPWS. Dr. Guzonas will act as industrial lead and co-ordinate the chemistry and materials projects in this program.

4. Other Research Relevant to IAPWS

Other researchers with active programs in high-temperature water chemistry are:

$ **Igor Svischev (Trent University):** Molecular simulations of high temperature aqueous systems
$ **Vladimiros Papangelakis (University of Toronto)** Hydrometallurgy of pressure-leach processes involving nickel, cobalt, copper and zinc ores.
$ **Paul Percival (Simon Fraser University):** Muonium ion chemistry and radiolysis in sub-critical and super-critical water using the TRIUMF cyclotron national facility.
$ **Alan Anderson (St. Francis Xavier University);** Solubility and phase relations in supercritical water using diamond anvil cell methods.

5. IAPWS Collaborations:

The Canadian Committee has two ongoing international collaborations. One is with the Czech National Committee (Tremaine, University of Guelph; and Sedlbauer, University of Liberec). Czech PhD student, Jana Ehlerova, started at Guelph in July, and the work is progressing well. The results of her previous IAPWS project, reported last year, were published as:

$ **Spectrophotometric Determination of the Ionization Constants of Aqueous Nitrophenols at Temperatures up to 225°C**, J. Ehlerova, L.N. Trevani, J. Sedlbauer and P.R. Tremaine, *J. Solution Chem.* **37**, 854-857 (2008).

A further international collaboration among Lister (University of New Brunswick), Svoboda (formerly Alstom, Switzerland) and Daucik (Dong Energy, Denmark) has been successfully

completed. The UNB student, Piti Srisukvatananan, spent time at a fossil power plant in Denmark and a nuclear plant in Switzerland, gathering information on high-pressure, high-temperature sampling systems, and then simulating typical sampling systems with a commercial CFD code. The results were presented in a report to IAPWS and published as a paper in the proceedings of ICPWS XV:

- **Corrosion Product Sampling in Power Plants under Water/Steam Cycle Conditions.** P. Srisukvatananan, D.H. Lister, C-E. Ng, R. Svoboda and K. Daucik. *Proc. 15th ICPWS, Berlin, Germany,* Sept. 7-11 (2008).

Further needs of such sampling systems have been identified and a proposal for further collaboration is being prepared.

6. Canadian National Committee Executive for 2009 and 2010

The executive for 2009 and 2010 is: David Guzonas (Chair); Derek Lister (Secretary Treasurer); Peter Tremaine (Past Chair); Member at Large (to be elected): CANDU Owners Group Representative (Ian Hey).

Peter Tremaine, CNC Chair
September 12, 2008

The Czech National Committee

International Association for the Properties of Water and Steam

REPORT on IAPWS related activities – August 2007 / August 2008

Submitted to the EC Meeting of IAPWS, Berlin – September 2008.

National Committee Contacts:

CZ NC PWS, Institute of Thermomechanics AS CR, v.v.i., Dolejškova 5, 182 00 Prague 8,
Czech Republic, Fax: + 420 2858 4695, E-mail: secr.czncpws@it.cas.cz
Head: Dr. Jan Hruby, E-mail: hruby@it.cas.cz

Following Institutions participated in the research into the thermophysical properties and chemical processes:

Institute of Thermomechanics (IT) AS CR, v.v.i., Department of Thermodynamics, Dolejskova 5, CZ-182 00 Prague 8.

Czech Technical University in Prague (CTU), Faculty of Mechanical Engineering, Department of Fluid Mechanics and Power Engineering, Technicka 4, CZ-166 07 Prague 6.

Technical University Brno (TU), Faculty of Mechanical Engineering, Energy Institute, Department of Power Engineering and Department of Thermodynamics and Environmental Engineering, Technicka 2, CZ-616 69 Brno.

Institute of Chemical Technology Prague (ICT), Power Engineering Department (ICT-IE) and Department of Physical Chemistry (ICT-IPC), Technicka 5, CZ-166 28 Prague 6.

University of West Bohemia (UWB), Faculty of Mechanical Engineering, Department of Power System Engineering, Univerzitni 8, CZ-306 14 Plzen.

SKODA POWER, Plzen, Inc., Tylova 57, CZ-316 00 Plzen.

Nuclear Research Institute, plc. (NRI), Rez, CZ-250 68 Rez.

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

SIGMA Research and Development Institute, Jana Sigmunda 79, CZ-783 50 Lutin.

Activities were sponsored by the Grant Agency of the Academy of Sciences and Grant Agency of the Czech Republic, SKODA POWER Plzen, Ministry of Education, Youth and Sport of the Czech Republic, and Ministry of Industry and Trade of the Czech Republic.

- Dr. Hruby (IT) with his collaborators, in collaboration with A. Harvey of NIST (USA), developed a formulation of thermophysical properties of liquid water at atmospheric pressure. The formulation was described in a draft of a Supplementary Release to be adopted in Berlin 2008.
- Dr. Hruby (IT) led the Evaluation Task Group of the proposal of “Release on the IAPWS Formulation for the Thermodynamic Properties of Seawater” by R. Feistel.
- Prof. Mares (UWB) with his collaborators took part at evaluation reports. Refs. [1 to 3] and contributed on data on thermal conductivity of water, on behaviour of super-cooled water, and on thermodynamic properties of water and steam. Refs. [5 to 7]
- Prof. Marsik (IT) coordinated research in the metastable states, nucleation and development of a new model of cavitation erosion potential. Refs. [7 to 9].

- Prof. Sedlbauer (TUL) and his team collaborated with team of Prof. Tremaine (Canada) and investigated the ionization constants of aqueous nitrophenols. Refs [10 to 11, 22].
- Research activities at the (CTU) continued in further improvement of the knowledge on following subjects: Determination of the particles in the super-heated steam using a new sampling technique, Refs. [12, 17]. Measurement of the electrostatic charge of water droplets during wet steam expansion Refs. [13 to 14]. Humidification of compressed and aftercooled air in the evaporative gas turbine cycle, Ref. [15].
- The activities of the SIGMA Research and Development Institute solved problems of erosion effects of cavitation bubbles on the blades of water pumps and the problems of the effect of water properties on cavitation phenomena. Refs. [7 to 9, 16].
- Dr. Jiricek (ICT-IE) with collaborators investigated corrosion processes and chemical effects in water and steam systems of power plants. Refs. [17 to 20].
- ICT-IE will organize the 7th International Power Cycle Chemistry Conference (CHEO 7), held from 11th to 12th September 2008.
- Dr. Hnedkovsky (ICT-IPC) with collaborators investigated properties of organic solutes in water. Published articles and conference contributions are under Refs. [21 to 29].
- Prof. Stastny (SKODA POWER) with co-workers studied effects of condensation of flowing steam with nucleation in salt solution zone and surface structure of artificial roughness on experimental blades, and collaborated in frame of the IAPWS ICRN 22. Refs. [30 to 33].

Young Scientists IAPWS Fellowships

- J. Ehlerova finished the 2007 Young Scientist IAPWS (CZ-Canada) Project "Predictive Scheme for Standard Thermodynamic Properties of Aqueous Substituted Benzenes over a Wide Range of Temperatures and Pressures" under supervising of Prof. J. Sedlbauer, and Prof. P. R. Tremaine. The project had two main objectives:
  - to develop the extended group contribution scheme by simultaneous treatment of all available standard thermodynamic data for nitro- and phenolate aqueous systems,
  - to supplement the existing scarce experimental results available on these aqueous systems at high temperatures by measurements of the ionization constants of isomeric nitrophenols to 250°C using hydrothermal indicators and UV-VIS spectroscopy.

  Her Final Report was submitted to EC IAPWS. The publication of the fellowship holder is in Ref. [10].
- J. Ehlerova performs her Young Scientist IAPWS (CZ-Canada) Project "Equilibrium Constants and Speciation of Aqueous Transition Metal Chlorocomplexes over a Wide Range of Temperatures and Pressures" under supervising of Prof. J. Sedlbauer, and Prof. P. R. Tremaine. The purpose of the collaborative project with IAPWS is to measure and model stepwise formation constants for the copper (II) chloride complexes at temperatures from 75 to 250°C. The low end of this range will provide thermochemical data needed for process design and optimization of the reactor and heat exchanger. The higher

temperature data are of fundamental value for steam generator design, both for the SCWR and more conventional power stations.
The Final Report of the Project will be finished by the end of the year 2008.

References:

[1] Revised Release on the Pressure along the Melting and Sublimation Curves of Water.

[2] Supplementary Release on Properties of Liquid Water at 0.1 MPa.

[3] Revised Release on the IAPWS Formulation for the Thermal Conductivity.

[4] Konas P.: *Contribution onto Problems of Heat Conductivity of Ordinary Water Substance*, pp.73-80. (in Czech). In: Proceedings of Power System Engineering, Thermodynamics & Fluid Flow, University of West Bohemia, Pilsen, 2008.

[5] Kalová J., Mares R.: *Super-Cooled Water,* pp.109-112. (in Czech). In: Proceedings of XXVIIth Meeting of Departments of Fluid Mechanics and Thermomechanics, University of West Bohemia, Pilsen, 2008.

[6] Mares R., Kalová J.: *New Data on Thermophysical Properties of Water and Steam,* pp.129-134. (in Czech). In: Proceedings of Power System Engineering, Thermodynamics & Fluid Flow, University of West Bohemia, Pilsen, 2008.

[7] Zima P., Sedlar M., Marsik F.: *Improved Model for Prediction of Cavitation Damage in Water Pumps*. In: Proceedings of 11th International Conference on Developments in Machinery Design and Control, Cerveny Klastor, 2007.

[8] Sedlar M., Zima P. and Marsik F.: *The Effect of Water Properties on Cavitation in Hydromachinery*. Presentation ICPWS Meeting 2007, Luzern, 2007.

[9] Zima P., Sedlar M., Marsik F., Muller M.: *Modelling of Cavitation Erosion in Water Pumps*. In: Proceedings of Fifth International Conference on Transport Phenomena in Multiphase Systems, Bialystok, 2008 (to be published).

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[13] Bartos O.: *A Study of Electrostatic Charge of Droplets during Expansion in Steam Nozzle and Low-Pressure Part of Steam Turbine,* PhD Thesis, CTU, Prague, 2008.

[14] Bartos O., Petr V.: *A Study of Electrostatic Charge of Droplets during Expansion of Wet Steam,* pp. 15-20. In: Proceedings of XXVIIth Meeting of Departments of Fluid Mechanics and Thermomechanics, University of West Bohemia, Pilsen, 2008.

[15] Zidova L.: *Analysis and Optimization of Gas Turbine Cycle with Evaporation Humidification of Air*, PhD. Thesis, CTU, Prague, 2008.

[16] Sedlar M., Zima P., Komárek, M.: *Cavitation Tunnel and Its Integration into Closed Experimental Loop in SIGMA R&D*, pp.99-105. (in Czech). In: Proceedings of Conference Developments in Pumping Technology, Lutin, 2008.

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[18] Jiricek I., Diblikova L.: *Aluminum Protection with Conductive Polymers*, ChemZi 1/3 (2007)**,** Institute of Chemistry, SAS, Tatrianské Matliare (in Czech).

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[30] Stastny M., Sejna M.: *Condensation of Flowing Steam with Binary Nucleation of NaCl and Water,* pp.313-320, In: Applied and Computational mechanics, Vol.1, No.1, University of West Bohemia, Pilsen, 2007.

[31] Šťastný M., Šejna M.: *Condensation of Flowing Steam with Nucleation In Salt Solution Zone*, IAPWS PCC Meeting, Lucerne, 2007.

[32] Šťastný M., Šejna M.: *Condensation of Flowing Steam with Nucleation in Salt Solution Zone,* Power plant Chemistry, Vol.9, 2007, No.10, pp.582-586.

[33] Stastny M.: *ICRN 22 Steam Chemistry in Turbine Phase-Transition Zone*. IAPWS PCC Meeting, Lucerne, 2007.

German National Committee to IAPWS

Research Activities on the Thermodynamic Properties of Water and Steam

Report "Research in Progress 2008"

Baltic Sea Research Institute, Warnemünde, Germany, Dr. rer. nat. habil. R. Feistel

1. Preparation of Draft Release “Seawater”:
   R. Feistel (proposer)
   Release on the IAPWS Formulation 2008 for the Thermodynamic Properties of Seawater
   The International Association for the Properties of Water and Steam
   Berlin, Germany, September 2008

2. Preparation of the background paper of the “Seawater Release”:
   R. Feistel,
   A Gibbs Function for Seawater Thermodynamics for -6 °C to 80 °C
   and Salinity up to 120 g/kg
   Deep-Sea Research I, doi: 10.1016/j.dsr.2008.07.004, in press

3. Publication regarding salinity definition:
   Millero, F.J., Feistel, R., Wright, D.G., McDougall, T.J.
   The Composition of Standard Seawater and the Definition of the Reference-Composition
   Salinity Scale
   Deep-Sea Research I, 55(2008) 50-72

4. Complementary paper for the new seawater properties standard:

   R. Feistel, D.G. Wright, K. Miyagawa, J. Hruby, D.R. Jackett, T.J. McDougall, W. Wagner:
   Development of Thermodynamic Potentials for Fluid Water, Ice and Seawater:
   A New Standard for Oceanography
   Proceedings ICPWS Berlin 2008, accepted

   R. Feistel, D.G. Wright, K. Miyagawa, J. Hruby, D.R. Jackett, T.J. McDougall, W. Wagner:
   Development of Thermodynamic Potentials for Fluid Water, Ice and Seawater:
   A New Standard for Oceanography
   Ocean Science Discussion 5(2008)375-418
   www.ocean-sci-discuss.net/5/375/2008/

   Feistel, R.: Thermodynamics of Water, Vapour, Ice and Seawater.
   Accreditation and Quality Assurance, 2008, accepted

   Trevor J. McDougall, Rainer Feistel , Frank J. Millero , Brian A. King ,
   Daniel G. Wright , David R. Jackett , Giles M. Marion , Chen-Tung Arthur
   Chen , Petra Spitzer:
   Improved seawater thermodynamics: How should the proposed change in salinity be implemented?
   DGM-Mitteilungen 3-4/2007, S.2-7
   CLIVAR Exchanges 45, Vol. 13, No. 2, 27-29, 2008

   Rainer Feistel, Stefan Weinreben
   Is Practical Salinity conservative in the Baltic Sea?
   OCEANOLOGIA, 50 (1), 2008, 73-82.
   http://www.iopan.gda.pl/oceanologia/50_1.html#A6

5. Contribution to the Preparation of Revised Advisory Note No. 3
   Hans-Joachim Kretzschmar, Rainer Feistel (proposers)
   Revised Advisory Note No. 3,
   Thermodynamic Derivatives from IAPWS Formulations

The International Association for the Properties of Water and Steam
Berlin, Germany, September 2008

6. Preparation of 15th ICPWS, liaison with SCOR / IAPSO-WG127, preparation of the WG127 meeting

7. ICRN 16:
Feistel, R.: (proposer)
IAPWS Certified Research Need
Thermophysical Properties of Seawater
http://www.iapws.org/icrn/ICRN16.pdf

University of Applied Sciences Zittau/Görlitz, Faculty of Mechanical Engineering, Department of Technical Thermodynamics, Prof. Dr.-Ing. habil. H.-J. Kretzschmar

1. Supplementary Backward Equations $v(p,T)$ for Region 3 of IAPWS-IF97
   - The comprehensive article on the backward equations $v(p,T)$ was submitted to the "Journal of Engineering for Gas Turbines and Power"

2. Thermodynamic Derivatives from IAPWS Formulations
   - A revision of the "Advisory Note No. 3 Thermodynamic Derivatives from IAPWS Formulations" with extended contents was prepared.

3. Development of Fast Property Algorithms Based on Spline Interpolation
   - A fast spline-interpolation method was developed and applied to the calculation of thermodynamic properties of steam.

4. Thermodynamic Properties of Humid Air
   - The research project "Thermodynamic Properties of Real Moist Air, Dry Air, Steam, Water, and Ice" of the American Society of Heating, Refrigerating, Air-Conditioning Engineers (ASHRAE) was investigated.

Recent Publications

- Wagner, W., Kretzschmar, H.-J., International Steam Tables, Springer, Berlin (2008)
- Kretzschmar, H.-J., Stöcker, I., Mollier *h-s* Diagram for Water and Steam, Springer, Berlin (2008)
- Kretzschmar, H.-J., Cooper, J. R., Dittmann, A., Friend, D. G., Gallagher, J. S., Harvey, A. H., Knobloch, K., Mareš, R., Miyagawa, K., Okita, N., Span, R., Stöcker, I., Wagner, W., and Weber, I., Supplementary Backward Equations $p(h,s)$ for the Critical and Supercritical Regions (Region 3), Equations for the Region Boundaries, and an Equation for the Two-Phase Region of the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam, Journal of Engineering for Gas Turbines and Power, Vol. 129 (2007) p. 1125-1137
- Kretzschmar, H.-J., Kraft, I., Kleine Formelsammlung Technische Thermodynamik, first and second Editions, Carl Hanser, Munich (2007)
- Kretzschmar, H.-J., Chapter 8 Technische Thermodynamik, In: Hering, E.; Modler, K.-H. Grundwissen des Ingenieurs, 14. Edition. Carl Hanser, Munich (2007)

Ruhr University Bochum, Germany, Faculty of Mechanical Engineering, Department of Thermodynamics, Prof. Dr.-Ing. W. Wagner

1. IAPWS-95 formulation

   – To bring some of the numerical information given in the release on IAPWS-95 in consistency with the results obtained when using the coefficients with 14 significant figures (the current results are based on the coefficients with 12 figures), the following values were recalculated: Pressure at the triple point, the coefficients n_1^0 and n_2^0 of Table 2 and last digits of a few calculated values in Tables 6-8

   – A suggestion for the corresponding editorial changes was made.

2. Revised Release for the melting pressure and the sublimation pressure of ice Ih

   – Some calculations were carried out to bring the melting-pressure equations for ice Ih and ice III into a better consistency with each other at the triple point ice Ih-ice III-liquid.

   – A draft revised release on the pressure along the melting and sublimation curves of ordinary water substance was prepared.

3. The manuscript of the book on the industrial formulation IAPWS-IF97 were completed. In the meantime the book was published. The reference of this book reads:

   Wagner, W., Kretzschmar, H.-J. International Steam Tables – Properties of Water and Steam Based on the Industrial Formulation IAPWS-IF97. Springer-Verlag, Berlin, 2008.

International **A**ssociation **f**or **t**he **P**roperties **o**f **W**ater **a**nd **S**team

Russian National Committee

Report of Russian National Committee (2008)

List of Publications

1. The Effect of Heat Flux on the Rate of Iron and Copper Corrosion Product Deposition in Boilers. *T.I. Petrova, V.I. Kashinskii, V.N. Semenov, V.V. Makrushin, A.E. Verkhovslii, P.A. Nikolaev and R.B. Duli Thermal Engineering vol. 55 No. 7, 2008*
2. Assessment of Efficiency of High-Temperature Filters Used for Reducing Exposure Dose Rate Received from the Equipment of the Primary Circuit. *V.F. Tyapkov, L.P. Khamyanov and N.B. Povalishin Thermal Engineering vol. 55 No. 7, 2008*
3. Determination of Phosphate Concentration in Boiler Water using Conductivity Measurements *B.M. Larin, E.N. Bushuev, Yu. Yu. Tikhomirova and S.V. Kiet Thermal Engineering vol. 55 No. 7, 2008*
4. Improvements in the Procedure for Design of Boiling-Type Evaporators for Highly Mineralized Media *A.S. Sedlov, Yu. A. Kuzma-Kitcha, I.P. Il'ina, E.O. Kon'kov and A.V. Lavrikov Thermal Engineering vol. 55 No. 7, 2008*
5. Steam-Oxygen and Steam-Water-Oxygen Methods for Cleaning, Passivation and Conservation of Power Engineering Equipment *N.N. Man'kina, A.A. Gol'din and A.A. Stolyarov Thermal Engineering vol. 55 No. 7, 2008*
6. Experience from Using AV-17-8 Anionite in Mixed-Bed Filters *D.V. Shevelev and O.M. Vladenkova Thermal Engineering vol. 55 No. 7, 2008*
7. The Influence of Filmformation Amines on Brass Corrosion Rate in Condenser Cooling Systems. *Petrova T.I., Repin D.A., New in Russian electroenergetics, No 8, 2008*

8. Some General Features of Phase Behavior for Ternary Sub- and Supercritical Mixtures with One Volatile Component. *Valyashko V.M. Presentations for the 13th International Symposium om Solubility Phenomena and Related Equilibrium Processes, July 27-31 (2008), Dublin, Ireland*
9. Na2CO3 Solubility Behavior in Ternary Hydrothermal Systems with Various Salts of Type 1. *Urusova, M.A.,Presentations for the 13th International Symposium om Solubility Phenomena and Related Equilibrium Processes, July 27-31 (2008), Dublin, Ireland*
10. Phase diagram of the system K2SO4-K2HPO4-H2O in a range of supercritical fluid heterogenization. *Urusova, M.A., Valyashko, V.M. Zh.Neorgan.Khimii, v.53, n.4, pp.660-672 (2008)*
11. Finding the values of steam properties with Mathad. *A.A. Alexandrov, V.F. Ochkov, K.A. Orlov and A.V. Ochkov. PTC Express. P. 1 -8, no 4.*
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13. The calculation and visualization of thermohysical properties 0f water and steam in Internet. *V.F. Ochkov, A.A. Alexandrov, K.A. Orlov and A.V. Ochkov A.A. New in Russian electroenergetics, 2008, No 9.*
14. Annual scientific session of the International Association on the Properties of Water and Steam (IAPWS). *A.A. Alexandrov, T.I. Petrova, V.F. Ochkov, D.S. Smetanin. Thermal engineering, 2008, No 7, P. 621-622*
15. Steam tables and diagrams on Mathcad Calculation Server for personal computers, pocket computers and smart phones. *V.F. Ochkov, A.A. Alexandrov, K.A. Orlov. Paper on ICPWS XV*
16. Experimental investigations of superheated and supercooled water. (A review of papers of the school of the academician V.P. Skripov). *V.G. Baidakov. Paper on ICPWS XV*

17. Heterogenization of supercritical fluids in ternary water-salt systems. *V.M. Valyashko Paper on ICPWS XV*
18. Effect of Water Chemistry on deposition Rate Iron Corrosion Products in Boiler Tubes. *T. I. Petrova, V.I. Kashinsky, N.R. Isianova, B. Dooley Paper on ICPWS XV*
19. Behaviour of Aluminium Corrosion Products in Water-Steam Cycle Power Plant. *T.I. Petrova, P.A. Nikolaev Paper on ICPWS XV*

U.S. National Committee to IAPWS
2008 Report on Activities of Potential Interest to IAPWS

Communicated from The Pennsylvania State University, University Park, PA:
The Energy Institutes' Electrochemical Laboratory (S.N. Lvov) at Penn State University continues to work in fundamental and applied areas on a variety of electrochemical and materials science studies related to traditional and renewable energy conversion systems. We lead interdisciplinary studies on electrochemistry of high-temperature aqueous systems in a number of scientific areas including electrochemical corrosion measurements, proton exchange membrane and solid oxide fuel cells, surface electrochemistry, etc. The key publications in 2007-2008 are as follows:

1. Lvov S.N. Electrochemical Techniques for Studying High Temperature Subcritical and Supercritical Aqueous Systems, in "Encyclopedia of Electrochemistry" (A. Bard, M. Stratmann, D.D. Macdonald, Eds.), Vol. 5, 2007, Wiley-VCH, pp. 723-747.
2. Zhou Z. F., Kumar, R., Thakur S. T., Rudnick L. R., Schobert H., Lvov S. N. Direct Oxidation of Waste Vegetable Oil in Solid-Oxide Fuel Cells, *Journal of Power Sources*, 2007, **171**, 856-860.
3. Chalkova E., Fedkin M. V., Komarneni S., Lvov S. N., Nafion/Zirconium Phosphate Composite Membranes for PEMFC Operating at up to 120 ^{o}C and Down to 13% RH. *J. Electrochemical Soc.,* 2007, **154**, B288-B295.
4. Gong Y., Yeboah Y.D., Lvov S.N., Balashov V., and Wang Z., Fe-Modified, Pt-Based Cathodic Electrocatalysts for Oxygen Reduction Reaction with Enhanced Methanol Tolerance, *J. Electrochemical Soc.,* 2007, **154**, B560-B565.
5. Engelhardt G. R., Biswas R., Ahmed Z., Lvov S. N., Macdonald. D. D., The Use of Channel Flow Cells for Electrochemical Kinetic Studies in High Temperature Aqueous Solutions, *Electrochim. Acta*, 2007, **52**, 4124-4131.
6. Zhou Z.F., Chalkova E., Lvov S.N., Chou P., and Pathania R. Development of a Hydrothermal Deposition Process for Applying Zirconia Coatings on BWR Materials for IGSCC Mitigation. *Corrosion Science,* 2007, **49**, 830-843.
7. Z. Zhou, E. Chlkova, S. N. Lvov, and P. H. Chou, *Hydrothermal Deposition of Zirconia Coatings on Pre-Oxidized BWR Structural Materials*, NACE Corrosion 2007, Paper #07414.
8. Balashov V.N., Fedkin M.V., Lvov S.N., and Dooley, B., Experimental system for electrochemical corrosion studies in high temperature aqueous solutions, NACE Corrosion, 2007, Paper #07403.
9. Z. Zhou, E. Chlkova, S. N. Lvov, and P. H. Chou, Hydrothermal Deposition of Zirconia Coatings on Pre-oxidized BWR Structural Materials, *J. of Nuclear Materials* (in press).
10. Rodriguez-Santiago, V., Fedkin, M.V., and Lvov, S.N., Study of The Electrochemical Step of Novel Active Metal Alloy Thermochemical Cycles for Hydrogen Production, *Electrochem. Soc. Trans*. (in press).
11. Fedkin, M.V., Chalkova, E., Wesolowski, D.J., Lvov, S.N., Understanding the Water Retention of Composite PEMs Based on Surface Chemistry of Inorganic Fillers, *Electrochem. Soc. Trans*. (in press).
12. Balashov, V.N., Fedkin, M.V., Lvov, S.N., Dooley, B., Experimental System for Studying Interfacial Electrochemistry at Temperature above 300 ^{0}C, *Electrochem. Soc. Trans*. (in press).
13. Chung, T.C., Zhang, Z., Chalkova, E., Wang, C., Fedkin, M.V., Komarneni, S., Sharma, S., and Lvov, S.N., Proton Conductive Composite Materials Using Functionalized and Crosslinkable VDF/CFTE Fluoropolymers and Proton Conductive Inorganics, *Electrochem. Soc. Trans*. (in press).

Communicated from the National Institute of Standards and Technology, Boulder, CO:
A collaboration is continuing with Prof. Richard Wheatley at the University of Nottingham, developing intermolecular pair potentials for aqueous systems for the quantitative calculation of second virial coefficients. Results for the water-carbon-monoxide binary have been obtained and a publication is in preparation. These results, along with previous results for water-hydrogen and literature data for water-CO_2, were used in performing vapor-liquid equilibrium calculations for water with synthesis gas at conditions that might be encountered in advanced power cycles.
Reference: Harvey, A.H., *Thermodynamic Data to Support High-Temperature Syngas Quench Design: Vapor-Liquid Equilibrium Calculations*, NISTIR 6654 (National Institute of Standards and Technology, Boulder, CO, 2008).

In collaboration with workers in Greece and Germany and at the University of Maryland, work is continuing on the joint IAPWS and IUPAC efforts to update the formulations for the transport properties of water and steam. The correlating surface for viscosity has been completed and a paper is being prepared for publication in *J. Phys. Chem. Ref. Data*. Work is well underway on the thermal conductivity.

NIST's Experimental Properties of Fluids group has designed and is building apparatus for two projects to measure thermophysical properties of aqueous gas mixtures at high temperatures. One apparatus is a high-temperature (up to 770 K) magnetic-suspension densimeter, which will be used to measure H_2O-N_2 and H_2O-CO_2 mixtures of interest for understanding the thermodynamics of combustion gases. An existing high-temperature thermal conductivity apparatus (using the transient hot-wire technique) is being converted to alternating-current operation (needed for polar fluids like water) in order to measure the thermal conductivity of H_2O-N_2 and H_2O-CO_2 mixtures at similar conditions (up to 750 K).

Communicated from Jonas, Inc., Wilmington, DE (www.steamcycle.com)**:**
Jonas, Inc. is working on the following projects related to IAPWS interests:
1. Effects of Corrosion Inhibitors on Corrosion of the Nuclear Component Cooling Water Piping Long term (over 20000 hrs) corrosion and SCC testing of four corrosion inhibitors - carbon steel base metal and welds. EPRI project.
2. Effects of Airborne Impurities on Corrosion of Gas Turbine Compressors Continuous measurement of the transport of airborne salts and acids from their sources (sea shore, cooling tower) to the GT compressor surfaces. Effects of weather, relative humidity, air filtration. Continuous long time measurement of the corrosion rate, surface conductivity, and weather parameters.
3. Development of a Moisture/Carry-over Monitor Two types of Moisture Monitors are being developed: separator based and heater based. The separator based monitor has been used in several PWR secondary systems.
4. Selection of the Piping material for the ITER Tokamak 500 MW Experimental Fusion Reactor Oak Ridge/Battelle project in which 316L ss and neutral water treatment with elevated oxygen and partial flow Powdex were recommended. Unresolved items include radiolysis in the neutron zone, corrosion and FAC of Cu and CuCrZr, crevice corrosion, and the effects of strong magnetic fields on corrosion, deposition, and piping stresses vs. delta ferrite.
5. Measurement of Separation of Water from Natural Gas An instrument which measures size distribution of water droplets in natural gas has been developed and used to determine efficiency of separators on a N. Sea platform, in piping, and in a lab.