THE INTERNATIONAL ASSOCIATION FOR THE PROPERTIES OF WATER AND STEAM

MEMBERS
Britain and Ireland
Canada
Czech Republic
Germany
Japan
Russia
Scandinavia (Denmark, Finland, Norway, Sweden)
United States of America

ASSOCIATE MEMBERS
Argentina and Brazil
Australia
France
Greece
Italy
New Zealand
Switzerland

EXECUTIVE SECRETARY

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Minutes of the Meetings

of the

Executive Committee

of the

International Association for the Properties of

Water and Steam

Plzeň, Czech Republic
4-9 September 2011

Prepared by: Barry Dooley

IAPWS

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Minutes of the Meetings
of the
Executive Committee
of the
International Association for the Properties of Water and Steam
held in
Plzeň, Czech Republic
4-9 September 2011

Plenary Session. Monday, 5th September 2011. 8:30 am

The President of IAPWS, Daucik, welcomed the Executive Committee (EC) and other IAPWS members to Plzeň for the Executive Committee (EC) and Working Group (WG) Meetings of IAPWS. The President officially opened the 2011 EC Meetings by introducing the National Delegates. Each of the Member and Associate Member countries of IAPWS was in attendance with the exception of Argentina/Brazil, France, Greece and Italy.

The President asked the delegate of Czech Republic to provide some opening comments. Hruby welcomed everybody to Plzeň and to the 2011 IAPWS meetings. He provided some background on the Czech National Committee and recognized the sponsors for the meetings: European Social Fund, Ministry of Education Youth and Sports, City of Plzeň, TECHNOPROCUR CZ, STEAG Energy Services, and CEZ Group a.s. He then introduced a few of the events which would take place during the week: the IAPWS Symposium, the IAPWS Dinner and and the various working group meetings.

1. Adoption of Agenda

Provisional agendas had been posted on the IAPWS Website for all IAPWS members by the Executive Secretary. There were no further agenda suggestions from the EC. The agenda was then approved by the Heads of all National Delegations and forms Attachment 1 of these minutes.

2. IAPWS Business and Appointment of Committees

2.1 Releases, Advisory Notes, ICRNs and Guidance Documents

The President indicated that three documents had been circulated to the National Committees by the Executive Secretary during the year since the Niagara Falls meeting for final review prior to being approved before or during the current EC Meeting. The Executive Secretary reminded the EC of these documents:

- Technical Guidance Document: *Phosphate and NaOH treatments for the steam-water circuits of drum boilers of fossil and combined cycle/HRSG power plants*. Distributed 16th June 2011. There had been a number of minor comments which had been addressed and the document will be reviewed by the PCC working group during the week prior to approval at the Friday EC.

- Revised Release on *Pressure along the Melting and Sublimation Curves*. Distributed on 5th September 2010. The comments received before 8th October 2010 (BIAPWS) were addressed, and thus the Release was approved at that time.

- ICRN 26. Distributed 31st May 2011. Comments received from BIAPWS and Russia have been addressed. The ICRN will remain available for comment by Postal Ballot up to 1st October 2011.

The respective Working Groups will report to the EC at the Friday meeting on any further changes prior to requesting approval.

2.2 Press Release.

The President asked Bellows to develop a Press Release on the IAPWS proceedings during the week. The Clerks of Minutes from each WG were asked to provide input. The Press Release is discussed in Minute 17.1 and is Attachment 10.

2.3 Evaluation Committee on International Collaboration.

The President indicated that one proposal had been received by the Executive Secretary prior to the meeting, and that any further suggestions from WGs should be given to the Executive Secretary by the end of day. The President then reminded the EC that the Committee to review the proposals would consist of the WG Chairmen, with the President and Executive Secretary as ex. officio members. A chairman would be chosen by the Committee. The discussion of this Committee is reported in Minute 15.1.

2.4 IAPWS Awards Committees

2.4.1 Helmholtz Award Committee

The President indicated that there was a Helmholtz Awardee this year. The Executive Secretary then reminded the EC that the Helmholtz Committee for the 2012 award would consist of a member from Czech Republic, Scandinavia, Germany, Japan and Russia. The President indicated that Czech Republic would provide the committee chairman. The President asked delegate Hruby to organize the committee and to report back to the EC on Friday with the names of the members of this committee (Minute 16.1).

2.4.2 Honorary Fellow Award Committee

The Executive Secretary requested that Rukes remain on the Committee as the Chairman for 2012 and the President requested that Bignold be the other member. The IAPWS President would be ex. Officio.

2.4.3 Gibbs Award Committee

The President reminded the EC that the next Gibbs Award would be conferred at the ICPWS in 2013 and that the selection process needed to be initiated. The Working Group Chairs and Heads of National Committees can provide nominations by May 2012. A Gibbs Award committee should be selected by the Friday EC meeting. Each WG and the SCSW was asked to provide a member for the committee by that time.

2.5 IAPWS Statutes and By-Laws

The President indicated that the US National Committee had made some suggested changes to the By-Laws. These had been circulated by the Executive Secretary to the National Committees on 20th April 2011 for comment prior to the IAPWS meetings. No comments had been received so the President requested Harvey to briefly review the suggestions.

- By-Law 3.5 indicates that documents can be approved at an annual meeting of the EC provided that a final (or near final) draft has been circulated to the the members suitably far in advance (1 or 3 months depending on the document).
- By-Law 6.2 indicates that documents which have been validated by a WG and the Editorial Committee can be distributed for postal ballot. But if the validation occurs at an annual meeting, this By-Law can result in an undue delay in reaching final approval at the next EC meeting.
- The US committee suggested a change to By-Law 6.2 so that documents become official after the postal ballot, and that the date on the document would be the date of the EC meeting where the postal ballot was authorized.
- The US committee further suggested that failure to vote on a postal ballot should be recorded as an "abstain" vote and not a "yes" vote as currently indicated in By-Law 6.2.

The President thanked Harvey and the US committee, and suggested that the presentation should be provided to the National Committees present for further discussion and vote at the Friday EC Meeting. The President also mentioned that if there were other suggestions for Statutes and By-Law changes these should also be raised on Friday and that he would then assign a committee to look at the overall changes so that they can be discussed at the 2012 meetings.

2.6 International Program Committee for the 16th ICPWS

The President requested Cooper to cover this item reminding the EC that the 16th ICPWS would be discussed at the Friday EC meeting. Cooper introduced the topic by showing a draft of possible Symposia topics for the 16th ICPWS and compared this to the actual symposia conducted at the 14th and 15th ICPWS. He then indicated that he would call an International Program Committee meeting later in the week. The President reminded the EC that this committee consists of the WG and Subcommittee Chairs. Cooper requested that Tremaine and Span also join the meetings because of their experience in past ICPWS. The President requested that Cooper provide the draft program to the WG Chairs and that each should come to the meeting with suggestions from their WG of suggested topics to include in the first ICPWS flyer. These could eventually become ICPWS Symposia titles.

2.7 Link on IAPWS Website to Software

The President indicated that Niagara Falls minute 18.2 recorded that Past President Friend had formed a small committee to investigate this topic. Harvey was asked to report on activity during the last year. He first indicated that it is IAPWS policy not to produce software, but that links to outside products, including software, are already allowed if endorsed by a National Committee. The committee suggests that links to software are OK as long as it is made clear that IAPWS is not responsible for the software. The committee also suggests that each link contains a short description and a disclaimer indicating that IAPWS is not responsible for the content of the software or website. A new window will open for the software to clearly indicate that this is not an IAPWS site.

2.8 Cooperation with BIPM/CIPM

The President asked Feistel to report on this item. Feistel indicated that following an August 2011 BIPM meeting in Paris, he had drafted a letter which proposes a close cooperation between IAPWS and BIPM/CIPM. The President suggested that as such a cooperation would involve a number of the IAPWS WGs that a small committee should be formed with Feistel as Chair and Friend, Cooper, Kretschmar, Harvey and Spitzer as members. Feistel was requested to report back to the EC on Friday with a completed letter.

2.9 WG Future Activities and Mission Statements

The President reminded the EC of activities discussed at the last two IAPWS meetings and requested that each WG review their Mission Statement and confirm that it is still applicable and up to date. He suggested that each WG Chairman provide this in the WG reports on Friday.

2.10 Other business Requiring Extensive Discusssions

No other business was raised by the EC.

3. <u>EC Mandate to Working Groups and Membership</u>

The President provided the following mandates to the WG Chairmen for action during the week.

3.1 Releases, Guidelines and Certified Research Needs.

The Executive Secretary indicated that seven ICRNs had either expired already or will expire in September 2011 and thus needed attention by the WGs during the week: #10 on pH required rewriting by PCAS, #14 on humid air needed revision by TPWS, #15 on metastable steam needed rewriting by TPWS, #20 on sensors for elevated temperatures which has been revised by PCC and is ready for review, #23 on dew point of flue gases needed revision by IRS, #25 on corrosion mechanisms needed PCC to finalize, and #26 on aluminum has been finalized by PCC and is currently being reviewed by National Committees.

3.2 Working Group Directions.

The President emphasized that each WG Chairmen should only report to the EC on Friday about those activities that need approval or discussion by the EC.

4. Preview by the WG Chairmen of the Week's Activities

President Daucik requested each WG Chairman to review briefly the main topics which would be covered in their WGs during the week. The details of the WG meetings are covered in detail in Minutes 7 to 11 (Attachments 4 to 8).

The President closed the opening session of the EC at 10.03am.

Activities During the Week

The first day activities of the WGs and Executive Committee were followed by the separate and joint WG meetings and symposia on Monday, Tuesday and Thursday.

The full IAPWS program for the week is shown in Attachment 2.

The IAPWS Symposium was held on Wednesday, 7th September 2011. The overall theme was on *Water and Aqueous Mixtures: Research for Future Energy Technologies*, and the Symposium Program is shown in Attachment 3.

Executive Committee Meeting. Friday, 9th September 2011

President Daucik opened the continuation of the EC Meeting at 8:30 am. Each of the Member and Associate Member countries of IAPWS was in attendance with the exception of Argentina/Brazil, France, Greece and Italy. In total there were 27 people assembled for the EC meeting. Daucik first asked the EC if there were any additional items that should be added to the Agenda. None were suggested. The Executive Secretary showed the latest Agenda with additional items relating from the Monday EC Meeting.

5. Acceptance of Minutes of Previous Meeting

President Daucik asked for comments and changes to the minutes of the EC meeting held in Niagara Falls, Canada in July 2010. No changes were noted, thus the 2010 Minutes were accepted.

6. President's Report

President Daucik opened his report by indicating that IAPWS is a well performing organization. It has excellent technical expertise, rational organization abilities and a sound financial background. Because of these three pillars IAPWS can continue year by year to bring new valuable contributions to the industrial use of water substance and aqueous solutions. Each Working Group (WG) and and the Sub-committee on Seawater (SCSW) has produced improvements in their field:

- TPWS – Extension of the latest advanced formulation on thermodynamic properties of water and steam to a broader range of variables and systems.
- SCSW – Preparation of much needed formulations for seawater and a high activity in collaboration with other international organizations and communities.
- PCAS – Transport, hydration, and reactions related to power cycle chemistry are deepened from green chemistry viewpoint.
- PCC – The impressive rate of production of Technical Guidance Documents, which provides the basis for worldwide development of application based on scientific ground.

The WGs have revised thir Mission Statements introduced last year. These statements indicate the direction of development of their activities.

The energy industry is at the current time under great pressure from the public. The fossil section is challenged by its contribution to climate change due to carbon dioxide. The nuclear section is under great pressure due to public opinion after the accident in Japan.

The improvement of efficiency is thus even more important than before and the IAPWS work in this aspect is of high importance. Water and steam will continue to be the most important energy transfer media and the products of IAPWS will continue to be appreciated.
The President finished his report by indicating that he wanted to thank the national delegates for the constructive proceedings and good spirit, and all participating members of WGs and guests for the great efforts in the past year.

7. Report and Recommendations of the Thermophysical Properties of Water and Steam (TPWS) and the Industrial Requirements and Solutions (IRS) Working Groups and the Subcommittee on Seawater (SCSW)

TPWS Chairman Kretzschmar opened this item by indicating that he would report on activities within TPWS and IRS during the week, and would also include some of the items from the Subcommittee on Seawater. He then highlighted only those activities from the working sessions during the week which needed action by the EC or which he thought were of interest to the EC. He indicated that all of the WG activities had been conducted jointly with the exception of one separate meeting each for IRS and the Subcommittee on Seawater which are reported in Minutes 8 and 9. Full Minutes and the Agenda for TPWS can be found in Attachment 4.

7.1 The WGs had discussed and endorsed a proposed international collaboration between the University of Maryland, USA and the Academy of Sciences of the Czech Republic, on the topic of thermodynamic properties of supercooled water.

7.2 The WGs had reviewed the new correlation for the thermal conductivity of ordinary water which was a joint effort with the International Association for Transport Properties. In addition to the correlation for general and scientific use, the release also contains instructions for industrial use. The WGs had also reviewed the evaluation of both the general/scientific formulation and the modification for industrial use. TPWS and IRS voted to approve the Release on the *IAPWS Formulation 2011 for the Thermal Conductivity of Ordinary Water Substance* and now the Chairman recommended that the EC send it out for Postal Ballot following review by the Editorial Committee.

7.3 The WGs had reviewed a proposed revision of the supplementary release on the properties of liquid water at 0.1 MPa, which had been changed only to reflect the new thermal conductivity formulation. A favorable test report had been presented. TPWS and IRS voted to approve the Revised Supplementary Release on *Properties of Liquid Water at 0.1 MPa* and now The Chairman recommended that the EC send it out for Postal Ballot following review by the Editorial Committee.

7.4 The WGs had discussed the expiring ICRN-15 on thermodynamic properties of metastable steam. A closing statement had been prepared. The WGs also reviewed a draft for a replacement ICRN with a broader scope. The WG Chairman now recommended to the EC (subject to minor editing) that the new ICRN *Thermophysical Properties of Metastable Steam and Homogeneous Nucleation* is sent for postal ballot to the National Committees.

7.5 The WGs had discussed a new method to extend the ideal-gas heat capacity formulation that was used in IAPWS-95, making its lower limit 50 K instead of 130 K with no change in IAPWS-95 itself. The WG Chairman now suggested minor editorial changes in the IAPWS-95 document to clarify its use for the low temperature gas. A Task Group (Feistel, Wagner and Weber) has been formed to prepare a Guideline for 2012 on the use of IAPWS-95 from 50 K to 130 K, and to consider if an editorial change is needed for the metastable region of IAPWS-IF97.

7.6 A minor modification has been made to the TPWS Mission Statement. The text is within the TPWS minutes (Attachment 4).

At this point in the TPWS report, a short EC discussion on Mission Statements resulted in providing direction to Web Master Harvey to develop a location on the IAPWS website where the Mission Statements can be clearly observed.

7.7 Based on an update by CODATA of the fundamental physical constants and some recent new recommendations from IUPAC about molecular weight, a report and recommendations for changes to the IAPWS Fundamental Constants document will be prepared for the 2012 meeting.

7.8 The Chairman reported that a few minor editorial revisions are needed for Advisory Note #2 to complete the document approved at the 2010 meeting. The WGs have authorized these revisions to update the document.

7.9 Membership and TPWS Officers. Chairman Kretzschmar requested that the following new members are approved:

J. Kalová (University of West Bohemia, Czech Republic)
V. Vinš (Institute of Thermomechanics, Czech Republic)
O. Hellmuth (Leibnitz Institute for Tropospheric Research, Germany)

The EC approved these Membership Changes Unanimously.

Kretzschmar then confirmed his intention to step down as TPWS Chairman at the conclusion of the 2011 meeting after six years. The current Vice-Chair, Harvey, will become Chair at that time. Hruby will remain as Vice-Chair.

The EC approved these TPWS Officer Changes Unanimously.

8. Report and Recommendations of the Industrial Requirements and Solutions (IRS) Working Group

IRS Chairman Weber indicated that many of the activities of IRS during the week had been reported in the TPWS report, but the IRS group had one separate meeting during the week. Minutes for IRS and the Agenda can be found in Attachment 5. He covered the following items with the EC.

8.1 Task Group: Industrial Requirements. Chairman Weber indicated that there was no activity to report but that IRS had voted to change the name to New Industrial Requirements Task Group.

8.2 Task Group: Industrial Survey. The Chairman informed the EC that there was no activity to report but that the TG will remain active with some membership changes.

8.3 Task Group: CFD Steam Property Formulation. The Chairman informed that EC that a new TG had been set up to determine if a steam property formulation using backwards equations to IAPWS-IF97 with different independent parameters would be acceptable for CFD calculations.

8.4 Task Group: Advisory Notes. The Chairman informed the EC that there had been no activity of this TG but that it would remain active with membership changes.

8.5 Task Group: IAPWS-IF97 Editorial Update. The Chairman informed the EC that a new TG had been set up to prepare a minor editorial change to the IAPWS-IF97 Release.

8.6 Weber reported that a minor change had been made to the IRS Mission Statement. The text is within the IRS Minutes (Attachment 5).

8.7 ICRN 23 Dew Point of Combustion Gases. IRS suggests a one year extension with possible update in 2012.

8.8 ICRN 14 Thermophysical Properties of Humid Air and Combustion Gas Mixtures. A closing statement has been developed. A new ICRN on Thermodynamic Properties of Humid Gases and CO_2-rich Mixtures has been developed and approved by the WG. This is now ready for finalization with the Editorial Committee followed by postal ballot.

8.9 IRS WG Membership. Chairman Weber requested that the following new member be approved:

A. Singh (GE, USA)

The EC approved this Membership Change Unanimously.

9 Report and Recommendations of the Subcommittee on Seawater (SCSW)

Subcommittee Chairman Feistel provided a report on the activities of the Subcommittee. Full minutes are in Attachment 6. He covered the following items with the EC.

9.1. Collaboration with BIPM. The Chairman reported on the Committee which had been requested by the President on Monday (Minute 2.8). The Committee had met during the week and formulated a draft letter for the President to send to the President of BIPM. This suggests increased cooperation between BIPM and IAPWS, which would be beneficial to both organizations. The Chairman suggested that the letter should be reviewed by the IAPWS President and sent prior to the next meeting of BIPM in October 2011.

Chairman Feistel also suggested that the Committee (Feistel (chair), Friend, Cooper, Harvey, Kretzschmar, Spitzer and Hellmuth) remain active during the next year to address any responses from BIPM. The President agreed that this was very sensible.

9.2 SCSW Mission Statement. Chairman Feistel reported some minor changes to the Mission Statement which he shared with the EC. The text is within the SCSW minutes (Attachment 6).

9.3 Membership and SCSW Officers. Chairman Feistel informed the EC that Vice Chairman McDougall will step down and that SCSW recommends Pawlowicz as a new Vice-Chair for SCSW, effective immediately. As background, Feistel also indicated that Pawlowicz will chair a new SCOR/IAPSO/IAPWS Permanent Group for Thermodynamics of Seawater.

The EC approved this SCSW Officer Change Unanimously.

Feistel requested that the following new members be approved:

J. Safarov (University of Rostock, Germany)
O. Hellmuth (Leibniz Inst. for Tropospheric Research, Germany)

The EC approved these Membership Additions Unanimously.

10. Report and Recommendations of Physical Chemistry of Aqueous Systems Working Group (PCAS)

Chairman Nakahara provided the PCAS Report to the EC. He indicated that based on the discussions at the EC in 2010, a number of very useful workshops had been held during the week with PCAS members and joint with PCC and with TPWS/SCSW. Full Minutes can be found in Attachment 7. He covered the following items with the EC:

10.1 Hydration Project. Chairman Nakahara indicated that discussion had taken place on the joint IAPWS/IUPAC project *Establishing Recommended Data on Thermodynamic Properties of Hydration for Selected Organic Solutes and Gases*. The data collection is now complete and a summary paper is in preparation. This may be submitted to the Journal of Physical and Chemical Reference Data. After the paper is finalized, an IAPWS guideline or a release will be prepared by PCAS.

10.2 ICRN 10 pH Measurements and Potentiometric Studies of Supercritical Aqueous Solutions. The Chairman reported that a closing statement will be prepared and a new ICRN drafted.

A suggestion was provided from the EC that an expert on pH from the SCSW should be involved in the development of this new ICRN.

10.3 PCAS Membership. Chairman Nakahara indicated a desire for PCAS to attract new young members. He will also address during the next year the item of inactive PCAS members and will review with the EC in 2012.

10.4 PCAS Mission Statement. Chairman Nakahara reported some changes had been made to the 2010 Mission Statement to reflect green technologies and hydrogen chemistry. The full Mission Statement is included in the PCAS Minutes (Attachment7).

11. Report and Recommendations of Plant Cycle Chemistry Working Group (PCC)

Chairman Svoboda highlighted those activities that needed action/approval by the EC. A full written report of the PCC WG activities forms Attachment 8. He covered the following items with the EC

11.1 Technical Guidance Documents. Chairman Svoboda reminded the EC that the first Guidance Document had been approved in 2008. This was on *The Measurement of Carryover of Boiler Water and Steam*. The second document which is entitled *Instrumentation for Monitoring and Control of Cycle Chemistry in Fossil and Combined Cycle/HRSG Plants* was approved in 2009. The third document entitled *Volatile Treatments for the Steam-Water Circuits of Fossil and Combined Cycle/HRSG Power Plants* was approved in 2010. During the last year the fourth document on *Phosphate and Caustic Treatments for the Steam-Water Circuits of Drum Fossil and Combined Cycle/HRSG Power Plants* was prepared. This document had been circulated to the Task Group, PCC, Editorial Committee and National Committees. Minor clarifying amendments had been reviewed with PCC during the week. Chairmen Svoboda requested that the EC approve this document.

The EC approved the Technical Guidance Document Unanimously

11.2 ICRN 20 Sensors for use at Elevated Temperatures. The Chairman reported that a major revision of this ICRN had been undertaken to include fossil and nuclear applications. It had been circulated to PCC and PCAS members and been approved. It is now ready for finalization through the Editorial Committee prior to a postal ballot.

11.3 International Collaboration on Sampling Lines. The Chairman informed the EC that there had been a delay in the activities due to the problems in Japan. It should be finished in 2012.

11.3 PCC Membership. The Chairman informed the EC that two PCC members had withdrawn from membership:

E. Maughan (Germany). Deceased.
D. Smetanin (Russia)

The Chairmen requested that the following six people are approved for membership in PCC:

K. Thomsen (Denmark)
P. Gotovtsev (Russia)
W. Cook (Canada)
F. de Vos (Netherlands)
G. Joy (Australia)
M. Myszczyszyn (Canada)

The EC approved these Membership Additions Unanimously.

PCC Officers. Chairman Svoboda then announced his intention to step down as PCC Chairman at the conclusion of the 2011 meeting. One of the current Vice-Chairs, Rziha, will become Chair at that time. The PCC WG also suggests that Rudge becomes the second Vice-Chair.

The EC approved these PCC Officer Changes Unanimously.

11.4 The PCC Mission Statement developed in 2010 is still up to date and no changes were made during the week. The text is within the PCC minutes (Attachment 8).

11.5 PCC Association with Major Conferences. Chairman Svoboda indicated that PCC desires to increase international awareness at major conferences in the areas of PCC activities. As examples he referenced the International Conference of Water Chemistry in Nuclear Reactor Systems (France 2012) and two Conferences on "Flow-accelerated Corrosion" (2013 in USA and France). Svoboda suggested that an association might involve the use of the IAPWS logo on conference documents, and supporting an IAPWS session. He emphasized that no cost to IAPWS would be involved and that there would be mutual benefit.

This item raised some discussion from the EC in terms of the methodology which will be used to accomplish the associations. This resulted in a proposal by the US Delegate:

The PCC Chairman will request the IAPWS President for Approval to be Associated with a Particular Conference.

The EC approved this proposal with one abstention (Czech Republic).

12. Editorial Committee Report

Editorial Committee Chairman Harvey reported that in the preceding year, the Editorial Committee had reviewed the two following documents: Revised Release on Sublimation and Melting of Ice, and the Technical Guidance Document on Phosphate and Caustic Treatments for Drum Units.

At this stage a question was raised on whether the new statement on the front cover of the latest Technical Guidance Document (TGD) concerning the accumulated knowledge of the PCC members, should be also inserted on the previous three documents. After some discussion, two proposals were suggested to the EC:

The Editorial Committee should Insert the Same Statement on each TGD and should Review the Cover Pages of all current IAPWS Documents

The EC Unanimously Approved these two Activities.

13. Membership and Associates

13.1 Members Defaulting on Dues.

The President asked the Executive Secretary to report on the members that are deficient in paying their dues. To the end of July 2011 the following member countries had not paid their 2011 dues: Canada and Greece. The Canadian delegate indicated that the 2011 payment was in process. The Greece National Committee also had not paid their dues from 2008 to 2010.

The EC then discussed the IAPWS Statute 3.2.1f which indicates that Members defaulting on the payment of dues for three years will have their status changed to that of Associate Member. In special circumstances the EC can vote to keep such a Member at the status of Full Member and reexamine the position each year. Following the 2010 EC meeting in Niagara Falls, the Executive Secretary reported that, as instructed by the EC, he had written to the Head of the Greece National Committee. The letter indicated that Greece was in danger of having its status changed to Associate Member if there was no positive response by 31st January, 2011. The Greece Chairman, Kastanaki, responded in August 2010 that because of the severe financial situation in Greece she was having great trouble in continuing to assemble the Greece National Committee. She indicated that they definitely wanted to continue being associated with IAPWS but thought that at the present time it would be best to revert to being an Assoicate Member of IAPWS. Based on this and after reviewing the Statutes, the US Delegate proposed a motion to change the status of the Greece to that of Associate Member.

The EC Approved this Motion unanimously.

The President then requested if there was any discussion about the Associate Memberships of Argentina/Brazil and Italy. The concensus was to keep them as Associate Members.

13.2 Application of Australia for IAPWS Associate Membership

The Executive Secretary requested that Joy briefly review the acitivities in Australia. Joy indicated that there was 56,000 MW of installed capacity in Australia with 260 generators covering many plant types (coal, gas, wind, solar, and oxy-fuel). There is already a very strong chemistry network across Australia through the Australian Power Industry (API) and the Australasian HRSG Users Group (AHUG) which will intergrate with a new Australian IAPWS. An Austalian wide steering committee has been formed and is already working on By-Laws, Membership and the first meeting. The steering committee wants to engage a wider focus than simply the power industry by involving seawater and thermodynamics and requested any assistance from the EC. Joy indicated that they want to take an aggressive approach and have activities up and running quickly so they can apply for IAPWS Membership at the next ICPWS in 2013.

The EC Unanimously Approved the Application of Australia for IAPWS Associate Membership.

13.3 Application of New Zealand for IAPWS Associate Membership

The Executive Secretary indicated that at the last minute the representative of New Zealand could not travel to Czech Republic. He had provided a few slides to introduce the EC to New Zealand. The Executive Secretary indicated that the country has about 4 million people with an established thermal power industry and is a dynamic and growing world leader in geothermal with about 750 MW installed which represents about 13% of the country's demand. They also have an established natural and environmental sciences sector with a focus on water (fresh, sea and atmospheric). They have formed a Planning Committee of Addison (Thermal Chemistry) and Lovell-Smith (Measurement Standards Laboratory of New Zealand). They intend to hold an initial meeting in late 2011/early 2012.

The EC Unanimously Approved the Application of New Zealand for IAPWS Associate Membership.

13.4 Switzerland as an Associate Member

The Executive Secretary requested the Head of the National Committee of Switzerland, formed in 2007, to say a few words on the advancement of the Swiss National Committee. Svoboda reported that there are 13 members of the Swiss National Committee, but they still have not been able to get any longterm financial commitment because of the financial turmoil in the Country.

13.5 Update on Scandinavian Joint Committee of IAPWS.

The Executive Secretary requested the deputy of the SIAPWS NC to provide an update following the the application in 2010 for a Scandinavian Joint Committee of IAPWS. Hellman reported that SIAPWS had started activities in 2011, had developed Statutes

and By-Laws and had transferred the remaining funds from the previous Danish National Committee after it was dissolved. SIAPWS has decided to exclude Iceland because at this time they couldn't find any members. So SIAPWS now consist of members from Denmark, Sweden, Norway, and Finland.

14. Executive Secretary's Report

14.1 Financial, Auditors and IAPWS Dues

The Executive Secretary reported that IAPWS remained on a sound financial footing with currently over $96,000 in the US bank account. The status as at 31st July 2011 in the bank account had been provided to each National Delegate present at the EC meeting.

The Executive Secretary next reported that the 2010 financial statements had been forwarded to the IAPWS Auditors in January 2011. Both VDI in Germany and Professor Savarik in Czech Republic had reviewed and approved the financial statements. The Auditors' reports had also been provided to all the National Delegates present.

The Executive Secretary proposed that these organizations continue to act as auditors.

The EC Approved this Unanimously.

The Executive Secretary proposed to the EC that the dues structure for member countries remain unchanged for 2012.

The EC Unanimously Agreed to this Proposal.

The Executive Secretary also provided a rough estimate of the income and known planned expenditures for 2011/2012.

14.2 Time and Place of the 2012, 2013 and 2014 Meetings

The Executive Secretary indicated that there had not been any esponse from the UAE to hold the 2012 meetings in Abu Dhabi. The US National Committee has agreed to host the meetings. The Executive Secretary requested that the US provide a few details. Harvey indicated that the meetings would be Boulder, Colorado and suggested dates 23-28 September 2012. These dates initiated EC discussion because of an exact overlap with a major Nuclear Water Chemistry Conference in Paris which will involve a number of PCC members. This resulted in suggestions for two other dates in mid-August or late-September. The US NC will confirm the dates within the next month. There will be a joint symposium with ASME on Energy/Water Issues, and a tour of the NIST laboratories.

The Head of the Russian NC indicated that the 2014 meetings will be held in Moscow.

The 16th ICPWS will be held in England and is being arranged by BIAPWS. The BIAPWS deputy, Cooper, indicated that BIAPWS has concluded an agreement with the Institution of Mechanical Engineers (IMechE) to act as co-hosts of ICPWS 16 and as conference administrators. BIAPWS has also identified a preferred date for the

conference of Sunday September 1st to Thursday September 5th 2013 and a preferred university location in the London area.

Cooper next reported on the International Program Committee for the 16th ICPWS which had been formed by the President on Monday (Minute 2.6). During the week the Chairs of each of the WGs and the SCSW had discussed with their members possible topics which will become Symposia Sessions at ICPWS. Each of the WG Reports (Minutes 7-11) had included a listing of these topics which are included in their minutes (Attachments 4-8). Cooper indicated that he will quickly develop this list of topics and share them with the BIAPWS/IMechE Local Organizing Committee. They will use this same list to develop the first flyer for the 16th ICPWS which will be issued towards the end of 2011. Cooper highlighted that PCC has included a separate Workshop on the Technical Guidance Documents which could be included within the timeframe of the ICPWS or on the day following. The President asked Cooper to thank BIAPWS for the work already conducted and requested that a revised timeline be issued soon to indicate the various important dates which involved IAPWS and the International Program Committee. Particular interest concerns the call for abstracts and review of these abstracts to develop the ICPWS program. This will involve a meeting of the Local Organizing Committee with the International Program Committee in England in early 2013.

15. Guidelines, Releases, Certified Research Needs, and International Collaborations

The President indicated that the Releases and ICRNs had been discussed within the WG Reports so no further action was required by the EC.

15.1 International Collaborative Projects.

The President requested the Chairman of the 2011 International Collaboration Committee (WG and SC Chairs) to report on the findings of that committee during the week. Rziha reported that one collaborative project had been proposed. The following is an overview of the proposed project. The details are provided in Attachments 9:

- *Towards an IAPWS Guideline for the Thermodynamic Properties of Supercooled Water*. The IAPWS sponsors are Anisimov and Sengers (USA) and Hruby (Czech Republic). The young scientist is Vincent Holten currently working as a Visting Assistant Research Scholar at the University of Maryland. It is proposed that the IAPWS funding of $19,200 will cover subsistence for 6 months (1st January to 30th June 2012) at the University of Maryland. A report on the research will be presented at the 2012 IAPWS meetings in the USA.

Rziha indicated that the Evaluation Committee supported the proposal and recommended to the EC that it is funded. This lead to review of the IAPWS Guidelines for Spending of IAPWS Funds (Toronto, September 1999) in relation to the expenditures projected over the next year.

The EC approved the proposal to fund the project with the delegates from Czech Republic and the US abstaining because of their involvement in the proposal.

16. IAPWS Awards

16.1 IAPWS Helmholtz Award

The President reported that the 2010 Helmholtz Award had been presented to Hertanto Adidharma from University of Wyoming at the IAPWS Symposium on Wednesday.

Daucik then asked the Czech Republic Delegate, Hruby, for the names of the 2012 Helmholtz Award Committee. The 2012 Helmholtz Committee will consist of: Chairman Hruby (Czech Republic), Hellman (SIAPWS), Span (Germany), Uchida (Japan) and Orlov (Russia). Nominations will be due to the Executive Secretary by 31st January 2012.

16.2 IAPWS Honorary Fellowships

The President reported that Mares (Czech Republic) had been elected Honorary IAPWS Fellow, following the established procedures and after unanimous approval through the postal ballot conducted by the Executive Secretary. The Fellowship Award had been presented at the IAPWS Dinner on Thursday evening by the IAPWS President. He reminded the EC of the Awards Committee for 2012 with Rukes as Chairman and Bignold as member with the IAPWS President as ex.-officio member. Nominations are due to the Executive Secretary by 31st January 2012.

16.3 Gibbs Award

The President had requested each of the WGs and SCSW on Monday to nominate a person to serve on this committee. During the WG/SC Reports (Minutes 7-11) the Chairs had provided the following names: Watanabe (TPWS), Cooper (IRS), Feistel (SCSW), Anderko (PCAS) and Rziha (PCC). The President requested that Watanabe be the chair of this group. The Executive Secretary will issue the nomination documents following the IAPWS meetings, but as reported on Monday, proposals will be due from WG/SC Chairs and Heads of NCs by May 2012. The selection process will take place at the IAPWS meetings in the USA in 2012.

17. New Business

17.1 Press Release

The President mentioned that Bellows had been asked on Monday to develop a Press Release. Bellows had written a "Highlights" with input provided by each WG and SC. The President asked him to circulate it to the WG/SC heads to finalize it. The final version is contained in Attachment 10.

17.2 IAPWS Statutes and By-Laws

Each of the WGs and SCSW had reviewed the suggestions made by the US committee on Monday (Minute 2.5). Each agreed with the suggestions made concerning changing By-Law 6.2. The President asked the EC to approve this By-Law suggested change.

The EC approved the change with one abstention (Russia).

The President next turned to discussion of the Statutes. There are a number of Statutes which need to be addressed:

- Statute 2 on Major Activities of IAPWS and By-Law 3 on Documents Issued by IAPWS.
- Statute 11 on currency of IAPWS and the bank accounts. Relates to By-Law 8.
- Statute 3.3 on Associate Members.

The President indicated that the EC needs to be prepared to present any suggested Statute changes to the General Meeting at the next ICPWS. He requested that a small committee be formed to review the Statutes mentioned above and any other items which might need change. He proposed that the committee consisting of Harvey (Chair), Svoboda and Watanabe develop a draft of the revised Statutes and By-Laws two months prior to the next IAPWS EC meeting in 2012. The Executive Secretary will circulate this to NCs and discussion will take place during the EC meeting.

The EC Unanimously Approved this Proposal.

17.3 Links on IAPWS Website to Software

Each of the WGs and SCSW had reviewed the proposal presented on Monday to link software to the IAPWS website (Minute 2.7). Discussion can be found in the minutes of the WGs and SCSW (Attachments 4-8). President Daucik requested a proposal for the EC on this matter. The US Delegate, Friend, suggested that the EC approves the general principle of links from the IAPWS website to software, which is supported by a National Committee and is associated with IAPWS Releases and Guidelines, and has approval of the appropriate WG. This link should contain a disclaimer that IAPWS is not responsible for the content of the software.

The EC approved this proposal unanimously

The Chair of the SCSW then proposed that the EC allows a similar link to TEOS-10 with a similar disclaimer.

The EC approved this proposal unanimously

17.4 Other New Business

President Daucik asked the EC if there was any further business. No other business was raised.

17.5 Reports from National Committees.

Written reports on progress in member countries were not reported to the EC but were either distributed to other members and the Executive Secretary during the IAPWS week, or sent to the Executive Secretary after the meetings. They are attached to these minutes as follows:

Czech Republic	Attachment 11
Germany	Attachment 12
Japan	Attachment 13
Russia	Attachment 14
USA	Attachment 15

17.6 Participants

Attachment 16 provides a list of participants at the IAPWS EC and WG Meetings and at the Symposium in Plzeň, Czech Republic in September 2011.

17.7 List of Members

An up-dated list of members of the Executive Committee, Working Groups, and Honorary Fellows will be developed by the Executive Secretary following the Plzeň Meetings. This will be forwarded electronically to the Head of each National Committee.

18. Closing Remarks and Adjournment

The President thanked Hruby and his Czech Republic NC colleagues for hosting the IAPWS Plzeň Meetings. He also thanked everybody for participating at this EC meeting. Then he formally closed the 2011 EC meeting at 11:42 am.

AGENDA for the EXECUTIVE COMMITTEE of IAPWS

Plzeň, Czech Republic. 4-9 September 2011

Monday, 5th September 2011. Opening Session (8:30 – 9:30am)

Opening Remarks and Welcome by IAPWS President, K. Daucik

1. Adoption of Agenda
2. IAPWS Business and Appointment of Committees
   - 2.1 Releases, Advisory Note, ICRNs and Guidance Documents
   - 2.2 Press Release
   - 2.3 Evaluation Committee on International Collaboration
   - 2.4 IAPWS Awards Committees for 2012 (Honorary Fellow, Gibbs, Helmholtz)
   - 2.5 IAPWS Statutes and By-Laws. Possible Revisions
   - 2.6 16th ICPWS
   - 2.7 Report on Committee to investigate link on IAPWS Website to software
   - 2.8 Report on Committee to investigate cooperation with CIPM
   - 2.9 WG Future Activities and Mission Statements
   - 2.10 Other business requiring special/extensive discussions
3. EC Mandate to Working Groups and Membership
   - 3.1 Releases, Guidelines and ICRNs
   - 3.2 WG Directions
4. Preview of Week's WG Activities by WG Chairmen

Friday, 9th September 2011. Executive Committee Meeting. (8:30am – 1:00pm)

5. Acceptance of Minutes of Previous Meeting
6. President's Report
7. Report and Recommendations of TPWS, IRS and the Sub-Committee on Seawater
8. Report and Recommendations of the Sub-committee on Seawater
9. Report and Recommendations of IRS
10. Report and Recommendations of PCAS
11. Report and Recommendations of PCC
12. Editorial Committee Report
13. Membership and Associates
    - 13.1 Report on Membership. Including Members Defaulting on Dues.
    - 13.2/3 Application of IAPWS Associate Members, Australia and New Zealand
    - 13.4 Report on Associate Member Switzerland
    - 13.5 Report on Scandinavian Joint Committee of IAPWS
14. Executive Secretary's Report
    - 14.1 Financial and Auditors
    - 14.2 Time and Place of 2012/2013/2014 Meetings.
      Includes BIAPWS's Update on the 16th ICPWS in 2013
15. Guidelines, Releases, Certified Research Needs, and International Collaborations
    - 15.1 International Collaborations
16. IAPWS Awards
    - 16.1 Helmholtz Award Committee
    - 16.2 Honorary Fellowship
    - 16.3 2013 Gibbs Award

17. New Business
    - 17.1 Press Release
    - 17.2 IAPWS Statutes and By-Laws
    - 17.3 Link to Software on IAPWS Website
    - 17.5 Other items raised during the IAPWS week
18. Adjournment

Schedule of IAPWS Meetings
Plzeň, Czech Republic. 4-9 September 2011

(All meetings will be at the Hotel Primavera, Plzeň, www.primaverahotel.cz)

Sunday 4 Sept. 6:00 pm Informal Get-together, Cocktails and Registration
(Location will be at the Hotel Primavera, Plzeň, www.primaverahotel.cz)

Monday 5 Sept. 8:30am. Opening Plenary Session - Executive Committee
10:00am TPWS/IRS/SCSW Joint Meeting
(To set agendas for the week and to conduct IAPWS Business, thus allowing remainder of week for technical matters)
10:00am. PCAS and PCC Separate Meetings
(To conduct IAPWS Business, thus allowing remainder of week for technical matters)
1:30pm. TPWS/IRS/SCSW Joint Meeting
1:30pm. PCC and PCAS Separate WG Meetings

Tuesday 6 Sept. 8:30am. PCAS Workshop (other WG Members will be welcome)
"Transport, Hydration, and Reactions in Hot Water"
8:30am PCC Workshop (other WG Members will be welcome)
"Update on Power Cycle Chemistry Research and Experience"
8:30am. TPWS/IRS/SCSW Joint Working Group Meeting
10:30am. TPWS/IRS/SCSW Joint Meeting. PCC, PCAS Separate Meetings
1:30pm TPWS/IRS/SCSW Joint Meeting.
1:30pm PCC/PCAS Joint WG Meeting and Workshop
3:30pm PCC and PCAS Separate Meetings

Wednes. 7 Sept. 9:00 – 5:00 **IAPWS Symposium**
" Water and Aqueous Mixtures: Research for Future Energy Technologies"
(Location will be at Hotel Primavera, Plzeň)

Thursday 8 Sept. 8:30am. IRS, SCSW and PCC Separate WG Meetings
8:30am. TPWS/PCAS Joint WG Meeting
"**Joint Chairmen: H-J. Kretzschmar and M. Nakahara"**
1:30pm. Separate meetings of Working Groups
(If needed to prepare for Executive meeting)
6:45 pm. **IAPWS Dinner/Banquet**.
(Pilsner Urquell Brewery)

Friday 9 Sept. 8:30am. Executive Meeting **(8:30am - 1: 00pm)**
(Will include at least one member from each National Delegation)
1:30 – 3:30 pm Technical visit to ŠKODA JS

TPWS - Thermophysical Properties of Water and Steam WG
SCSW - Subcommittee on Seawater
IRS - Industrial Requirements and Solutions WG
PCAS - Physical Chemistry of Aqueous Solutions WG
PCC - Power Cycle Chemistry WG

Barry Dooley
4th May 2011

IAPWS 2011 SYMPOSIUM

Water and Aqueous Mixtures: Research for Future Energy Technologies

September 7, 2011, Primavera Hotel & Congress Centre, Pilsen

09:00 – 09:10 Opening Word & Helmholtz Award Announcement

09:10 – 10:10 **Helmholtz Award Lecture**
Hertanto Adidharma, University of Wyoming
Towards a Complete Thermodynamic Description of Geologic and Industrial Aqueous Electrolyte Systems: A Statistical Associating Fluid Theory Approach

The Award is given yearly to a qualified researcher to recognize promising early-to-mid career scientists and engineers who are making significant contributions to, or defining new directions in the areas of research of interest to IAPWS.

10:10 – 10:30 Coffee Break

10:30 – 11:20 Ivo Nezbeda, Jan Evangelista Purkyně University in Ústí nad Labem
From Ice to Steam and Aqueous Solutions with a Non-speculative Molecular Model

11:20 – 12:10 Luboš Prchlík, ŠKODA POWER (Doosan Power Systems)
Large Steam Turbines for Elevated Steam Parameters and Implications for Construction Materials Used

12:10 – 13:30 Lunch

13:30 – 14:20 David Guzonas, Atomic Energy of Canada Limited (AECL)
Water Chemistry in a Supercritical Water-cooled Reactor

14:20 – 15:10 Shunsuke Uchida, Japan Atomic Energy Agency
Accident of Fukushima-Daiichi NPP and Its Influence on Energy Policy in Japan

15:10 – 15:30 Coffee Break

15:30 – 16:20 Martin Prokš, ŠKODA JS a.s.
Training Reactor VR-1 CVUT Prague, Cavity Effects, Temperature Effects

16:20 – 17:10 Jan Kysela, Reseach Centre Řež Ltd.
Experimental Water Chemistry Research for Boiling and Supercritical Water Cooled Reactor

18:00 – 20:00 Dinner

Minutes

IAPWS Thermophysical Properties of Water and Steam WG

Plzeň, Czech Republic, September 5-8, 2011

NOTE: These Minutes include many items that were held jointly with the IRS Working Group and/or the Subcommittee on Seawater (SCSW). Items are listed according to their order on the TPWS agenda, which is Attachment A. **Bold print** denotes significant actions.

1-2. The meeting was opened on Monday morning, September 5 by the TPWS Chair, Hans-Joachim Kretzschmar. The agenda (Attachment A) was adopted after minor additions (attachment reflects additions). The Chair noted that, in accordance with our procedure, the 2010 Minutes had been circulated and approved with minor corrections shortly after the 2010 meeting. Allan Harvey was appointed Clerk of Minutes for TPWS.

3. H.-J. Kretzschmar and G. Doleisch demonstrated access to a password-protected website for documents and presentations of the TPWS and IRS Working Groups and the SCSW. The site is accessible from the Working Groups page on www.iapws.org.

4. M. Anisimov discussed a proposed international collaboration between the group at the University of Maryland and the group of J. Hruby at the Academy of Sciences of the Czech Republic, on the topic of thermodynamic properties of supercooled water. The Working Groups endorsed the proposal.

5. (thermal conductivity) J. Sengers reported on the new correlation for the thermal conductivity of ordinary water, a joint effort with the International Association for Transport Properties. In addition to the correlation for general and scientific use, the release also contains instructions for industrial use. R. Mareš presented the report of the evaluation of both the general/scientific formulation and the modification for industrial use, with a favorable recommendation. **The Working Groups TPWS AND IRS voted to approve the Release on the IAPWS Formulation 2011 for the Thermal Conductivity of Ordinary Water Substance and to recommend that the EC send it out for Postal Ballot following review by the Editorial Committee.** Prof. Kretzschmar, on behalf of the Working Groups, will send letters of appreciation to Dr. Huber at NIST and to Mr. Miyagawa thanking them for all their excellent work on this project.

H.-J. Kretzschmar presented a report on behalf of Mr. Miyagawa on the consequences on viscosity and thermal conductivity calculations in the industrial Region 3 if the density is obtained not by iteration but rather by the $v(p,T)$ backward equations. This procedure is very accurate for viscosity; for thermal conductivity there is a small region where significant accuracy is lost.

6. (properties at 0.1 MPa) A. Harvey presented a proposed revision of the supplementary release on properties of liquid water at 0.1 MPa, changed only to reflect the new thermal conductivity formulation. H.-J. Kretzschmar presented the favorable test report on behalf of Mr. Miyagawa. **The Working Groups TPWS AND IRS voted to approve the Revised Supplementary Release on Properties of Liquid Water at 0.1 MPa and to recommend that the EC send it out for Postal Ballot following review by the Editorial Committee.**

7. (Industrial steam property calculations) (this item is reported in the IRS Minutes).

8. (humid air, CCS technology) (the first 2 talks under this item are reported in the PCC Minutes) (the remainder of this item is reported in the IRS minutes).

9. (seawater for industrial use) J. Cooper, as Chair of the Task Group, reported that no progress had been made during the year. A document (Guideline or Advisory Note, to be decided) will be prepared and circulated in time to discuss at the 2012 meeting.

10. (seawater) (these items are reported under item #8 in the SCSW Minutes)

11. (dew point of combustion gases) (this item is reported in the IRS Minutes)

12. (metastable steam and nucleation) J. Hruby explained the expiring ICRN-15 on thermodynamic properties of metastable steam and gave some reasons why it had not produced the data hoped for. He has prepared a closing statement, and the WGs endorsed closing the ICRN with this statement. He then presented a draft for a replacement ICRN with a broader scope. **The WG voted to recommend (subject to minor editing) sending the new ICRN "Thermophysical Properties of Metastable Steam and Homogeneous Nucleation" for consideration by the National Committees.**

13. (supercooled water) V. Holten presented the status of an ongoing project to produce a better description of the thermodynamic properties of supercooled water.

14. (molecular simulations, joint with PCAS) O. Marsalek, N. Matubayasi, and K. Yasuoka presented their molecular simulation work, with titles described in the Agenda.

15. (IAPWS/BIPM collaboration) R. Feistel gave a report on this issue, describing the overlap of interests and possible areas of cooperation, and some of the questions that need to be answered. TPWS and SCSW decided to appoint several individuals to help in deciding what the initial letter from IAPWS to BIPM should say; these were J. Cooper, R. Feistel, D. Friend, A. Harvey, O. Hellmuth, H.-J. Kretzschmar, and P. Spitzer.

16. (16th ICPWS) J. Cooper briefly described a tentative list of topics for the 2013 ICPWS in the UK. Any comments from WG members were asked to be given to him by noon Wednesday.

17. (IAPWS-95 at low temperatures) R. Feistel reported that a method had been developed to extend the ideal-gas heat capacity formulation that was used in IAPWS-95, making its lower limit 50 K instead of 130 K with no change in IAPWS-95 itself. W. Wagner suggested minor editorial changes in the IAPWS-95 document to clarify its use for the low-temperature gas. **It was agreed (with one negative vote) to authorize the proposed editorial changes, consisting of changing a mention of 200 K for extrapolation in this region to 130 K, deleting the following sentence, and updating the corresponding reference. R. Feistel, W. Wagner, and I. Weber were appointed as a Task Group to prepare a Guideline for 2012 on use of IAPWS-95 from 50 K to 130 K, and to consider if an editorial change is needed for the metastable region of IAPWS-IF97. The TPWS Chair may appoint an Evaluation Task Group during the year if a draft is prepared sufficiently before the 2012 meeting.**

18.1. Regarding the requested Mission Statement, the following minor modification of the statement adopted last year was agreed on:

To develop state-of-the-art formulations for the thermophysical properties of water (in all its phases) and important water-containing mixtures as needed for scientific and industrial applications, and to encourage and facilitate research to improve knowledge of these properties.

18.2. A. Harvey reported that very recently CODATA had issued an update of the fundamental physical constants, and that there were also some recent new recommendations from IUPAC about molecular weight to be considered. A report and recommendations for changes to the Fundamental Constants document will be prepared for the 2012 meeting.

18.3. A. Harvey and J. Cooper reported that a few minor editorial revisions were needed to complete the document approved at the 2010 meeting. **They were authorized to make these revisions and update the document.**

18.4. TPWS supported the proposed revision to the By-Laws.

18.5. TPWS appointed Prof. Koichi Watanabe to be its representative to the Gibbs Award committee.

18.6. I. Weber reported that the Advisory Note Task Group appointed in 2010 had not made any progress. **The following changes were made in its membership: M. Hiegemann is the new Chair, P. Murphy is added as a member.**

18.7,8. A. Harvey presented the recommendation of the Task Group formed by the EC to investigate links to live table calculations hosted elsewhere. K. Orlov presented a modification of the proposal and demonstrated how it would look on the Russian site. The WG endorsed this recommendation for providing these links (with disclaimer) on the IAPWS website.

18.9. H.-J. Kretzschmar reported on the availability from his institute of free steam tables for Excel, Mathcad, and for pocket calculators.

18.10. J. Cooper stated that there was nothing new to report regarding liaison with the IEC.

18.11. This item was postponed.

19. Regarding collaborative projects, no further WG action is required.

20. **The WG approved the addition of J. Kalová (University of West Bohemia, Czech Republic), V. Vinš (Institute of Thermomechanics, Czech Republic), and O. Hellmuth (Leibniz Institute for Tropospheric Research, Germany) to membership in TPWS.**

21. The Chair of TPWS, Prof. Kretzschmar, will step down at the conclusion of the 2011 meeting. Dr. Harvey, currently a Vice-Chair, stated his willingness to become Chair at that time. **It was voted to recommend to the EC that Dr. Harvey become Chair of TPWS, effectively immediately after this meeting, and that Dr. Hruby remain Vice-Chair.**

22/23. The Chair and Clerk of Minutes were appointed to prepare the contribution to the Press Release and the formal motion of the TPWS WG to the EC.

24. The meeting was adjourned at 5:15 PM on Thursday, September 8.

Agenda for the Working Group

Thermophysical Properties of Water and Steam (TPWS)
Plzeň, Czech Republic, 04-09 September 2011

1. Opening Remarks; Adoption of Agenda
2. Appointment of Clerk of Minutes
3. OPAL Web Space for Working Material for WGs TPWS, IRS, and SC SW, joint with WG IRS and SC SW (G. Doleisch, H.-J. Kretzschmar)
4. Potential International Collaborative Projects
5. Release on the IAPWS Formulation 2011 for the Thermal Conductivity of Ordinary Water Substance, joint with WG IRS and SC SW
   - Report (J.V. Sengers, E. Vogel, R.A. Perkins, M.L. Huber, D.G. Friend, M.J. Assael, I.N. Metaxa)
   - Test Report on the Scientific Formulation (R. Mares, J. Hrubý, K. Miyagawa, V. Vinš, K. Orlov)
   - Test Report on the Industrial Formulation (W.T. Parry, J. Hrubý, K. Miyagawa, V. Vinš, K. Orlov)
   - Formal consideration of the Release
   - Additional Test Report on Using Backward Equations $v(p,T)$ of IAPWS-IF97 Region 3 for Calculating Thermal Conductivity (K. Miyagawa, H.-J. Kretzschmar)
6. Revised Supplementary Release on Properties of Liquid Water at 0.1 MPa, joint with SC SW and WG IRS
   - Report (A.H. Harvey)
   - Test Report (K. Miyagawa, H.-J. Kretzschmar)
   - Formal consideration of the Revised Supplementary Release
7. Industrial Requirements and Solutions for Steam Property Calculations, joint with WG IRS (Tuesday 08:30 am)
   - 7.1 Report of the Industrial Requirements Task Group (I. Weber, W.T. Parry)
   - 7.2 Report of the Industrial Survey Task Group (W.T. Parry)
   - 7.3 Using IAPWS Formulations in Power Cycle Calculations with the Program EBSILON (R. Pawellek, P. Krueger, STEAG Energy Services Zwingenberg, Germany)
   - 7.4 Steam Property Calculations for CFD Applications (P.J. Murphy)
   - 7.5 Implementation of TTSE in Power Plant Transient Simulation Software – Experiences and Results (H. Steuer, J. Bonifay, Siemens Energy Erlangen, Germany)
   - 7.6 Other Backward Equations with Different Independent Variables for IAPWS-IF97 (J. Cooper)

8. Properties of Humid Air and Humid Combustion Gases for CCS Technology, joint with WGs IRS, PCAS, PCC and SC SW (Tuesday 01:30 pm)
   - Thermodynamic Modeling of Processes Related to Carbon Dioxide Capture and Sequestration (A. Anderko)
   - Development of Thermodynamic Models for Hydrates in Water–Carbon Dioxide Mixture (V. Vinš, A. Jäger, J. Gernert, J. Hrubý, R. Span)
   - Closing Statement for ICRN-14 (A.H. Harvey, R. Span)
   - Proposal for a new ICRN (R. Span, A.H. Harvey)
9. Guideline on the Properties of Sea Water for Industrial Use, joint with WGs IRS and SC SW (Tuesday 1:30 pm, after joint session with PCC)
   - Report of the Task Group (J. Cooper, R. Feistel, M. Hiegemann)
10. Properties of Seawater (R. Feistel), joint with SC SW and partly with WG IRS (Tuesday 1:30 pm, after joint Session with PCC)
    - 10.1 Implementation of the TEOS-10 Libraries (T.J. McDougall, P. Barker, R. Feistel, J. Reissmann)
    - 10.2 New Seawater Measurements (R. Feistel, F.J. Millero, J. Safarov, A. Heintz, E. Hassel)
    - 10.3 Regular Measurement of Seawater Density with Anton Paar Instruments (B. Laky, S. Weinreben, R. Feistel)
    - 10.4 Task Group Report "Industrial Requirements" (M. Hiegemann, J. Bellows, H. Glade)
    - 10.5 Task Group Report "Transport Properties" (A. Anderko)
      Available Technical Report: Wang, P, Anderko, A.: Modeling Thermal Conductivity of Electrolyte Mixtures in Wide Temperature and Pressure Ranges: Seawater and Its Main Components.
    - 10.6 Electrical Conductivity of Seawater (R. Feistel, R. Pawlowicz)
    - 10.7 Solubility of CO_2 in Seawater (J. Safarov)
    - 10.8 On the Definition of Relative Humidity (R. Feistel, J. Lovell-Smith)
11. Dew Point of Combustion Gases, joint with WGs IRS, PCAS, and SC SW (Thursday 08:30 am)
    - Report on new Dew Point Equations and Status of ICRN-23 (N. Okita)
12. Metastable Steam and Nucleation, joint with WGs IRS, PCAS, and SC SW (Thursday 08:30 am)
    - Report of the Task Group (J. Hrubý, K. Yasuoka, N. Okita)
    - Discussion about ICRN 15, expires September 2011
13. Properties of Supercooled Water, joint with PCAS and SC SW (Thursday 08:30am)
    - Peculiar Thermodynamics and Equation of State for Supercooled Water (V. Holten, C.E. Bertrand, J. Kalova, D. Fuentevilla, M.A. Anisimov, and J.V. Sengers)
      Available Technical Reports:
      Holten, V., Bertrand, C.E., Anisimov, M.A., Sengers, J.V.,
      Thermodynamic Modeling of Supercooled Water.
      Kalova, J., Mares, R., Anisimov, M.A., Sengers, J.V.,
      Scaled Equation of State for Supercooled Water in the mean-field Approximation.

14. Molecular Simulations, joint with PCAS (Thursday 08:30 am)
    - 14.1 Structure, dynamics and reactivity of the hydrated electron (O. Marsalek, Institute of Organic Chemistry and Biochemistry, Academy of Sciences of the Czech Republic)
    - 14.2 Molecular study of hydration over a wide range of thermodynamic conditions (N. Matubayasi)
    - 14.3 Molecular dynamics simulation of vapor/liquid coexistence for water and methane/water (K. Yasuoka)
15. Suggestions for IAPWS - BIPM Collaboration, joint with SC SW
    - Report (R. Feistel, S. Rudtsch)
16. Discussion of Main Topics for the 16th ICPWS 2013 in London (H.-J. Kretzschmar, A.H. Harvey, J. Hrubý), joint with WG IRS and SC SW
17. Editorial Changes on the IAPWS-95 Release and a Guideline on a Low-temperature Extension of IAPWS-95 (R. Feistel, W. Wagner)
18. Reports on Other TPWS, IRS and SC SW Activities
    - 18.1 Revision of the Mission Statement of WG TPWS (H.-J. Kretzschmar, A.H. Harvey)
    - 18.2 Guideline on Fundamental Constants (A.H. Harvey), joint with WG IRS and SC SW
    - 18.3 Update of Advisory Note # 2: Roles of Various IAPWS Documents (J.R. Cooper, A.H. Harvey), joint with WG IRS and SC SW
    - 18.4 Changes of IAPWS Statutes and By-Laws (A.H. Harvey)
    - 18.5 Nomination of a TPWS Representative for Gibbs Award Committee (H.-J. Kretzschmar, A.H. Harvey)
    - 18.6 Report of the Advisory Note Task Group (I. Weber, W.T. Parry)
    - 18.7 Web presentation of Releases, etc. (A.H. Harvey), joint with WG IRS and SC SW
    - 18.8 Links to Live Calculations of IAPWS Releases on IAPWS Website (K.A. Orlov, V.F. Ochkov), joint with WG IRS and SC SW
    - 18.9 Steam Tables for Excel®, Mathcad®, and Pocket Calculators for Education on the IAPWS Website (H.-J. Kretzschmar), joint with WG IRS
    - 18.10 Liaison with IEC (J.R. Cooper), joint with WG IRS
    - 18.11 Discussion about IAPWS Meetings Regarding Locations and Costs (H.-J. Kretzschmar), joint with IRS and SC SW
19. Other Business
    - Report on International Collaborative Projects
20. Membership
21. Election of new Chair
22. Preparation of contribution to Press Release
23. Preparation of the Formal Motion to the EC
24. Adjournment

Minutes of Meeting for the Working Group
Industrial Requirements and Solutions (IRS)
Plzeň, Czech Republic, 04-09 September 2011

Remark: Most of the IRS meetings were held as joint meetings with TPWS (marked by *). Of these joint meetings the IRS minutes cover the topics chaired by the IRS chairman.

1. Opening Remarks; Adoption of Agenda.
Chairman I. Weber welcomed the WG members to Plzeň. The agenda was adopted.

2. Appointment of Clerk of Minutes.
P. Murphy was appointed clerk of minutes.

3. OPAL Web Space for Working Material. *
See TPWS minutes.

4. Potential International Collaborative Projects. *
See TPWS minutes.

5. Release on the IAPWS Formulation 2011 for the Thermal Conductivity of Ordinary Water Substance. *
See TPWS minutes.

6. Revised Supplementary Release on Properties of Liquid Water at 0.1 MPa.*
See TPWS minutes.

7. Industrial Requirements and Solutions for Steam Property Calculations.

7.1 Report of the Industrial Requirements Task Group.
I. Weber presented a brief history of the Task Group. There was no activity during the last year. I. Weber proposed changing the name of the TG to "New Industrial Requirements TG". The scope of this TG has been proposed to be "to collect new industrial requirements regarding formulations, properties, and fluids". The WG agreed to these changes. I. Weber was elected Chair, replacing W. Parry.
New TG Membership: I.Weber (chair), W. Parry, B. Rukes, M. Hiegemann, R. Mares, N. Okita, H.-J. Kretzschmar, K. Miyagawa, P. Murphy and M. Kunick

7.2 Report of the Industrial Survey Task Group.
I. Weber reported that there were no activities to report. P. Murphy was elected Chair, replacing W. Parry.
New TG membership: P. Murphy (chair), W. Parry, B. Rukes, M. Hiegemann, A. Novy, N. Okita and J. Cooper

7.3 Using IAPWS Formulations in Power Cycle Calculations with the Program EBSILON.

R. Pawellek gave a brief history of STEAG Energy Services and the EBSILON program. He then showed how IAPWS formulations are used inside of EBSILON. He then gave a demonstration of the capabilities of EBSILON with 3 different power plant models.

7.4 Steam Property Calculations for CFD Applications.

P. Murphy presented the results of CFD analysis using steam property calculations. He showed the need for faster steam property calculations, the impact on the CFD results of metastable steam properties, and the results of sensitivity studies on the size of steam look-up tables and interpolation routines.

7.5 Implementation of TTSE in power plant transient simulation software - experiences and results.

J. Bonifay presented an overview of the Plant Dynamics Group in Siemens and the Siemens power plant transient simulation software Dynaplant and Dymola. He then showed how TTSE steam table lookup routines have been added to the software. He presented results that show that TTSE steam table lookup routine is 10 times faster than the IF97 formulation.

7.6 Other Backward Equations with Different Independent Variables for IAPWS-IF97.

J. Cooper talked about the potential need for an industrial formulation using density and internal energy as the independent variables for use in CFD. J. Hruby stated that he was working on such a formulation. A CFD Steam Property Formulation TG has been formed to investigate if this formulation is sufficient for CFD calculations. This TG consists of J. Hruby (Chair) and P. Murphy

8. Properties of Humid Air and Humid Combustion Gases for CCS Technology. *

R. Span gave a brief history of ICRN-14. The closing statement for ICRN-14 was then reviewed. The WG agreed to recommend to the EC that ICRN-14 be closed.

R. Span then gave an overview of the proposed ICRN for the properties of humid air and humid combustion gases for CCS technology. The proposed ICRN is focused on CCS technology, and more specifically requirements resulting from oxyfuel process. The WG agreed to recommend to the EC that the new ICRN be adopted, pending review of the editorial committee.

9. Guideline on the Properties of Sea Water for Industrial Use. *

See TPWS minutes.

10. Properties of Sea Water*

See the minutes of the Subcommittee on Seawater.

11. Dew Point of Combustion Gases.

N. Okita gave an update on ICRN-23. Two papers have been published in the Oil and Gas Journal on this subject. The two equations presented have been investigated by the Japanese national committee. This evaluation cannot be completed without access to the data used to determine the equations. Repeated attempts to contact the author have been unsuccessful. The WG agreed to recommend to the EC that ICRN-23 have a 1 year extension. The WG also agreed to recommend to the EC that IAPWS contact the Oil and Gas Journal to help contact the paper author.

12. Metastable Steam and Nucleation, joint with WGs TPWS, PCAS, and SC SW. *

See TPWS minutes

13. Suggestions for IAPWS - CCT Collaboration. *

See TPWS minutes.

14. Discussion of Main Topics for 16th ICPWS 2013 in London*

See TPWS minutes.

15. Reports on Other TPWS, IRS and SC SW Activities

15.1 Updated IRS mission statement

The IRS mission statement has been updated as follows:
"To identify and prioritize industrial requirements for water, steam, and aqueous systems, to work with other IAPWS working groups to deliver solutions and to support implementation of solutions."
The IRS WG agreed to recommend to the EC the updated mission statement.

15.2 Guideline on Fundamental Constants. *

See TPWS minutes

15.3 Update of Advisory Note # 2: Roles of Various IAPWS Documents. *

See TPWS minutes

15.4 Changes to IAPWS By-laws

By-law changes were presented by A. Harvey. IRS agreed to recommend to the EC the proposed changes to the By-laws.

15.5 Gibbs Award Committee

J. Cooper was selected as the IRS WG representative on the Gibbs Award Committee.

15.6 Report of Advisory Note Task Group*

I. Weber reported that the TG had no activity the past year. It was recommended to keep the TG active, with the following changes: M. Hiegemann replaces W. Parry as Chair of the committee, P. Murphy added to the committee.
New TG membership:
M. Hiegemann (chair), W. Parry, B. Rukes and P. Murphy

15.7 Web presentation of Releases, etc. (A.H. Harvey)*

See TPWS minutes

15.8 Links to Live Calculations of IAPWS Releases on IAPWS Website*

See TPWS minutes

15.9 Steam Tables for Excel®, Mathcad®, and Pocket Calculators for Education on the IAPWS Website. *

See TPWS minutes

15.10 Liaison with IEC.*

See TPWS minutes

15.11 Discussion about IAPWS Meetings Regarding Locations and Costs. *

See TPWS minutes

16. Other Business

-Report on International Collaborative Projects *

See TPWS minutes

17. Membership

P. Murphy nominated A. Singh as a member of the IRS committee, J.M.H. Levelt-Sengers second the nomination. The WG elected A. Singh as a member of the IRS WG.

18. Preparation of the Press Release

Chairman and Clerk of Minutes prepared the IRS contribution to the Press Release

19. Preparation of the Formal Motion to the EC

Chairman and Clerk of Minutes prepared the report to the EC

20. Adjournment

Chairman I. Weber adjourned the meeting 2011-09-08, 17:10

Minutes

IAPWS Subcommittee on Seawater (SCSW)

Plzeň, Czech Republic, September 5-8, 2011

NOTE: These Minutes include some items that were held jointly with the TPWS and/or IRS Working Groups. Items are listed according to their order on the SCSW agenda, which is Attachment A. **Bold print** denotes significant actions.

1. The meeting was opened on Monday, September 5 by the SCSW Chair, Rainer Feistel. The agenda (Attachment A) was adopted.

2. Allan Harvey was appointed Clerk of Minutes for SCSW.

3. (included as item #3 in the TPWS Minutes)

4. (thermal conductivity) (included as item #5 in the TPWS Minutes)

5. (0.1 MPa liquid properties) (included as item #6 in the TPWS Minutes)

6. (humid gases) (included in IRS Minutes)

7. (seawater for industrial use) (included as item #9 in TPWS Minutes)

8.1. R. Feistel reported on the implementation into software libraries of the TEOS-10 standard formulations, which has been officially recommended for marine science by the International Union of Geodesy and Geophysics (IUGG) in 2011. Next steps in library development were described, although progress has been slowed by loss of key personnel. Details on the libraries are available at www.TEOS-10.org.

8.2. R. Feistel reported on recent measurements of density and sound speed in the group of F. Millero for seawater to moderately high temperatures at atmospheric pressure. J. Safarov reported on recent measurements, not yet published, of seawater densities over a wide range of temperature (to 195 °C), pressure (to 140 MPa) and salinity (to 55 g/kg). These data will all be useful for possible extension of the seawater thermodynamic formulation to higher temperatures as desired for some industrial applications.

8.3. S. Seitz and P. Spitzer reported on an ocean metrology project through the EMRP (European Metrology Research Programme). Areas of interest to IAPWS include traceability of practical salinity to density, getting data for sound speed over a wider range, metrology of dissolved oxygen, and standards for the pH of seawater and trace composition measurements.

8.4. B. Laky and S. Weinreben reported on the development of an instrument for high-accuracy measurements (also at sea) of the difference between seawater density and pure water density at the same temperature, as part of an effort toward making density-based salinity standards. The need to degas the fluids for reliable operation of the vibrating-tube instrument was emphasized. Some results were presented for Baltic Sea Water.

8.5. M. Hiegemann (with contributions from Task Group member H. Glade who was not present) reported on industrial requirements for seawater properties in desalination and other applications. To meet the needs of these industries, the tentative recommendation is for temperatures up to 150 °C to be covered, with salinities at least to 70 and preferably to 100. Pressures are not so high compared to oceanographic conditions (80 MPa to cover reverse osmosis). An industry survey was made, with 5 of 10 recipients responding. Suggestions regarding needs mostly did not affect the required range, but also included zero liquid discharge plants which have high salinities (and varying composition) at crystallization. In discussion, cooling towers was mentioned as another area of interest. **The Task Group will follow up with those who did not respond to the initial survey, and then incorporate the results into a revised seawater ICRN to be considered in 2012.**

8.6. A. Anderko summarized his work with P. Wang on modeling the thermal conductivity of seawater. The work turned out well, and has been submitted for publication. **Dr. Anderko and the Task Group on Transport Properties appointed in item 6 of the 2009 SCSW minutes were encouraged to work toward developing a an IAPWS Guideline, with minor changes to the current work so that it meets the new pure-water thermal conductivity correlation in the pure-water limit. The draft Guideline should be distributed prior to the 2012 meeting, at which time an Evaluation Task Group will be appointed with the goal of approving the formulation in 2013.**

8.7. R. Feistel, in conjunction with R. Pawlowicaz who was absent, presented an update on the electrical conductivity of natural waters and seawater. There is a desire to produce an IAPWS correlation equation for this property as a function of salinity, meeting the low-density limiting laws (part of which has been newly derived). Progress was also reported on a project for relating the chemical composition to conductivity, density, temperature, and salinity for less concentrated natural waters.

8.8. A. Anderko reported on his recently published work with P. Wang on surface tension of electrolyte solutions, which can be applied to seawater.

8.9. P. Spitzer presented work, some of which was done by G. Marion, on the varying standards and definitions used for pH and efforts to rationalize them in a way that works for seawater, including establishing uniform nomenclature, definitions, and conventions.

8.10. J. Safarov reported on his experimental work in progress for measuring the solubility of carbon dioxide in water and seawater from 273 K to 298 K up to about 5 MPa.

8.11. R. Feistel reported on some preliminary work with Jeremy Lovell-Smith on clarifying the different definitions in use for relative humidity..

8.12. Regarding the Mission Statement requested by the President, the following minor modification of last year's statement was adopted:

Intended for application in oceanography, marine technology and industry, it is the aim of the Subcommittee on Seawater to develop new and to improve existing formulations on thermophysical properties of seawater, including physical and chemical properties of related ambient substances such as ice, humid air and seawater solutes.

9. (metastable steam and nucleation) (included as item #12 in the TPWS Minutes)

10. (supercooled water) (included as item #13 In the TPWS Minutes)

11. (IAPWS/BIPM cooperation) (included as item #15 in the TPWS Minutes)

12.1-12.6 (included under item 19 of the TPWS Minutes)

13. **It was voted to accept to membership in SCSW O. Hellmuth (Leibniz Institute for Tropospheric Research) and J. Safarov (University of Rostock). It was announced that T. McDougall was stepping down as a Vice-Chair of SCSW. Rich Pawlowicz was selected as a new Vice Chair; we recommend that the EC approve this change.**

14. The SCSW endorsed the recommendations of the Website Task Group and the proposed change to the By-Laws.

15. The Chair and Clerk of Minutes were appointed to prepare the formal motion of the WG to the EC.

16. The meeting was adjourned at 5:15 PM on Thursday, September 8.

Agenda for the Subcommittee on Seawater (SC SW)

Pilsen, Czech Republic, 04-09 September 2011

1. Opening Remarks; Adoption of Agenda
2. Appointment of Clerk of Minutes
3. OPAL Web Space for Working Material for WGs TPWS, IRS, and SC SW, joint with WG IRS and TPWS
4. Release on the IAPWS Formulation 2011 for the Thermal Conductivity of Ordinary Water Substance, joint with WG IRS and TPWS
   - Report (J.V. Sengers, E. Vogel, R.A. Perkins, M.L. Huber, D.G. Friend, M.J. Assael, I.N. Metaxa)
   - Test Report on the Scientific Formulation (R. Mares, J. Hruby, K. Miyagawa, V. Vins, K. Orlov)
   - Test Report on the Industrial Formulation (W.T. Parry, J. Hruby, K. Miyagawa, V. Vins, K. Orlov)
   - Formal consideration of the Release
5. Revised Supplementary Release on Properties of Liquid Water at 0.1 MPa, joint with TPWS and WG IRS
   - Report (A.H. Harvey)
   - Test Report (K. Miyagawa, H.-J. Kretzschmar)
   - Formal consideration of the Revised Supplementary Release

Tuesday 01:30 pm:

6. Properties of Humid Air and Humid Combustion Gases for CCS Technology, joint with WGs IRS, PCAS, and TPWS
   - Thermodynamic Modeling of Processes Related to Carbon Dioxide Capture and Sequestration (A. Anderko)
   - Closing Statement for ICRN-14 (A.H. Harvey, R. Span)
   - Proposal for a new ICRN (R. Span, A.H. Harvey)
7. Guideline on the Properties of Seawater for Industrial Use, joint with WGs IRS, PCAS, and TPWS
   - Report of the Task Group (J. Cooper, R. Feistel, M. Hiegemann)
   - Report of the Evaluation Task Group (J. Hruby, R. Mares, K. Miyagawa)
   - Formal consideration of the Guideline
8. Properties of Seawater (R. Feistel), joint with TPWS and in part with WG IRS
   - 8.1 Implementation of TEOS-10 Libraries (T.J. McDougall, P. Barker, R. Feistel, J. Reissmann)
   - 8.2 New Seawater Measurements (R. Feistel, F.J. Millero, J. Safarov, A. Heintz, E. Hassel)
   - 8.3 The EMRP ENV05 Ocean Metrology Project (S. Seitz, P. Spitzer, H. Wolf)

8.4 Regular measurement of seawater density with Anton Paar instruments (B. Laky, S. Weinreben, R. Feistel)

8.5 Task Group Report "Industrial Requirements" (M. Hiegemann, J. Bellows, H. Glade)

8.6 Task Group Report "Transport Properties" (A. Anderko)

8.7 Electrical Conductivity of Seawater (R. Feistel, R. Pawlowicz)

8.8 Surface Tension of Aqueous Electrolytes (A. Anderko)

8.9 pH of Seawater and Pitzer Equations (P. Spitzer, G.M. Marion)

8.10 Solubility of CO_2 in Seawater (J. Safarov)

8.11 On the Definition of Relative Humidity (R. Feistel, J. Lovell-Smith)

Thursday 08:00 am:

9. Metastable Steam and Nucleation, joint with WGs IRS, PCAS, and TPWS
   - Report of the Task Group (J. Hruby, K. Yasuoka, N. Okita)

10. Properties of Supercooled Water, joint with PCAS and TPWS

    - Novel Thermodynamics and Equation of State for Supercooled Water - Proposal for an ICRN (V. Holten, Ch. Bertrand, J. Kalova, D. Fuentevilla, M. Anisimov, J. Sengers)

11. Suggestion for IAPWS - BIPM Collaboration, joint with TPWS
    - Report (R. Feistel, S. Rudtsch)

12. Reports on Other TPWS Activities

    12.1 Guideline on Fundamental Constants (A.H. Harvey), joint with WG IRS and TPWS

    12.2 Update of Advisory Note # 2: Roles of Various IAPWS Documents (J.R. Cooper, A.H. Harvey), joint with WG IRS and TPWS

    12.3 Report of the Advisory Note Task Group (I. Weber, W.T. Parry) , joint with TPWS

    12.4 Web presentation of Releases, etc. (A.H. Harvey), joint with WG IRS and TPWS

    12.5 Links to Live Calculations of IAPWS Releases on IAPWS Website (K.A. Orlov, V.F. Ochkov), joint with WG IRS and TPWS

    12.6 Discussion about IAPWS Meetings Regarding Locations and Costs (H.-J. Kretzschmar), joint with WG IRS and TPWS

13. Membership

14. Other Business

15. Preparation of the Formal Motion to the EC

16. Adjournment

2011 IAPWS Annual Meeting
Plzen, Czech Republic
September 5-9, 2011

PCAS WG Minutes

Present:

Masaru Nakahara (chair)	nakahara@scl.kyoto-u.ac.jp
Andre Anderko (vice chair, clerk of minutes)	aanderko@olisystems.com
Jana Ehlerova	jana.ehlerova@tul.cz
David Guzonas	guzonasd@aecl.ca
Frantisek Marsik	marsik@it.cas.cz
Tomas Nemec	nemec@it.cas.cz
Peter Tremaine	tremaine@uoguelph.ca
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Milan Sedlar	milan.sedlar@sigma.vvu.cz
Josef Sedlbauer	josef.sedlbauer@tul.cz
Nobuyuki Matubayasi	nobuyuki@scl.kyoto-u.ac.jp
Hertanto Adidharma	adidharma@uwyo.edu

Monday, September 5, morning

1. **Opening remarks.** Masaru Nakahara presented the meeting agenda, which was previously distributed by e-mail (PCAS Appendix A). The agenda has been adopted unchanged. Andre Anderko was appointed clerk of minutes.

2. **Minutes of the 2010 Meeting** in Niagara Falls were adopted as written.

3. **General policy regarding PCAS meetings.** Masaru Nakahara summarized the group's future policy with regard to meetings. PCAS will meet for internal discussions in separate meetings whereas most technical presentations and discussions will be carried out in joint meetings with other working groups.

4. **Mission statement.** Last year, we prepared a draft of a mission statement, which was subsequently distributed. Masaru Nakahara opened the mission statement for discussion. Frantisek Marsik proposed expanding the mission statement to incorporate items pertaining to the hydrogen economy. Also, it was questioned whether it is appropriate to focus on high-temperature systems considering that a substantial amount of work within PCAS pertains to low-temperature systems. Consensus has been reached that green technologies (such as hydrogen chemistry) should be included but the focus on high-temperature systems should remain to differentiate PCAS from other bodies that deal with aqueous chemistry. David Guzonas prepared a modified mission statement. The revised (in italics) mission statement reads:

   1) To provide critically evaluated thermodynamic and transport property data for solutes and interfaces in high-temperature high-pressure aqueous solutions of interest to the electric power industry, *developers of green technologies*, and other industrial applications.

2) To develop new experimental techniques and modeling methods needed to obtain key thermodynamic and transport property data for high temperature aqueous solutions and interfaces relevant to the IAPWS mission.

5. **PCAS output.** Possible forms of output from PCAS were discussed. It has been concluded that the project on hydration properties should result in a guideline or release.

6. Membership. Masaru Nakahara proposed to extend invitations to younger scientists to join PCAS and raised the topic of inactive members. It has been generally agreed that the PCAS chair will send out e-mails to inactive members to ask them whether they intend to participate. If they respond positively, they will be retained on the member list. If they respond negatively, they will be removed. If they do not respond after repeated attempts to contact them, they will be also removed.

Monday, September 5, afternoon

7. Topics for ICPWS 16 (London, UK). The group analyzed the draft program for ICPWS 16. The group went through the 14 topics that have been included in Jeff Cooper's draft. The following conclusions have been reached:

It is suggested to rename Symposium 5 "Reactions in Hydrothermal Systems" to differentiate it from Symposium 2, which deals with thermodynamics of aqueous systems in general.

For Symposium 3 ("Molecular Simulation & Spectroscopy in Aqueous Systems"), it may be beneficial to separate molecular simulation from spectroscopy, especially if the number of submissions warrants having separate symposia.

It is recommended to combine Symposium 8 ("Power Cycle Chemistry, IAPWS Technical Guidance Documents") and 9 ("Power Cycle Chemistry in Nuclear Plant, Safety and New Build") because of the closeness of topics.

Symposium 10 ("Water Purification & Other Auxiliary Systems") may be eliminated because of the narrowness of the topic.

The group suggested possible people to organize or co-organize the sessions that pertain to PCAS activities. Peter Tremaine would be willing to chair Symposia 2 or 5 or 12. Andre Anderko could do the same for Symposium 2. It has been suggested that Kenji Yasuoka and/or Igor Svishchev could chair Symposium 3 (or its molecular simulation component). Somebody may be considered in the area of hydrogen production.

8. Unesco letter. Masaru Nakahara has received a letter from UNESCO that explores the possibility of collaboration to disseminate knowledge in the area of aqueous chemistry. Masaru Nakahara will show the letter to the group and consider a response.

Tuesday, September 6, morning

9. PCAS Workshop "Transport, Hydration and Reactions in Hot Water"

Three presentations were given:

J. Sedlbauer, Establishing Recommended Data on Thermodynamic Properties of Hydration for Selected Solutes and Gases

This talk was delivered in relation to the hydration project supported jointly by IAPWS and IUPAC. The chair has continuously encouraged the publication of some papers on the hydration for the past few years. The group reviewed the complicated history of this project. The IAPWS financial support (8,000 euro) was expended before Josef Sedlbauer took over the project. He emphasized that model development was not part of the project. The data collection had been completed but no papers as yet. A summary paper is still in preparation. It may be submitted to the Journal of Physical and Chemical Reference Data. After the paper is finalized, a guideline or a release will be prepared.

M. Ueno, T. Matsui, T. Hoshino, Transport Properties of Tetraalkylammonium Ions in water and alcohols

Transport processes of Ionic mobility and association have been determined as functions of the concentration, temperature, and pressure by using a reliable conductivity equation. The behaviors of alkaline metal, halide, and a variety of tetraalkylammonium ions are investigated and compared from the viewpoint of the dynamic hydration. The experimental results were discussed in terms of the Hubbard-Onsager dielectric friction theory.

Y. Tsujino and M. Nakahara, Noncatalytic Hydrothermal Reaction of Carbon Dioxide with Hydrogen to Form Formic Acid

The kinetics and thermodynamics of the new version of the Water-Gas-Shift Reaction (formic acid discovered as the reaction intermediate) were investigated. It was emphasized that formic acid is useful for the green applications, such as the CO_2 sequestration and the H_2 chemical tank for fuel cells etc.

Tuesday, September 6, afternoon

10. TPWS/PCC/PCAS Joint WG Meeting and Workshop

The following presentation was given:

A. Anderko, P. Wang, M.M. Lencka, R.D. Springer and J.J. Kosinski, Thermodynamic Modeling of Processes Related to Carbon Dioxide Capture and Sequestration

The thermodynamic equilibrium data where carbon dioxide and amines are involved were collected and formulated. The formulation of the equilibrium of the neutralization reactions is studied for the applications.

Thursday, September 8, morning

11. TPWS/PCAS Joint Meeting

The following presentations were given:

N. Okita, Dew Point for Flue Gas in Power Plant Exhaust: Status of Dew Point Equations (in relation to ICRN 23)

R. Span, Thermodynamic Properties of Humid Gases and CO_2 – Rich Mixtures (in relation to closing ICRN 14 and formulating a new ICRN)

J. Hruby, Thermodynamic Properties of Metastable Steam (in relation to closing ICRN 15 and proposing a new ICRN on Thermophysical Properties of Metastable Steam and Homogeneous Nucleation)

V. Holten, C. Bertrand, J. Kalova, D. Fuentavilla, M. Anisimov, J. Sengers, Peculiar Thermodynamics of Supercooled Water

O. Marsalek, Structure, Dynamics and Reactivity of Hydrated Electron

N. Matubayasi, Molecular Study of Hydration Over a Wide Range of Thermodynamic Conditions (PCAS contribution)

Hydration free energies computed for H_2, CO, CO_2, CH_4, HCOOH, CH_3OH, etc. as a function of temperature and density of water were reviewed. Molecular interpretation of the hydration mechanism was given for hydrophobic and hydrophilic solutes.

R. Sakamaki and K. Yasuoka, Molecular Dynamic Simulation of Vapor-Liquid Coexistence for Water and Methane-Water

Thursday, September 8, afternoon

12. Membership. The issues of dealing with inactive members have been revisited. The group went through the membership list and decided to remove the members who cannot be contacted. For the remaining inactive members, an attempt will be made to contact them by e-mail and clarify their intentions to continue their membership.

13. ICRNs. ICRN 10 (pH Measurements and Potentiometric Studies of Supercritical Aqueous Solutions) will be closed. Frantisek Marsik will prepare a new version of this ICRN. Also, Masaru Nakahara indicated that there will be a joint ICRN with PCC on electrochemical potential sensors.

14. Gibbs Award Committee. Andre (Vice-chair)

15. International collaboration. No international collaboration is currently planned.

Adjournment. The meeting adjourned at 2:30 pm.

The International Association for the Properties of Water and Steam
http://www.iapws.org

Physical Chemistry of Aqueous Systems Working Group (PCAS WG)

Preliminary Schedule

Pilzen, Czech Republic, 4 – 9 September, 2011

Sun 4, Sept.		Informal Get-together, Cocktails and Registration
Mon 5	08:30	Opening Plenary Session - Executive Committee
	10:00	PCAS Meeting
	13:30	PCAS Meeting
Tue 6	08:30	PCAS Workshop on "Transport, Hydration, and Reactions in Hot Water" 1. Josef Sedlbauer: Progress Report on the IAPWS Project on High-temperature Hydration Thermodynamics of Some Organic Compounds and Gases 2. Masakatsu Ueno: Transport Processes of Tetraalkylammonium Ions in Water and Alcohols at High Temperatures 3. Yasuo Tsujino and Masaru Nakahara: Noncatalytic Hydrothermal Reaction of Carbon Dioxide with Hydrogen to Form Formic Acid
	10:30	PCAS Joint (TPWS/IRS/SCSW/PCC) Meeting
	13:30	PCAS/TPWS/IRS/SCSW/PCC Joint Meeting and Workshop From PCAS, Andre Anderko talks on: Thermodynamic Modeling of Processes Related to Carbon Dioxide Capture and Sequestration
	15:30	PCAS/TPWS/IRS/SCSW/PCC Joint Meeting
Wed 7	09:00-17:00	IAPWS Symposium "Water and Aqueous Mixtures: Research for Future Energy Technologies"
Thu 8	08:30	PCAS/TPWS Joint Meeting From PCAS, Nobuyuki Matubayasi talks on: Molecular study of hydration over a wide range of thermodynamic conditions
	11:00	PCAS Meeting
	13:30	PCAS Meeting (Summary, Report for EC)
		IAPWS Dinner/Banquet
Fri 9	08:30	EC Meeting (8:30-13:00)
	13:30-15:30	Technical Visit to SKODA JS

Agenda for PCAS WG

1. Opening
2. Appointment of Clerk for Minutes
3. Adoption of Schedule and Agenda
4. PCAS Missions and Activity Style
5. Progress Report and Future perspective on The Hydration Project by Josef
6. Possibility of International Collaboration Project
7. Possibility of Release
8. Possibility of ICRN
9. Membership
10. Others

IAPWS Working Group Power Cycle Chemistry (PCC)

Minutes of IAPWS PCC WG Meetings
Plzeň, Czech Republic, 4-9 September 2011.

Chairman: Robert Svoboda
Members present See PCC Attachment A

1. Agenda

1.1. Amendments / Adoption of Agenda
There were no amendments to the draft agenda.

1.2. Week program: split up of PCC for joint workshops and task groups.
R. Svoboda summarized the schedule.

2. Appointment of Clerk of Minutes

G. Bignold agreed to act as Clerk of Minutes.

3. Approval of Minutes of PCC WG in Niagara Falls, Canada, 2010

The minutes were approved without any corrections.

4. Progress Reports on PCC Activities 2010 / 2011

4.1. International Collaboration

D. Lister reported that progress with the collaboration on sampling had been unavoidably delayed as a result of the Japanese earthquake disaster. He described the development of equipment for the programme and the results of initial tests showing the need for adaptations to experimental techniques to avoid the influence of the iron content of the titanium sample lines on the results. The student, J. Xiong, had benefitted from substantial help and advice from S. Uchida, K. Daucik and R. Svoboda. The delays would require extension of the programme into 2012.

R.Svoboda commented on the variations between the tests with titanium sample lines and the common industrial practice of using stainless steel. He suggested that experiments in stainless steel using radiotracers would be a valuable alternative.

M. Rziha suggested the use of hot thioglycollic acid for recovering deposited iron (rather than the nitric/hydrofluoric acid mixture that had proved too aggressive).

J. Bellows noted the importance of controlling redox conditions in generating the source iron for the tests.

G. Bignold indicated that practical plant experience was that mixtures of dissolved iron and particulate oxides gave substantially higher total iron concentrations than had been generated in the experiments to date.

T. Petrova asked for clarification of the chemistry used to control pH in the samples. LiOH had been used for pH control.

F-U. Leidich indicated examples in ultra-supercritical plants where carbon steel materials have been used for sample lines; release of materials from these has influenced conductivity and pH.

The progress report is available in PCC 2011 workshop handouts. The continuing importance of the topic of representative sampling was agreed.

The PCC had no new proposals for international collaboration in 2011. D. Lister suggested that a proposal for a further phase of work would be appropriate and agreed to produce a draft for PCC consideration by end of May 2012.

Action D. Lister

4.2. ICRN

ICRN#13 on Surface tension. F. Gabrielli had prepared a closure statement. R.Svoboda proposed its circulation to PCC members for their agreement.
Action R. Svoboda

ICRN#17 on Amines. J.Bellows undertook to provide an update to A. Harvey (for IAPWS website) by the end of the meetings.

Action J. Bellows

ICRN#18 on Thermal decomposition of ion exchange resins. A closure statement has been published (K. Daucik). No further action.

ICRN#19 on Sampling of corrosion products. Subject to minor updating on the basis of the on-going work.

ICRN #20 on High temperature sensors. S Uchida presented the current version of this ICRN at the PCC workshop. It was agreed that the draft should be fully supported. R. Svoboda will seek Executive approval for postal ballot by National Committees.

Action R.Svoboda

ICRN#25 on Corrosion mechanisms that are related to the presence of contaminants in steam/water circuits, particularly in boiler-water. W. Cook had incorporated all comments received on the draft and undertook to have further discussions with J.Bellows and G Bignold before submission to PCC for approval. Deadline - end of September.

Action W. Cook, J Bellows, G. Bignold.

ICRN#26 on Behaviour of Aluminium in the Steam Water Cycle of Power Plants has been circulated to National Committees for postal ballot in October 2010.

4.3. PCC Task Groups

IAPWS Guidance documents

B. Dooley reviewed progress over the last three years. Three guidance documents have been issued, covering carry-over, key instrumentation and AVT chemistry for steam/water circuits and all are now in widespread use worldwide.

The most recent changes to the new guidance document on alkaline treatments for drum boiler plants were presented by B. Dooley and unanimously approved by PCC. It was agreed that this document is now ready for presentation to the IAPWS Executive for final approval on 9 September.

Action R. Svoboda

H. Takaku introduced a number of potential updates to the guideline document on instrumentation for power cycle steam/water cycles. These included introduction of an additional column covering optional choices within the tables and the use of silica monitors for drum boiler water. The suggestions were debated. The case against recommending silica monitoring for boiler water was put forward by M.Rziha. The case for keeping optional alternatives in the main text of the document rather than in the tables was made by B.Dooley and M.Rziha. G.Bignold agreed to lead a task group to consider the upgrades proposed by the Japanese committee and to submit a revision for PCC consideration. Task Group to include M, Ball, B.Dooley, M. Hellman, F.-U. Leidich, M. Rziha, H. Takaku.

Action G. Bignold

S.Uchida reported that, as a result of discussions between interested parties, the proposal to develop a guidance document for circuit chemistry for nuclear plants, potentially in collaboration with IAEA, has been put in abeyance at this time.

R.Svoboda reported that progress has been made on the development of a guidance document on steam purity requirements for steam turbines. It is aimed to circulate an early draft for comment by the end of November. Task Group comprises B. Dooley, J. Bellows, M. Rziha, R. Svoboda, H. Takaku.

Action R. Svoboda

The potential for a guidance document on sampling and QA/QC for steam/water circuit monitoring was discussed. M. Rziha stated the strong case for the production of such a

document. F-U. Leidich reported that VGB are actively producing a document covering sampling; G. Bignold also stated that an ISO standard exists and is currently under revision. PCC agreed that an IAPWS guidance document should be aimed at underwriting the strategy of the more specific recommendations in ISO, VGB and other more detailed guidelines. A Task Group will be led by D. Lister and will comprise P. Colman, W. Cook, k. Daucik, F.-U. Leidich, H. Takaku, K. Thomsen, R. Svoboda and S.Uchida.

Action D.Lister

PCC policy with regard to review of guidance documents was debated. It was agreed that the documents can be updated whenever there is new information to be included, and would be subject to review every five years.

Quantification of chemistry related asset damage,

K. Daucik reported that, despite the importance, no new information had been made available since the last meeting. Accordingly, he agreed to prepare a paper for publication, based on the material that he had presented in 2009.

Action K.Daucik

4.4. European Standard EN 12952

G.Bignold reported that the task of revision of both of the CEN standards covering boiler water chemistry requirements (EN 12952 part 12 and EN 12953 part 10) had been added to the work lists of the Working Groups of CEN technical committee TC269. The working groups had yet to implement this work.

BIAPWS will continue to maintain contact with the revision (via representation by M. Robson on BSi and via representation by P. Colman on the Irish Standards committee).

4.5. PCC Public Relations

R. Svoboda expressed the PCC's gratitude to A. Bursik for publication of information about PCC meetings in PowerPlant Chemistry.

The suggestion made by J. Cooper that the subject of the Guidance Documents should be the basis for a Symposium at the ICPWS in 2013 was endorsed.

B. Dooley recommended that there should be a change to IAPWS Statutes to elevate the Technical Guidance Documents to the same level of authority as IAPWS Releases. This would make Guidance Documents major activities of IAPWS. R. Svoboda agreed to take this proposal to the executive.

Action R. Svoboda

PCC supported the proposal that they should be actively associated with the forthcoming relevant conferences on water chemistry of nuclear reactor systems (France 2012) and on flow accelerated corrosion (USA an France 2013).

A proposal for a letter to every manufacturer of fossil and combined cycle plants promoting the use of the IAPWS Guidance Documents was discussed. No actions were agreed.

4.6. Other Action List Items

There were no other items not covered on the agenda.

5. Priority List Review

The priority list was discussed on a point by point basis. The outcome is attached (attachment C).

6. Other Business

PCC re-examined the current mission statement and M. Rziha proposed that it remains fully fit for purpose and requires no updating in 2011. This view was unanimously agreed. R. Svoboda will report this position to the executive.

Action R.Svoboda

M.Rziha chaired a discussion PPC views on the topics for the ICPWS in U.K. in 2013. The PCC's proposals to the ICPWS programme committee and IAPWS executive are set out in Attachment D.

7. Changes in Membership, election of Officers

News of the recent death of Eric Maughan was greeted with great sadness. Eric's lively temperament and capacity for open debate will be sadly missed. J.Bellows will convey PCCs condolences to Mrs Maughan.

R. Svoboda has completed five years as PCC Chairman and is now stepping down. The appointment of M. Rziha as Chairman was unanimously agreed.

M. Rziha proposed that A. Rudge be approached to stand as new vice-chairman. PCC agreed to this suggestion. R. Svoboda will contact A. Rudge to request that he should take on the role. Action R.Svoboda

D. Smetanin has withdrawn from membership of PCC (information supplied by T. Petrova).

B. Hughes has recently left the industry. His status with respect to PCC will be clarified by BIAPWS (G. Bignold).

Apologies for absence from the current meeting had been received from Andre Bartos, Frank Gabrielli, Richard Harries, Sven-Erik Therkildsen and Andy Rudge.

The following new members of PCC were proposed and unanimously accepted.

New Member	Proposed by:	Seconded by:
Karsten Thomsen	K. Daucik	M. Rziha
Pavel Gotovsev	R. Svoboda	B. Dooley
Willy Cook	D. Lister	R. Svoboda
Frank de Vos	M. Rziha	G. Bignold
Gary Joy	B.Dooley	R. Svoboda
Melonie Myszczyszyn	J. Bellows	K. Daucik

R.Svoboda will propose acceptance of these additional PCC members by the executive committee.

8. Preparation of Action List 2010 / 2011, Task Distribution, Next Year's Agenda

9. Preparation of PCC WG Report for Executive Meeting

10. Miscellaneous and Adjournment

Plzeň, Czech Republic, 4-9 September 2011

Those present at the PCC WG meeting were as follows:

J Bellows	USA
G Bignold	UK
A. Bursik	Germany
P.Colman	Ireland
W Cook	Canada
K Daucik	Denmark
F de Vos	Netherlands
B Dooley	Canada / USA
A. Drexler	Germany
A. Fredrikson	Sweden
P Gotovtsev	Russia
S Hanawa	Japan
V. Hanus	Czech Republic
M. Hellman	Sweden
I Hey	Canada
T Ichihara	Japan
G.Joy	Auatralia
B. Larin	Russia
F.-U. Leidich	Germany
D Lister	Canada
H. Kido	Japan
M Miyajima	Japan
M Myszczyszyn	Canada
T. Petrova	Russia
P. Rudasová	Czech Republic
M Rziha	Germany
P Safařik	Czech Republic
M.Štăstny	Czech Republic
R Svoboda	Switzerland (Chair PCC)
H Takaku	Japan
K. Thomsen	Denmark
S. Vidokovic	Serbia
S Uchida	Japan
H. Zychová	Czech Republic

Plzeň, Czech Republic, 4-9 September 2011

PCAS / PCC workshop (Tuesday 13:30 - 15:30)

1. Andre Anderko: "Thermodynamic Modelling of Processes Related to Carbon Dioxide Capture and Sequestration" (*)

2. Vaclav Vins, Andreas Jäger, Johannes Gernert: "Development of Thermodynamic Models for Hydrates in Water–Carbon Dioxide Mixture" (*)

3. Joint PCSAS / PCC discussion on draft ICRN 20: Sensors for use at Elevated Temperature in the Plant Cycle of the Power Industry" (Uchida)

4. Satoshi Hanawa (JAEA): "High Temperature ECP Sensors to Be Applied in An In-pile Loop of An Experimental Reactor"

5. Hiroshi Takaku, (Prof., Shinshu University, retired), Li-Bin Niu (Associate Prof., Shinshu University) and Hodaka Katou (Graduate Student of Shinshu University): "Crevice corrosion of LP steam turbine materials evaluated by electrochemical re-passivation potential measurement in simulated AVT water with mixed chloride and sulphate ions"

6. Robert Svoboda, Brett A.Reinboth, Matthias Svoboda: "Monitoring generator cooling water system chemistry by the electrochemical potential"

7. Miroslav Stastny, Miroslav Sejna: Effects of Expansion Rate on Binary Condensation of NaCl and Steam Flowing in a Turbine Cascade"

PCC workshop (Tuesday 08:30-12:00 and Thursday 08:30-10:00)
Update on Power Cycle Chemistry Research and Experience

1. Tarou Ichihara , Haruka Kido (Mitsubishi Heavy Industries, LTD.): "Achievement on OT (Oxygenated Feed-Water Treatment) Application in Japan"

2. Shunsuke Uchida: (JAEA) "The Effects of Ferrous Ion Transport in Bulk Water on FAC Rate"

3. M. Yoshida and K. Marugame (Naigai Chemical Products Co.), M. Matsumura (Hiroshima University) H. Takaku: "The Evaluation of FAC by Jet-In-Slit Equipment and the Effect of Pre-filming on the FAC"

4. I.Burakov, T.Petrova (MPEI): "Influence of amines on corrosion rate of carbon steel in boiling water"

5. P.Gototvtsev, V.Voronov. "Mathematical Modelling at Cycle Chemistry Monitoring Systems"

6. Andreas Drexler, Ute Ramminger, Jörg Fandrich (Areva): "Conditioning and Lay-up of secondary side systems in nuclear power plant with film forming amine"

7. Shunsuke Uchida (JAEA): "Water Chemistry Guidance in Nuclear Power Plants in Japan"

8. Michael Rziha (Siemens): "Overview on VGB-working groups activities regarding the guidelines R450 (Chemistry Steam Water Cycle - update), and R451 (Sampling - new guideline)"

9. Karsten Thomsen (Vattenfall, DK): "Action limits and supervision in the revised VGB 450L guideline"

10. Frank-Udo Leidich (Alstom): "Cold end corrosion in steam turbines: diagnosis and remedies"

11. Jinbiao Xiong (University of Tokyo), Derek Lister (University of New Brunswick): "Results of the International Collaboration Project on improved sampling techniques for corrosion products in water"

12. B.M.Larin, E.N.Bushuev, Yu.Yu. Tikhomirova, S.V.Kiet (Ivanovo State Energy University); "Determination of Phosphate Concentration in Boiler Water using Conductivity Measurements"

Plzeň, Czech Republic, 4-9 September 2011

PCC Priority List for Further Research

1. Interfacial situation in advanced ultra supercritical plants

Formation and exfoliation mechanism of scale (oxide films) in steam lines
effects of chemistry (oxygen, ammonia ?)
Corrosion interactions materials / steam, influence / effect of supercritical parameters, protective layers, radiation
Faster decomposition of chemicals (TOC, ammonia etc)?

Status 2011: Joint PPC/PCAS ICRN #21 is on the IAPWS website

2. Development / Application of Sensors (Ambient and High Temperature Sensors)

ECP (nuclear, fossil application), ORP,
problem: abstract parameters, acceptance by plant operators

Status 2010: ICRN #20 has been issued in 2006, some activities known in 2009 (Balashov, Petkin, Lvov), re-formulation in 2010 related to the needs from nuclear industry (Uchida), 2011: still on-going

3. * Corrosion mechanisms that are related to the presence of contaminants in steam/water circuits, particularly in boiler-water

Define critical species / quantify critical quantities of steam generator water impurities, synergy with other species (e.g. oxygen), consideration of the materials

Status 2011: Geoff Bignold drafted ICRN #25 and passed the responsibility to Willy Cook. To be finalized in 2011 (Cook, Bignold, Bellows)

4. * The relationships between the chemistry of the contaminants and their concentration at point of measurement

Main scope will be the minimum requirements for sampling specifically for Fe, Cu, Co, Oxygen, etc.

Status 2011: ICRN #19 on sampling has been extended to 2012. International collaboration 2006/7 2010/2012. (Uchida, Lister, Daucik, Svoboda). 4 papers by Piti et al. IAPWS Guidance Document on sampling under consideration

5. * The quantification of risk of asset damage

problems of getting background data, important long-term issue
need: tool for operators, design engineers & commercial persons
PCC: to provide basic background data, e.g. corrosion / deposition rates

PCC task group has been set up (chair: K.Daucik)
Status 2011: available information has been compiled, although insufficient for being basis of an IAPWS document, a publication on the existing results will be made (Daucik, 2012)

6. Improved understanding of condensation mechanisms

- dropwise vs filmwise condensation in condensers (improve heat transfer)
- heterogeneous – homogeneous nucleation models for prediction of condensation in steam turbines (chemistry, electrostatic,...)

- chemistry of the phase transition zone in nuclear turbine systems
- development of liquid films on surfaces in saturated steam environments
  (especially with regard to Flow Accelerated Corrosion)

ICRN #22 is on the IAPWS website; additional ICRN on FAC related issue may be considered for 2012

7. Deposition of contaminants and corrosion products in steam and water circuits

- supersaturation,
- mass transfer,
- adsorption,
- crystal nucleation,
- deposit re-dissolution,
- scouring and exfoliation,
- activation and activity transport in reactor systems
- Mechanism and Influence of Cu Deposition :
  (essentially a solved problem from a scientific viewpoint)
  - mechanism of deposition on a turbine blade is not understood
  - discrepancies in temperature influence on deposition (?)

Status 2011: wide range of information available and research ongoing, opportunity for several ICRN

8. Radiation chemistry of water

Radiolysis, main importance for nuclear generation

2007 PCAS/PCC presentations have been made

Status 2011: major issue for supercritical water reactors. Workshops held regularly in connection to the bi-annual International Conference on Water Chemistry in Nuclear Reactor Systems

9. * Behaviour of Aluminium in the steam / water cycle

- **Al release under various water treatment regimes**
- volatile carry-over and deposition in the turbine
- depsoition on boiler tubes,
- solubility in water and steam
- behaviour in condensate purification
- interaction of Al with boiler chemistry
- specfication values for Al in feedwater, boilerwater, steam
- impact of the use of Al on materials and cycle chemistry of the rest of the cycle

Status 2011: ICRN #26 in processing, final draft is available (Rziha, Svoboda)

10. Water cooling of copper in electrical machines

- generator stators
- accelerators

Status 2011: paper at ICPWS 2008;EPRI guideline 2008, CIGRE guidance document to be published (draft document approved), new investigations Palmer/Svoboda considered

11. Water use outside the steam / water cycle

- cooling water
- waste water
- external process
- recycling for use as make-up
- etc.

For further consideration for 2012, possibly new IAPWS sub-committee.
PCC does not have the resources to take leadership on these items.

12. Chemistry in geothermal and oil / sand cycles

Behaviour of water constituents, effects on system materials, geochemical and waste water issues, including behaviour of radionuclides in these waters.

Status 2011: ICRN to be considered for 2012 (Leidich, Rziha, Myszczyszyn)

**** urgent priority***

The numbering in the list is made for reference only and does not contain any information on actual priority

In addition, PCC should maintain awareness of the following items

- Chemistry and corrosion related items to future nuclear generation systems (6-best-design-reactor concepts, Generation IV reactor plants, ITER)

- High pressure / high temperature steam and humid air (24 MPa and up, 2000°C), thermophysical properties and chemistry formulation.
  (Long term interest in power industry, Treated in TPWS)

Plzeň, Czech Republic, 4-9 September 2011

Symposia for 16th ICPWS

Number	Title
1	Calculation of Props for Industry *Including Water Injection into Gas Turbine Compressors*
2	Thermodynamic & Transport Props of Aqueous Systems
3	Molecular Simulation & Spectroscopy in Aqueous Systems
4	Non Equilibrium, Metastable & Critical State
5	Thermodynamics & Kinetics in Hydrothermal Systems
6	Electrochemistry & Corrosion in High Temperature Water
7	Apparatus, Materials & Monitoring Instrumentation for Application at High Temperatures & Pressures
8	Power Cycle Chemistry in Plants with Fossil and Renewable Energy Sources

- Combined Cycles
- Fossil Fired Plants
- Solar Plants
- Geothermal Plants

- **Separate Half Day Workshop** on *IAPWS Technical Guidance Documents*
  # Introduction of Guidance Documents
  # Discussion on Philosophy of Guidance Documents
  # Discussion with Expert Panel (Members from PCC)
  # Discussion for the Needs on New Guidance Documents

9	Power Cycle Chemistry in Plants with Nuclear Energy Sources Fusion Reactors (ITER) Supercritical Reactors, Generation 4 Reactors, etc. *Safety and New Build*
10	Water Purification & Chemistry of Auxiliary Systems

- Auxiliary Systems
- Cooling Water
- Air Cooled Condenser
- Membrane Techniques
- Re-use of Water / Zero Discharge Concepts
- Hybrid Cooling Systems

11	CO_2 in Power Generation Capture, Transportation& Storage
12	Hydrothermal Geochemistry
13	*Supercritical Water for Advanved Materials Synthesis Waste Treatment etc.*
14	Themophysical Props. of Sea Water. Application to Global Climatic and Oceanographic Modeling & Desalination

Proposal for Young Scientist IAPWS Fellowship Project

Towards an IAPWS Guideline for the Thermodynamic Properties of Supercooled Water

IAPWS Sponsors

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August 2011

Abstract

Support is requested for an IAPWS Fellowship for a young scientist, Vincent Holten, to pursue research "Towards an IAPWS guideline for the thermodynamic properties of supercooled water"

1. INTRODUCTION

During the past decades considerable amount of experimental information for thermodynamic properties of supercooled water has become available (see Attachments). These experiments have revealed an anomalous temperature dependence of the isobaric heat capacity, the isothermal compressibility, and the thermal expansivity coefficient of supercooled water. Several scenarios for explaining the anomalous behavior of these thermodynamic properties have been proposed. One theoretical possibility is the suggested presence of a metastable liquid-liquid critical point in supercooled water.

In a previous project supported by IAWPS it was demonstrated that a simple engineering-type cubic mean-field equation of state did indicate that the presumed existence of such a liquid-liquid critical point does yield a plausible physical explanation of the anomalous temperature dependence of the thermodynamic properties mentioned above (Attachment I). This observation was confirmed by Bertrand and Anisimov [1] on the basis of a nonclassical model for the critical thermodynamic behavior of supercooled water. The analysis of Bertrand and Anisimov [1], as well as some earlier work of Fuentevilla and Anisimov [2], encouraged us to embark on a project towards the possible development of a theoretical model for the thermodynamic properties of supercooled water that would yield not only a physical explanation for the anomalous temperature dependence of heat capacity, compressibility, and expansivity, but also an accurate representation of all experimental data, include the dependence of volume or density on temperature and pressure. A report on the status of this project is presented in Appendix II.

The project proposed will not only enable IAPWS to be actively engaged in a subject of considerable contemporary scientific interest , but it is also of direct relevance to IAPWS, since the thermodynamic behavior of supercooled water serves as a reference standard for a description of the thermodynamic properties of seawater. For future work of IAPWS on the thermodynamic properties of seawater information for the equation of state of supercooled water at least down to –25°C and up to 150 MPa will be desirable [3]. As documented in Attachment II, extrapolation of the IAPWS-95 formulation for the thermodynamic properties of H_2O does not yield a satisfactory representation of the thermodynamic properties of supercooled water.

2. Issues

In Attachment II it is demonstrated that a theoretical model based on the existence of a metastable liquid-liquid critical point can represent the experimental thermodynamic property data of supercooled water up to pressures of 150 MPa, which is the pressure range of direct interest to IAPWS [3]. It is even possible to modify the model empirically so as to obtain a representation of the thermodynamic properties of supercooled water up to pressures of 400 MPa. However, before we can propose a guideline for a fundamental equation of state for supercooled water, still a number of issues need to be addressed.

First the theoretical model assumes a linear dependence of the liquid-liquid curve on temperature and pressure. While the location of this liquid-liquid curve is somewhat uncertain, it is likely not a straight line as a function of temperature and pressure. We need to investigate how to incorporate curvature of the liquid-liquid transition line into the theory.

The presumed existence of a liquid-liquid critical point is not the only possible explanation proposed for the anomalous behavior of the thermodynamic properties of supercooled water as discussed in Section 7 of Attachment II. A scientifically extremely interesting question is whether we can rule out any of the other scenarios suggested for the cause of the anomalous thermodynamic behavior of supercooled water. One example to be addressed is whether response functions, like the compressibility, diverge at only one temperature corresponding to a critical temperature, or to a range of temperatures corresponding to a spinodal curve.

Nevertheless, without prejudging the results of the results, we do think it should be possible to develop a reliable guideline for the thermodynamic properties of supercooled water al least in the range of temperatures and pressures of direct relevance to an IAPWS.

Another goal of the project is the development of a representative equation for the surface tension of supercooled water. The research will be pursued in collaboration with the Institute of Thermodynamics, Academy of Sciences of the Czech Republic, where scientists have embarked on an experimental program for measuring the surface tension and of densities at high pressures of supercooled water.

3. Young investigator

We have found a young scientist, Vincent Holten, from the Technical University Eindhoven who is uniquely qualified to pursue this research. A Curriculum Vitae of Vincent Holten is presented in Attachment III.

Vincent Holten has a Ph.D. from the Technical University Eindhoven in The Netherlands. As part of his Ph.D. research he studied the thermophysical properties of supercooled water and his thesis contains a review of this subject. In Eindhoven he also started collaboration with Jan Hrubý on the surface tension of supercooled water.

From April 1, 2011 till the present Vincent Holten has been working as a Visiting Assistant Research Scholar at the University of Maryland on the subject of thermodynamic modeling of supercooled water. The stay of Vincent Holten at the University of Maryland was part of an exchange program between the Burgers Program for Fluid Dynamics at the University of Maryland and the J.M. Burgerscentrum for Fluid Mechanics in The Netherlands. Vincent Holten is also the leading author of Attachment II.

3. Implementation of project

We envision a nine-month project starting October 1, 2011. For this purpose Vincent Holten will return to the University of Maryland the end of September on a travel grant from the J.M. Burgerscentrum in The Netherlands. His stay at the University of Maryland from October 1 till December 31, 2011 will be supported by a research grant from the Division of Chemistry of the US National Science Foundation. We request IAPWS support for a six-months stay of Vincent Holten at the University of Maryland from January 1 till June 30, 2012. A report on the research to be completed under this project will be reported at the 2012 annual meeting of IAPWS.

3. Budget (in $ US)

Subsistence for 6 months for IAPWS Young Scientist……$ 19,200

References

[1] C.E. Bertrand and M.A. Anisimov, J. Phys. Chem. B, in press.
(doi: 10.1021/jp204011z).
[2] D.A. Fuentevilla and M.A. Anisimov, Phys. Rev. Lett. **97**, 195702 (2006), erratum ibid. **98**, 149904 (2007).
[3] R. Feistel, private communication (2011).

Attachment I: J. Kalova, R. Mareš, M.A. Anisimov, and J.V. Sengers, *Scaled equation of state for supercooled water in the mean-field approximation*, Technical Report (International Association for the Properties of Water and Steam, September, 2011).

Attachment II: V. Holten, C.E. Bertrand, M.A. Anisimov, and J.V. Sengers, *Thermodynamic modeling of supercooled water*, Technical Report (International Association for the Properties of Water and Steam, September, 2011).

Attachment III: Curriculum Vitae of Vincent Holten

Note: This proposal has been endorsed by Andre Zeijseink, representative of IAPWS in The Netherlands.

Highlights

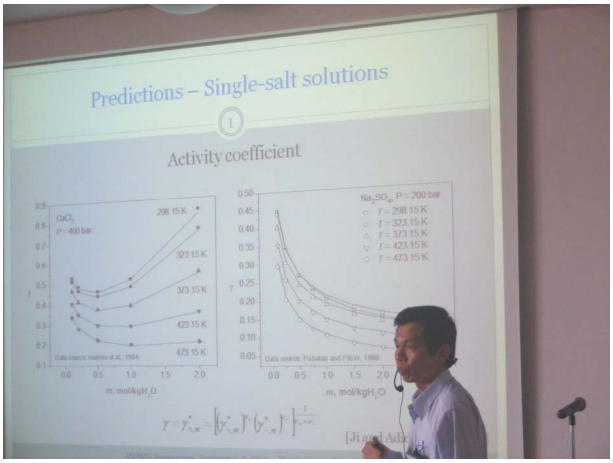
International Association for the Properties of Water and Steam

2011 Meeting

Continuing a series of conferences started in 1929, 89 scientists and engineers from 16 countries attended the annual meetings of the International Association for the Properties of Water and Steam (IAPWS), September 4-9 in Plzen, Czech Republic. The meeting was hosted by the Czech National Committee of IAPWS and the University of West Bohemia in Plzen. The meeting connects academic researchers with engineers who use their information. It provides the researcher with guidance on useful problems and provides the engineers with the latest research. IAPWS has traditionally concentrated on the science underlying the thermodynamics and chemistry in steam power plants, but is broadening into other aspects of power generation and high temperature aqueous systems as well as seawater and ice. Discussions range from puzzling power plant chemistry results to reports on solutions to such problems to practical implications of fundamental theory and molecular modeling of thermodynamic and transport properties.

This year IAPWS welcomed an Australian national committee and a New Zealand national committee as new associate members.

The IAPWS delegates were joined by 22 additional people from the Czech Republic for a symposium on **Water and Aqueous Mixtures: Research for Future Energy Technologies**. The symposium opened with the IAPWS Helmholtz award lecture "Towards a Complete Thermodynamic Description of Geologic and Industrial Aqueous Electrolyte Systems: A Statistical Associating Fluid Theory Approach", given by Hertanto Adidharma of the University of Wyoming. The Helmholtz Award is given annually to a young scientist for work of interest to IAPWS. The symposium continued with presentations on molecular modeling of aqueous systems, new steam turbines for ultrasupercritical plants, supercritical water reactors, and an authoritative review of the events at Fukushima, Japan.



Hertanto Adidharma presents the IAPWS Helmholtz Award Lecture, introducing many in the audience to Statistical Associating Fluid Theory.

IAPWS produces releases, guidelines, technical guidance documents, and certified research needs (ICRN's). Information may be found at the IAPWS website: www.iapws.org.

A major accomplishment was the Release on the Thermal Conductivity, the first complete update in over 30 years. The release was an international effort jointly with the International Association for Transport Properties. This release completes the complete revision of the state-of-the-art formulations for the properties of water and steam that started with the release on the thermodynamic properties in 1995.

The ICRN is guidance for funding agencies and an aid to people doing research in defining important research. ICRN's expressing the need for improved thermodynamic properties of CO2-rich systems for carbon capture and sequestration and for improved understanding of homogeneous nucleation and properties of metastable steam were approved this year.

The new seawater standard TEOS-10 that is based on the IAPWS formulations for fluid water, ice, seawater and humid air, has recently also been adopted by the International Union of Geodesy and Geophysics (IUGG). To improve the metrological basis of TEOS-10, IAPWS is in contact with the BIPM in Paris and is intensifying cooperation with several European metrological institutes in the framework of the new EURAMET project "ENV05 – Ocean". Reports were presented on newly developed commercial instruments to enable regular, SI-traceable seawater density measurements with repeatability better than 1 ppm even under harsh conditions at sea. New extended measurements of seawater properties at high temperatures and pressures, as urgently needed by the industry, were reported.

The working group on Physical Chemistry of aqueous solutions is increasingly focusing its activities on the physico-chemical aspects of the development of green technologies. This includes hydrogen chemistry, modeling of processes related to CO2 capture and interactions between CO2 and minerals in geologic environments.

IAPWS will be sending a questionnaire to industrial organizations eliciting needs for steam properties and new priorities. People interested in receiving the questionnaire are encouraged to contact the Executive Secretary of IAPWS.

The Power Cycle Chemistry Working Group completed a new technical guidance document, "Phosphate and NaOH treatments for the steam-water circuits of drum boilers of fossil and combined cycle/HRSG power plants". The working group keeps a priority list for research related to power plant chemistry. It is currently headed by the behavior of aluminum in the steam / water cycle, the metal-water/steam interface in advanced ultra supercritical plants, and the accuracy of water and steam sampling in power plants. This working group includes in its scope the concentrated solutions found in the cooling water that goes through power plant condensers, makeup water and waste streams.

IAPWS welcomes scientists and engineers with interest in the thermophysical properties of water, steam, and aqueous systems and in the application of such information to industrial uses. The next IAPWS meeting is planned for Boulder, Colorado, USA, late summer or early fall, 2012. Further information on meetings can be found at the IAPWS website, www.iapws.org, as it becomes available. IAPWS documents may also be found on the website.

People interested in IAPWS documents and activities should contact the chairman of their IAPWS National Committee (see website) or the IAPWS Executive Secretary, Dr. Barry Dooley, Structural Integrity Associates, Inc., 2616 Chelsea Drive, Charlotte, North Carolina 28209, USA, e-mail: bdooley@structint.com. People do not need to be citizens or residents of member countries to participate.

The Czech National Committee

International Association for the Properties of Water and Steam

REPORT on IAPWS related activities – July 2010 / August 2011

Submitted to the EC Meeting of IAPWS, Plzeň, Czech Republic – September 2011.

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 in 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 Thermodynamics and Department of Power Engineering, Technicka 4, CZ-166 07 Prague.

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.

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

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

Activities were sponsored by the Grant Agency of the Academy of Sciences of the Czech Republic, 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.

The board of the CZ NC PWS for the period 2010-2013:

Dr. J. Hruby, Prof. R. Mares, Dr. T. Nemec, Prof. P. Safarik, and Prof. J. Sedlbauer.

- In the 2010 IAPWS Meeting in Niagara Falls, Canada participated 7 workers from CzR. One of presented papers is in Ref. [1].
- Brief information has been published on web sites of CZ NC PWS to the new documents adopted and authorized by IAPWS.
- A joint project IT AV ČR and WBU Plzen sponsored by the Ministry of Education, Youth and Sports (MEYS, MŠMT in Czech) enables cooperation with IAPWS for the next two years, till 2012 inclusive.
- Dr. Hruby (IT) with his collaboratoers investigated properties of homogeneous and heterogeneous nucleation and heat transfer, Refs. [2 to 6].
- Prof. Mares (UWB) with his collaborator investigated a temperature dependence of the surface tension of water, Refs [7 and 8]
- Prof. Mares and Dr. Kalova (UWB) collaborated with Prof. M. A. Anisimov (USA) and investigated thermophysical properties of supercooled water, Ref.[9]

- Prof. Marsik (IT) with his research team studied condensation problems and cavitations processes, Refs. [1, and 10 to 12].
- Prof. Sedlbauer (TUL) and his team continued in the research into chemistry of aqueous systems. Refs. [13 and 14]
- Prof. Sedlbauer (TUL) coordinated IAPWS-IUPAC Joint Project: Establishing recommended data on thermodynamic properties of hydration for selected organic solutes and gases.
- Research activities at the (CTU) continued in further improvement of the current knowledge on the following subjects: determination of the heterogeneous particles in the superheated steam in turbines, Ref. [2], and development of correction in classical nucleation theory, Ref. [15].
- The problems studied in SIGMA Research and Development Institute (SIGMA) have been related mainly to the problems of nucleation processes and bubble dynamics during hydrodynamic cavitation and problems of cavitation instabilities in hydraulic machinery. Refs. [1 and 16].
- Dr. Jiricek (ICT-IE) with collaborators investigated renewable power sources and chemical effects in water and steam systems of power plants. Refs. [2, 17 to 21].
- Dr. Hnedkovsky (ICT-IPC) with collaborators investigated properties of organic solutes in water. Published articles are under Refs. [22 and 37].
- Prof. Stastny (SKODA POWER) with co-workers tested and applied the numerical model of the steam flow in nozzles and turbine blade cascades with NaCl binary nucleation and condensation, Ref. [38].
- ICT-IE organized 8th International Conference on Power Cycle Chemistry (CHEO8) from 7th to 8th September 2010 in Prague.
- Dr.Nemec worked with Dr.A.Harvey (USA) on some improvements to the IAPWS website that will increase the usability of the website.
- The CZ NC PWS collaborated with IT and WBU on the preparation and organization of the IAPWS Meeting 2011, Plzen.

Young Scientists IAPWS Fellowships

Information on the Young Scientists IAPWS Fellowship Projects.

- Dr. V. Vins performs his Young Scientis IAPWS Fellowship Project (CZ-Germany) "Development of Thermodynamic Models for Hydrates in Water – Carbon Dioxide Mixtures" under supervising of Dr. J. Hruby and Prof. R. Span. Preliminary results will be presented and discussed at the 2011 IAPWS Meeting in Plzen. The Final Report of the Project will be finished by the end of the year 2011.
- Dr. Kalova handed over the Final Report finished in the frame of the Young Scientists IAPWS Fellowship Project 2010 „Thermophysical Properties of Supercooled Water". A brief summary will be presented on negotiations of WG PCAS at the IAPWS Meeting 2011 in Plzen. The results will be published in proceedings and journals.

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German National Committee to IAPWS

Research Activities on the Thermodynamic Properties of Water and Steam

Report "Research in Progress 2011"

Baltic Sea Research Institute, Warnemuende
Dr. Rainer Feistel

Recent Publications

- W. Wagner, T. Riethmann, R. Feistel, A.H. Harvey (2011):
  New Equations for the Sublimation Pressure and Melting Pressure of H2O Ice Ih.
  J. Phys. Chem. Ref. Data, under review at NIST, to be submitted before the Pilsen meeting
- Feistel, R. (2011):
  Thermodynamic Properties of Seawater.
  EOLSS 2-03-07, submitted June 2011, http://www.eolss.net/
- Feistel, R. (2011):
  TEOS-10: A New International Oceanographic Standard for Seawater, Ice, Fluid Water and Humid Air.
  International Journal of Thermophysics, DOI: 10.1007/s10765-010-0901-y
  http://www.springerlink.com/content/p4834412420n5j61/
- Wright, D.G., Pawlowicz, R., McDougall, T.J., Feistel, R., Marion, G.M. (2011):
  Absolute Salinity, "Density Salinity" and the Reference-Composition Salinity Scale: Present and Future Use in the Seawater Standard TEOS-10.
  Ocean Science, 7, 1–26, www.ocean-sci.net/7/1/2011/, doi:10.5194/os-7-1-2011
- Seitz, S., Feistel, R., Wright, D.G., Weinreben, S., Spitzer, P., de Bievre, P. (2011):
  Metrological Traceability of Oceanographic Salinity Measurement Results.
  Ocean Sci., 7, 45–62. www.ocean-sci.net/7/45/2011/
- Feistel, R., Marion, G.M.M., Pawlowicz, R., Wright, D.G. (2010):
  Thermophysical Property Anomalies of Baltic Seawater.
  Ocean Sci., 6, 949-981, www.ocean-sci.net/6/949/2010/
- Feistel, R. (2011):
  Stochastic Ensembles of Thermodynamic Potentials.
  Accreditation and Quality Assurance, 16, 225-235
- Marion, G.M., Millero, F.J., Camoes, F., Spitzer, P., Feistel, R., Chen, C.-T.A. (2011):
  pH of Seawater.
  Marine Chemistry, doi:10.1016/j.marchem.2011.04.002, in press

Zittau/Goerlitz University of Applied Sciences, Faculty of Mechanical Engineering, Department of Technical Thermodynamics
Prof. Dr. Hans-Joachim Kretzschmar

1. Development of Fast Property Algorithms Based on Spline Interpolation
   - The algorithms for fast spline-interpolation methods are being developed and applied to the calculation of thermodynamic properties of different fluids.
   - An algorithm for generating spline-interpolation data grids with optimized data density for the user requirements 'range of state' and 'accuracy' is being developed.
2. Thermodynamic Properties of Humid Air
   - The property library LibHuAirProp of the American Society of Heating, Refrigerating, Air-Conditioning Engineers (ASHRAE) for calculating thermodynamic and transport properties for real moist air, steam, water and ice has been completed.
3. Property Libraries for Calculating Heat Cycles
   - The property library LibIF97 for steam and water has been extended to include sublimation and melting pressures and ice properties.
   - The property libraries for steam, water, ice, seawater, humid combustion gases, humid air, ammonia/water mixtures and water/lithium bromide mixtures have been connected to DYMOLA (Modelica) for non-stationary process calculations.

Recent Publications

- Wagner, W.; Kretzschmar, H.-J.:
  Chapter 2.1 Properties of Water and Steam.
  In: *VDI Heat Atlas*, 2nd ed., Springer (2010), ISBN: 978-3-540-77876-9
- Herrmann, S.; Kretzschmar, H.-J.; Teske, V.; Vogel, P.; Ulbig, P.; Span, R.; Gatley, D.P.:
  Properties of Humid Air for Calculating Power Cycles.
  Journal of Engineering for Gas Turbines and Power, 132 (2010), pp. 093001: 1-8
- Feistel, R.; Wright, D. G.; Kretzschmar, H.-J.; Hagen, E.; Herrmann, S.; Span, R.:
  Thermodynamic Properties of Sea Air.
  Ocean Science, pp. 91-141, 6 (2010)
- Kretzschmar, H.-J., Stöcker, I.:
  Mollier h,s-Diagramm von Wasserdampf (*Mollier h-s* Diagram for Steam).
  Annex in: Zahoransky, R.: *Energietechnik* (*Power Engineering*), 5th Ed.
  Vieweg Verlag, Wiesbaden (2010), ISBN 978-3-8348-1207-0

Ruhr University Bochum, Faculty of Mechanical Engineering,
Department of Thermodynamics
Prof. em. Dr. Wolfgang Wagner

1 Article “New Equations for the Melting Pressure and Sublimation Pressure of H2O Ice Ih”

The manuscript for the background article for the “IAPWS Revised Release on the Pressure along the Melting and Sublimation Curves of Ordinary Water Substance” was written. The reference for this article reads: *Wagner, W., Riethmann, T., Feistel, R., and Harvey, A. H.* New Equations for the Melting Pressure and Sublimation Pressure of H_2O Ice Ih. Submitted to *J. Phys. Chem. Ref. Data*.

2 Stoffwerte für Wasser und Wasserdampf (Steam Tables for Water and Steam),VDI Wärme Atlas 2012

Section D2.1 “Stoffwerte für Wasser und Wasserdampf” (Properties of Water and Steam) of the VDI-Wärme Atlas 2012 (VDI-Heat Atlas), 11th German Edition, is being worked on. The corresponding steam tables are calculated based on the Industrial Formulation IAPWS-IF97 and the current equations for the transport properties and other properties based on the corresponding IAPWS Releases. The reference for this publication reads: *Wagner, W. and Kretzschmar, H.-J.,* Stoffwerte von Wasser und Wasserdampf, VDI-Wärmeatlas, 11. Auflage, Abschnitt D2.1, pp. 1-15, Springer-Verlag, Berlin, 2012.

Current Status of Research Activities in Japan

Submitted to the Executive Committee Meeting, IAPWS, Plzeň, Czech Republic, September 2011

by

Japanese National Committee
International Association for the Properties of Water and Steam
c/o The 139th Committee on Steam Properties
Japan Society for the Promotion of Science (JSPS)
5-3-1, Kojimachi, Chiyoda-ku
Tokyo 102-0083, Japan

The Japanese National Committee to the IAPWS is countinuing to play an active function as the 139th Committee on Steam Properties chaired by Professor Masaru Nakahara, Kyoto University, at the Japan Society for the Promotion of Science (JSPS), Tokyo.

The following research projects on the thermophysical and physical-chemical properties of water substances including various aqueous systems of technological importance are currently in progress at several universities and institutions in Japan.

At the Nuclear Science and Engineering Directorate, Japan Atomic Energy Agency, Tokai-mura, Dr. S. UCHIDA is promoting research projects on the effects of hydrogen peroxide on stress corrosion cracking of stainless steel, which are going to be demonstrated at the in-pile loop experiments at JMTR, and has finished the first phase of the project on flow accelerated corrosion (FAC) in PWR, which has been supported by the Nuclear and Industrial Safety Agency (NISA). 1) The results of the six year research project on FAC, which were published in more than 15 technical articles, were awarded as the 2010 Award for Distinguished Technology of the Atomic Energy Society of Japan, "Development of Evaluation Methods for Pipe Wall Thinning by Coupled Analysis of Flow Dynamics and Corrosion" [(1)-(10)]. 2) Irradiation resistant high temperature sensors for electrochemical corrosion potential (ECP) measurement have been developed for applying them for in-pile SCC experiments[(11), (12)]. 3) Theoretical model based on a coupled model of water radiolysis and mixed potential analyses has been developed for evaluating corrosive conditions in BWR primary cooling system and in in-pile loop of JMTR. A collaborative project between NRL-Rez in Czech and JAEA-JMTRin Japan has been promoted for demonstrating applicability of the model[(13), (14)].

[Latest publication: (1) S. Koshizukam M. Naitoh, S. Uchida and H. Okada, "Evaluation Procedure for Wall Thinning due to Flow Accelerated Corrosion and Liquid Droplet Impingement", Proc. Int. Symposium on the Aging Management & Maintenance of Nuclear Power Plants (ISaG2010), Mitsubishi Research Institute, May, 27-28,Tokyo, Japan (2010), (2) M. Naitoh, S. Uchida, H. Okada, T. Ohira and S. Koshizuka, "Evaluation of Wall Thinning of PWR Feed Water Piping with the Coupled Model of Static Electrochemical Analysis and Dynamic Double Oxide Layer Analysis", Proc. PVP2010, 2010 ASME Pressure Vessel and Piping Division Conference, July 18-22, 2010, Bellevue, Washington, USA, PVP2010- 25517 (2010), (3) S. Uchida, M. Naitoh, H. Okada, S. Koshizuka, Taku Ohira and D. H. Lister, "Evaluation of FAC Simulation Code Based on Verification and Validation", Power Plant Chemistry, 12 (9), 550 (2010), (4) S. Uchida, M. Naitoh, H. Okada, Taku Ohira, S. Koshizuka and D. H. Lister, "Evaluation of Wall Thinning of PWR Feed Water Piping with the Coupled Model of Static

Electrochemistry Analysis and Dynamic Double Oxide Layer Analysis", Proc. Nuclear Plant Chemistry Conference 2010, NPC2010, Oct. 3-7, 2010, Quebec City, Canada, Canadian Nuclear Society, (2010) (in CD), (5) M. Naitoh, S. Uchida, H. Okada and S. Koshizuka, "Plant-Unique Procedures Applied to Mitigate Wall Thinning of PWR Feed Water Piping due to Flow Accelerated Corrosion", Proc. 8th Int. Meeting on Nuclear Thermal-Hydraulics, Operation and Safety (NUTHOS-8), NUTHOS0060, Oct. 10-14, 2010, Shanghai, China (in CD), (6) M. Naitoh, S. Uchida, H. Okada and S. Koshizuka, "Pipe Wall Thinning due to Flow Accelerated Corrosion and Liquid Droplet Impingement", Proc. 7th Korea-Japan Symposium on Nuclear Thermal-Hydraulics and Safety (NTHAS7), N7P0070, Nov. 14-17, 2010, Chuncheon, Korea (in CD), (7) D. H. Lister and S. Uchida, "Reflections on FAC Mechanisms", Power Plant Chemistry, 12 (10), 650 (2010), (8) H. Okada, S. Uchida, M. Naitoh, J. Xiong and S. Koshizuka, "Evaluation Methods for Corrosion Damage of Components in Cooling Systems of Nuclear Power Plants by Coupling Analysis of Corrosion and Flow Dynamics (V) Flow Accelerated Corrosion in Single and Two-phase Flow Conditions", J. Nucl. Sci. Technol., 48 [1], (2011) 65-75, (9) S. Uchida, M. Naitoh, H. Okada, Taku Ohira, S. Koshizuka and D. H. Lister, "Application of Coupled Electrochemistry and Oxide Layer Growth Models to Water Chemistry Improvement against Flow Accelerated Corrosion in the PWR Secondary System", Corrosion 2011, Paper No.09468, Mar. 14-17, Houston, TX, USA., National association of Corrosion Engineers (2011) 1-16, (10) D. H. Lister, A. Feicht, M. Khatibi, L. Liu, K. Fujiwara, T. Ohira and S. Uchida, "The Mitigation of Flow-Accelerated Corrosion in the Feedwater Systems of Nuclear Reactors – the Influence of Dissolved Oxygen under Different Operating Conditions", Power Plant Chemistry, 13 [4], (2011) 188-196, (11) S. Uchida, "Corrosion monitoring applications in nuclear power plants – a review", Edited by Stefan Ritter and Anders Molander, European Federation of Corrosion Publications, Number 56 (EFC 56): Corrosion Monitoring in Nuclear Systems, Maney Publishing, Leeds, UK (2010), 158-170, (12) S. Uchida, T. Satoh, Y. Wada and Y. Satoh, "An electrochemical sensor array for in-situ measurements of hydrogen peroxide concentration in high-temperature water", Edited by Stefan Ritter and Anders Molander, European Federation of Corrosion Publications, Number 56 (EFC 56): Corrosion Monitoring in Nuclear Systems, Maney Publishing, Leeds, UK (2010), 239-254, (13) S. Hanawa, T. Nakamura, S. Uchida, P. Kus, R. Vsolak and J. Kysela, "ECP Measurements Under Neutron and Gamma Ray in In-pile Loop and their Data Evaluation by Water Radiolysis Calculations", Proc. Nuclear Plant Chemistry Conference 2010, NPC2010, Oct. 3-7, 2010, Quebec City, Canada, Canadian Nuclear Society, (2010) (in CD), (14) P. Kus, R. Vsolak, J. Kysela, S. Hanawa, T. Nakamura and S. Uchida, "ECP Measurements in the BWR-1 Water Loop Relative to Water Composition Changes", Proc. Nuclear Plant Chemistry Conference 2010, NPC2010, Oct. 3-7, 2010, Quebec City, Canada, Canadian Nuclear Society, (2010) (in CD).]

[contact: Dr. S. Uchida; E-mail: uchida.shunsuke@jaea.go.jp].

The Research Center of Supercritical Fluid Technology, Graduate School of Engineering, Tohoku University is studying organic and inorganic reactions in sub- and supercritical water. Some projects are cooperative with Chinese Academy of Sciences (Kunming) and Tongji University (China). In 2010-2011, the following research areas were studied: density measurement, saccharide modification, polysaccharide depolymerization, formation of functional organic materials, formation of luminescent inorganic materials, formation mechanism of catalytic inorganic materials, and redox cycles for carbon cycling. The densities of methanol-water mixtures have been measured and analyzed via molecular dynamic simulation [Takumi Ono, Shunsuke Kobayashi, Taka-aki Hoshina, Yoshiyuki Sato and Hiroshi Inomata, "Volumetric Behavior and Solution Microstructure of Methanol-Water Mixture in Sub- and Supercritical State via Density Measurement and MD Simulation", Fluid Phase Equilibria, 302,(2011)55-59]. In Aida, Watanabe, and Smith et al. [T.M. Aida, N. Shiraishi, M. Kubo, M. Watanabe, R.L. Smith Jr, Reaction kinetics of d-xylose in sub- and supercritical water, Journal of Supercritical Fluids 55 (2010)

208-216.], the reaction pathway, reaction mechanism and reaction kinetics of D-xylose transformation at high temperatures (400 ^{o}C) and high pressures (100 MPa) are reported. Retro-Aldol reaction of D-xylose increased with increasing water density . Reaction of D-xylose to D-xylulose occurred by the Lobry de Bruyn-Alberta van Ekenstein (LBET) pathway. In Aida, Watanabe, and Smith et al. [T.M. Aida, T. Yamagata, M. Watanabe, R.L. Smith Jr, Depolymerization of sodium alginate under hydrothermal conditions, Carbohydrate Polymers 80 (2010) 296-302.], depolymerization of sodium alginate with hydrothermal treatment (180–240 ^{o}C) is studied. Alginate depolymerization occurs by releasing mannuronic acid preferentially first that is followed by the release of guluronic acid. In Fang and Smith et al. [Z. Fang, R.L. Smith Jr, J.A. Kozinski, T. Minowa, K. Arai, Reaction of D-glucose in water at high temperatures (410 °C) and pressures (180 MPa) for the production of dyes and nano-particles, Journal of Supercritical Fluids 56 (2011) 41-47.], reaction of D-glucose was studied at high temperatures (410 ^{o}C) and high pressures (180 MPa). By allowing the reaction to proceed and decompose, micron-sized particles and colored solutions could be produced by slow heating, while rapid heating resulted in the formation of dye-like substances with glucose-like structures. Near nano-size particles could be produced with the method In Takesue et al. [M. Takesue, A. Suino, Y. Hakuta, H. Hayashi, R.L. Smith, Crystallization trigger of Mn-doped zinc silicate in supercritical water via Zn, Mn, Si sources and complexing agent ethylenediamine tetraacetic acid, Materials Chemistry and Physics 121 (2010) 330-334.] decomposition of metal chelates in supercritical water was studied with the purpose to produce of Mn-doped zinc silicate, α-Zn_2SiO_4:Mn^{2+}, which is a practical industrial phosphor. The complexing agent used was ethylenediamine tetraacetic acid (EDTA) with various Zn and Mn sources. Remarkably, for the sulfate sources of Zn and Mn, addition of EDTA with Si source, tetraethoxyorthosilicate (TEOS) gave botryoidal druses of rod-like shaped α-Zn_2SiO_4:Mn^{2+}, which only occur in natural deposits (willemite) in La Calamine, Belgium (Moresnet). In Aida, Watanabe, Smith et al. [K. Kaseda, M. Takesue, T.M. Aida, M. Watanabe, H. Hayashi, R.L. Smith Jr, Restructuring mechanism of NbO_6 octahedrons in the crystallization of $KNbO_3$ in supercritical water, Journal of Supercritical Fluids (2011).], the mechanism of $KNbO_3$, which is a Pb-free piezoelectric material and alternate material to zirconate titanate, is studied in supercritical water. The material can form by two different crystallization routes that depend on the conditions of water. It was found that the restructuring of NbO_6 octahedrons is a primary factor in the crystallization mechanism. Namely, the rearrangement of edge-sharing NbO_6 octahedrons to corner-sharing NbO_6 octahedrons proceeds directly under homogeneous conditions and provides polygonal-shaped $KNbO_3$. In Jin and Smith et al. [F.M. Jin, Y. Gao, Y.J. Jin, Y.L. Zhang, J.L. Cao, Z. Wei, R.L. Smith, High-yield reduction of carbon dioxide into formic acid by zero-valent metal/metal oxide redox cycles, Energy & Environmental Science 4 (2011) 881-884.], hydrothermal conditions are used to reduce carbon dioxide to formic acid via oxidation of zero-valent fine particle metals. Reduction of the oxidized metal for recycle is accomplished by treatment with an organic compound. The cycle is demonstrated with zero-valent Fe, which gives 80 % formic acid yield. Recycle of the oxidized metal is by contact with glycerin, which gives lactic acid and essentially 100 % yield of zero-valent Fe.

At the Institute of Multidisciplinary Research for Advanced Materials at Tohoku University, Prof. M. KAKIHANA and his group have developed a panel of stable, non-toxic and water-soluble compounds of Si, V, Ti and Ta. These compounds can be utilized for the synthesis of oxide materials by solution based processes, which are based on the hydrothermal processing or which include a hydrothermal treatment as one of the key synthesis steps. Rutile- and brookite polymorphs of TiO_2 were selectively synthesized by a facile hydrothermal method using a novel titanium-picolinato complex as a precursor. Porous microspheres several micrometers in size, composed of a highly ordered arrangement of nanorods were synthesized in the presence of a picolinic acid additive. Hydrothermal treatment of a citratoperoxotitanate complex at high NH_3 concentrations resulted in the formation of agglomerated brookite particles with unusual snowflake-like shapes. Using the same method, the aspect ratios of the obtained rod-like brookite particles increased from 5 up to 20 with an increase of the NH_3 concentration. A new chemical route for synthesis of spherical agglomerations of titanic acid and titanium dioxide was developed on the basis of solvothermal treatments of a series of water-soluble titanium complexes in mixed solutions of water / amine. [M. Kakihana, M. Kobayashi, K. Tomita, and V. Petrykin, Bull. Chem. Soc. Japan, **83**, 1285 (2010). Q. Duc Truong, M. Kobayashi, H. Kato, and M. Kakihana, J. Ceram. Soc. Jpn., **119**, 513 (2011). K. Yamamoto, S. Matsushima, K. Tomita, Y. Miura, and M. Kakihana, J. Ceram. Soc. Jpn., **119**, 494 (2011).] Profs. T. SATO and S. YIN with co-workers studied on the panoscopic assembling of ceramic materials applicable for environmental clean-up, energy saving, UV/NIR shielding, preventing the healthy damage, etc. by solvothermal reactions. They successfully prepared visible light responsive photocatalysts with controllable phase compositions, morphologies, together with excellent visible light induced deNO_x activity. They also researched on the synthesis of multifunction thin films with UV/NIR shielding property, photocatalytic activity and superhydrophobicity or superhydrophilicity. The relationship between morphologies and photo-chemical properties of inorganic materials was investigated in detail. In addition, environmental friendly synthesis of lead-free dielectric ceramic materials, ceria-based inorganic UV-shielding materials with excellent safety, comfort and transparency in the visible light region; rare earth oxide nanoparticles with controlled morphology and excellent fluoresence properties, Ag/γ-Al_2O_3 nanocomposites with excellent deNO_x catalytic activity, were carried out. [Phosphorous Res. Bullet., **24**, 43-48(2010); Mater. Chem. Phys. **123**, 516–520(2010); Mater. Res. Bull., **45**, 1345-1350(2010); J.Solid State Chem., ***183, 1545-1549***(2010)*;* J.Nanomater., **2010**, 629727(6pages), (2010); Appl.Phys.Lett., **97**, 103102 (3pages) (2010); J.Mater.Chem.,**20**, 8227-8229(2010); Adv. Sci. Technol. **63**, 30-35(2010); Adv. Sci. Technol. **63**, 36-40(2010); Adv. Sci. Technol. **63**, 52-57(2010); Adv. Sci. Technol. **63**, 107-113(2010); J.Solid State Chem., **183**, 2456-2460(2010); Inter.J. Moden Phys. B, **24,** 3209-3214(2010); Appl. Clay Sci., **50**, 118-124(2010); J.Alloy Compd. **508**, L1-L4(2010); International J. Optics, **2010**, Article ID 261420, 6 pages (2010); J.Mater.Res., **25**, 2392-2400(2010); Nanoscale Res.Lett., **6**: 5(2011); *Appl. Catal. B. Chem.* **102**, 286-290(2011); *Appl. Catal. B. Chem.* **103**, 462-469(2011); J.Alloys Comp. **509**, 1482-1488(2011); CrystEngComm, **13,** 741-746(2011); J.Mater.Chem.,**21**, 5099-

5105(2011); *Res. Chem. Intermed.*, **37**, 319-327(2011); Nanosci. Nanotechnol. Lett. **3**, 413-416(2011); *Appl. Catal. B. Chem.* **105**, 206-210(2011); J.Cer. Soc.Jpn., **119**,445-450(2011); Phosphorus Res. Bull. **25**, 68-71(2011). Mater. Integration, **24**, No.2, 54-61(2011); J. Alloys Comd., **509**, 8581-8583(2011); *Appl. Catal. B:Environ.,* **106**, 586-591(2011); *ACS Applied Materials & Interfaces*, **3**, 2794-2799(2011); *Chem.Commun.*, **47**, 8853-8855(2011); Mater. Sci. Appl., **2** 757-763(2011)]. The relationship between morphologies and photo-chemical properties of inorganic materials was mainly investigated in detail. Profs. A. MURAMATSU and K. KANIE with co-workers have been studied the synthesis of monodispersed particles and their formation mechanism in liquid and/or solution phase. Recenty they have investigated preparation of ITO particles as a transparent conductive film component, $BaTiO_3$ as dielectrics and/or piezoelectric material, ferric oxides as a magnetic material and so on. Also, they have been making their maximum efforts on the hybridization of monodispersed particles with organic material such as liquid crystals, in order to obtain multi-functional materials. In addition to these original methods, the Liquid-Phase Selective Deposition has also been developed as a novel preparation method of heterogeneous catalysts for industrial use in dilute solution of metal precursory complexes. [Chemistry Letters, 38(6), 562-563 (2009); Chemosphere, 76(5) 638-643 (2009); Applied Catalysis B 87(3) 239-244 (2009); Materials Transactions, 50, 2808-2812 (2009); Chemistry Letters 39, 1080-1081 (2010); Chmeistry Lettrs, 39, 319-321 (2010); Journal of Materials Chemistry, 20, 8153-8157 (2010)]. Adschiri laboratory, recently, proposed a new method to synthesize organic inorganic hybrid nanocrystals by using supercritical hydrothermal method. In the supercritical state, organic molecules and metal salt aqueous solution forms a homogeneous phase, and water molecule works as a catalyst for promoting organic inorganic reactions.Thus, in the presence of organic capping agents in hydrothermal synthesis, hybrid nanoparticles are synthesized. Adschiri laboratory has challenged to synthesize variety of hybrid nanomaterials, includingTiO_2, CeO_2,$MgFe_2O_4$,Cu_2O,ZnO and $BaFe_2O_4$, [Zeitschrift fuer Naturforschung B-A J. CHEM. SCIE., 65*b,*1045-1050(2010) ; B. Jeyadevan, J. Supercrit. Fluids, 53(1-3)92-94(2010) ; MATER.LETT. 64(9),1049-1051 (2010) ; J.MATER. RES.,25(2), 219-223(2010)] .Since these nanoparticles has organic legands on the surface, affinitybetween nanoparticles and solvents can be controlled to have perfect dispersion. [Ind. Eng. Chem. Res., 49 (20), 9815–9821(2010);CHEM. LETT.,39(9), 961-963(2010) ; NANOSCALE,2(5),689-693(2010)]

At the Energy Technology Research Institute, National Institute of Advanced Industrial Science and Technology, Drs. M. MORIMOTO, Y. SUGIMOTO, S. SATO, and T. TAKANOHASHI have clarified the effect of supercritical water on upgrading reaction of oil sand bitumen. They comprehensively compared the yields and properties of products prepared in supercritical water and high-pressure nitrogen at 430 to 450°C and about 25 to 30 MPa. It was found that the dispersion effect of supercritical water led to intramolecular dehydrogenation of the heavier component and prevention of recombination reactions, and consequently gave the highest conversion. Also, the chemical effect of

supercritical water on the upgrading reaction of bitumen was stated to be almost negligible. [Morimoto, M., Sugimoto, Y., Saotome, Y., Sato, S. and Takanohashi, T., *Journal of Supercritical Fluids*, 55, 223-231 (2010)]. [contact: Dr. T. Takanohashi; E-mail: toshi-takanohashi@aist.go.jp, Dr. M. Morimoto; E-mail: m.morimoto@aist.go.jp]

At the department of material and environmental chemistry, Utsunomiya University, Dr. T. SATO and co-workers has been studying heavy oil upgrading through water gas shift reaction in supercritical water. They used formic acid as a model hydrogen source because formic acid is an intermediate of water-gas shift reaction in supercritical water. In supercritical water, formic acid reduced coke formation during the decomposition of bitumen especially in high water/oil ratio region. A reaction model was proposed and the model predicted that hydrogenation of the asphaltene core was important for the suppression of coke formation [Takafumi Sato, Shota Mori, Masaru Watanabe, Mitsuru Sasaki, Naotsugu Itoh, "Upgrading of bitumen with formic acid in supercritical water," J. Supercrit. Fluids, 55, 232-240 (2010)]. The gasification of biomass in supercritical water was studied. The production of hydrogen from the biogas obtained from the supercritical water gasification of glucose was improved. The apparatus combined the flow-type reactor for supercritical water gasification and the flow-type steam reforming rector with hydrogen permeable palladium membrane reactor was developed and found the hydrogen removal in membrane reactor enhance hydrogen recovery [Takafumi Sato, Takeyuki Suzuki; Mitsuhiro Aketa; Yasuyoshi Ishiyama; Kenichi Mimura; Naotsugu Itoh, "Steam reforming of biogas mixtures with a palladium membrane reactor system," Chem. Eng. Sci., 65, 451-457 (2010)] Gasification of bean curd refuse in high-temperature water with noble metal catalysts in supercritical water. In the case of Ru/C catalyst, bean curd refuse decomposed to intermediates and then intermediates were gasified to mainly methane and carbon dioxide. The sum of the yield of gases significantly increased with increase in water density. Water was effective hydrogen source in gasification [Takafumi Sato, Kentaro Inda, Naotsugu Itoh, "Gasification of bean curd refuse with carbon supported noble metal catalysts in supercritical water", Biomass and Bioenergy, 35, 1245-1251 (2011)]. [contact: Dr. T. Sato; E-mail: takafumi@cc.utsnomiya-u.ac.jp]

At the Material Properties Division, National Metrology Institute of Japan (NMIJ, formerly NRLM), National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan, a section lead by Dr. K. FUJII is working on the density, viscosity, and refractive index standards. A determination of the Avogadro constant is being conducted in this section as an international project organized by the Comité International des Poids et Mesures (CIPM). This project continued through 2004 to 2011 with participants of eight National Metrology Institutes (BIPM, IMGC, IRMM, NIST, NMI-Australia, NMIJ, NPL, and PTB). The target of this project is to replace the present definition of the kilogram with a new definition based on fundamental physical constants. For the fundamental reduction of uncertainty in the Avogadro constant, a 5 kg of ^{28}Si crystal was prepared, and the final result of measurements was summarized in a paper [B. Andreas, Y. Azuma, G. Bartl, P. Becker, H. Bettin, M. Borys, I. Busch, M. Gray, P. Fuchs, K. Fujii, H. Fujimoto, E. Kessler, M. Krumrey, U. Kuetgens, N. Kuramoto, G. Mana, P. Manson, E. Massa, S. Mizushima, A. Nicolaus, A. Picard, A. Pramann, O. Rienitz,

D. Schiel, S. Valkiers, and A. Waseda, "Determination of the Avogadro Constant by Counting the Atoms in a ^{28}Si Crystal," Phys. Rev. Lett., 2011, Vol. 106, 030801]. Following this result, the redefinition of the kilogram will be discussed at the forth coming Conférence Générale des Poids et Mesures (CGPM) to be held in October 2011. In this project, the density of the crystal has been determined with a relative standard uncertainty of 3×10^{-8} [N. Kuramoto and K. Fujii, "Improvement in the volume determination for the Si spehers with an optical interferometer," IEEE Trans. Instrum. Meas., 2009, Vol. 58, No. 4, pp. 915-918]. Using the silicon crystals as a solid density standard, density standard liquids and PVT properties of fluids are calibrated by the magnetic suspension densimeter developed at the NMIJ [Y. Kano, Y. Kayukawa, K. Fujii, and H. Sato, "A new method for correcting a force transmission error due to magnetic effects in a magnetic levitation densimeter," Meas. Sci. Technol., 2007, Vol. 18, pp. 659-666]. In his group a new absolute viscosity measurement by the falling ball method is in progress. Nanotechnologies for measuring the falling distance and diameters of small silicon spheres have been developed for providing reference data for liquid water with a relative standard uncertainty of 0.01 % [Y. Fujita , N. Kuramoto, Y. Kurano, and K. Fujii, "A new project at NMIJ for an absolute measurement of the viscosity by the falling ball method," Proc. 14th ICPWS, Kyoto, 2004, 112-115]. Based on the viscosity of water, calibration of the viscosity standard liquids is being conducted in a range 1 mPa s to 500 Pa s [Y. Fujita, Y. Kurano and K. Fujii, "Evaluation of uncertainty in viscosity measurements by capillary master viscometers," Metrologia, 2009, Vol. 46, pp. 237–248]. Calibration service for non-Newtonian liquid has also started in 2009 using a new falling cylinder method. Dr. K. FUJII is working as a chairman of the WG-Density, CCM (Consultative Committee for Mass and Related Quantities) to organize the research activities on the density standards at the National Metrology Institutes. In May 2011, the CCM WG-Density meeting was held at the BIPM, and an idea for clarifying the roles of CIPM and IAPWS standards for the density of water has been confirmed [A. H. Harvey, R. Span, K. Fujii, M. Tanaka and R. S .Davis, "Density of water: roles of the CIPM and IAPWS standards," Metrologia, 2009, Vol. 46, pp. 196-198]. For details, contact Dr. K. Fujii, Chief, Fluid Properties Section, NMIJ (E-mail: fujii.kenichi@aist.go.jp).

At the Department of Mechanical Engineering, Keio University, Yokohama, Prof. K. YASUOKA and his group are studying the molecular dynamics (MD) simulation to clarify the nucleation phenomena. They reported nucleation phenomena with spherical seed. [D. Suh and K. Yasuoka, J. Phys. Chem. B., in press. DOI:10.1021/jp201964h] They also reported the thermodynamic properties of vapor/liquid coexistence for water and water/methane. [R. Sakamaki, A. K. Sum, T. Narumi, R. Ohmura, and K. Yasuoka, J. Chem. Phys., 134, 144702(2011). DOI : 10.1063/1.3579480 ; R. Sakamaki, A. K. Sum, T. Narumi, and K. Yasuoka, J. Chem. Phys., 134, 124708(2011). DOI : 10.1063/1.3574038] They reported contact angle hysteresis for droplets on Nanopillared surface and in cassie and wenzel states. [T. Koishi, T., K. Yasuoka, S. Fujikawa, and X. C. Zeng, ACS Nano, in press. DOI : 10.1021/nn2005393] They repoted non-gaussian fluctuations resulting from power-law trapping in a lipid bilayer. [T. Akimoto, E. Yamamoto, K. Yasuoka, Y. Hirano, and M. Yasui, Phys. Rev. Lett., in press.] They reported Size Dependent Phase Changes in Water Clusters. [T. Kaneko, T. Akimoto, K. Yasuoka, A. Mitsutake, and X.

C. Zeng, J. Chem. Theory Comput., in press.] [contact: Prof. K. Yasuoka; E-mail: yasuoka@mech.keio.ac.jp].

At the Department of Mechanical Systems Engineering, National Defense Academy, Yokosuka, Prof. N. KAGAWA and his group developed a twin-cell type adiabatic calorimeter for water + alcohol and water + ammonia mixtures. The thermometers of the apparatus are being replaced to improve the measurement uncertainty. By the modified apparatus, isochoric heat capacities of water and R 134a will be measured for temperatures from 220 to 520 K and pressures to 30 MPa. [contact: Prof. N. Kagawa; E-mail kagawa@nda.ac.jp]

Ret. Prof. H. TAKAKU was retired from Faculty of Engineering of Shinshu University in Nagano City at the end of March of 2006. He has been working as a temporary technical adviser at Naigai Chemical Products Co., LTD. in Tokyo since May of 2006. He and his coworkers engaged in Shinshu University, Naigai Chemical Products Co., the electric power companies and turbine manufacturer are conducting researches on the corrosion of materials for steam turbines in geothermal power plants, for boiler tubes and low pressure steam turbines in the conventional thermal and combined cycle power plants, and other subjects on corrosion and water chemistry for power plants, and so on. [The latest papers: (1) T. Nakane, L.-B. Niu, Shuji Oishi and H. Takaku, "Influence of Organic Acids on Corrosion Behavior of Boiler Tube Materials in Simulated AVT Waters Coexisted with Chloride Ions ", *Journal of Japan Institute for Metals*, 74 (9), 565-571 (2010); (2) L.-B. Niu, T. Goto, T. Nakane, H. Takaku and Yoshihiro Sakai, "Effect of Cl^- and SO_4^{2-} on Pitting Corrosion Susceptibility for Materials of Low-Pressure Steam Turbines in Power Plants", *Journal of Japan Institute for Metals*, 74 (10), 635-642 (2010); (3) T. Nakane, L.-B. Niu, S. Oishi and H. Takaku, "Electrochemical Corrosion Behaviors and Formed Film Characteristics of Boiler Tube Steel Weldments in Simulated AVT Waters", *NETSU SHORI* (*Journal of The Japanese Society for Heat Treatment)*, 50 (6), 614-619 (2010); (4) T. Nakane, L.-B. Niu and H. Takaku, "Effect of Chloride and Sulfate in Simulated AVT Waters on Electrochemical Corrosion Behaviors and Film Characteristics of Low Pressure Steam Turbine Materials", *Power Plant Chemistry*, 12 (7), 376-383; (5) T. Nakane, L.-B. Niu, H. Takaku and S. Oishi, "Evaluation of Corrosion Resistances and Characteristics of Films Formed on Boiler Tube Steels in Simulated AVT Water", *Zairyo -to- Kankyo (Journal of Corrosion Engineering of Japan)*, 60 (5), 265-270 (2011).] [Contact: Prof. H. Takaku; E-mail: takaku06@ybb.ne.jp]

At the Department of Mechanical Systems Engineering, Toyama Prefectural University, Toyama, Dr. H. MIYAMOTO and their group have been studying the various thermodynamic properties including the PVTx, critical locus, and saturation properties. ["The precise measurement of the (vapour-liquid) equilibrium properties for (CO_2 + isobutane) binary mixtures", Y. Nagata, K. Mizutani, and H. Miyamoto, J. Chem. Thermodyn., 2011, 43, pp. 244-247] ["(p, ρ, T, x) properties for CO_2/*n*-butane binary mixtures at T= (280 to 440) K and (3 to 200) MPa", T. Sugiyama, S. Orita, and H. Miyamoto, J. Chem. Thermodyn., 2011, 43, pp. 645-650]. Most of our apparatuses for higher pressure ranges had been

developed by the Uematsu Laboratory in Keio University. We aim to clarify the mixing effects of various natural substance mixtures (including aqueous solutions) at temperatures up to 600 K and at pressures up to 200 MPa. [Contact: Dr. H. Miyamoto; E-mail: miyamoto@pu-toyama.ac.jp]

At the Institute for Chemical Research, Kyoto University, Uji, Kyoto, Prof. M. NAKAHARA, Prof. N. MATUBAYASI, Dr. C. WAKAI, and their coworkers study the structure, dynamics, and reactions in super- and subcritical water and related systems such as ionic liquids and lipid membranes by means of multinuclear NMR (nuclear magnetic resonance) spectroscopy and computer simulation. Their current focus are (1) the accurate determination of the self-diffusion coefficients of water and organic solvents and the elucidation of the intermolecular-interaction effect ["Scaled Polynomial Expression for Self-Diffusion Coefficients for Water, Benzene, and Cyclohexane over a Wide Range of Temperatures and Densities", K. Yoshida, N. Matubayasi, Y. Uosaki, and M. Nakahara, *J. Chem. Eng. Data* **55**, 2815-2823 (2010)], (2) the rotational dynamics of benzene in ionic liquid and the effect of temperature and solvent charge ["Exploring the reorientation of benzene in an ionic liquid via molecular dynamics: Effect of temperature and solvent effective charge on the slow dynamics", Y. Yasaka, M. L. Klein, M. Nakahara, and N. Matubayasi, *J. Chem. Phys.* (Communication), **134**, 191101 (4 pages) (2011)], and (3) the diameter dependence of the lipid-membrane dynamics and the presence of multiple orders of dynamical time scale ["NMR-NOE and MD Simulation Study on Phospholipid Membranes: Dependence on Membrane Diameter and Multiple Time Scale Dynamics", M. Shintani, K. Yoshida, S. Sakuraba, M. Nakahara, and N. Matubayasi, *J. Phys. Chem. B **115**, 9106–9115 (2011)*]. [contact: Prof. M. Nakahara; E-mail: nakahara@scl.kyoto-u.ac.jp & Prof. N. Matubayasi; E-mail nobuyuki@scl.kyoto-u.ac.jp]

At the Department of Molecular Chemistry and Biochemistry, Doshisha University, Kyo-Tanabe, Kyoto, Prof. M. UENO, Prof. IBUKI and their group have been studying the electric conductivities of 1:1 electrolytes in high-temperature alcohols (methanol and ethanol) ["Electric conductivities of 1:1 electrolytes in high-temperature ethanol along the liquid-vapor coexistence curve. II. Tetraalkylammonium bromides", *J. Chem. Phys.*, **134** (12), 124509 1-8 (2011); "Electrical conductivities of 1:1 electrolytes in high-temperature methanol", *Netsu Sokutei*, **37** (2), 64-72 (2010)]. In our laboratory, the densities and viscosities of aqueous solutions have been also studied ["Pressure and temperature effects on the density and viscosity of DMF-water mixtures", *J. Physics: Conference Series*, **215**, 012074 1-4 (2010)]. [Contact: Prof. M. Ueno; E-mail: mueno@mail.doshisha.ac.jp]

At Department of Applied Chemistry & Bioengineering, Osaka City University, Dr. N. KOMETANI and his co-workers have studied the TiO_2 photocatalysis in high-temperature high-pressure water. They revealed that TiO_2 exhibits high photocatalytic activity even under sub- and supercritical conditions [N. Kometani, K. Sugimoto, A. Fujita, Y. Yonezawa, "Photocatalytic Activity of TiO_2 Nanoparticles in Hydrothermal and Supercritical Water", *J. Chem. Eng. Jpn.*, **40**, 463-467 (2007)]. Based on this finding, the hybrid process in which the hydrothermal and photocatalytic techniques are combined has been developed. It has been demonstrated that such hybrid process could be applied to the treatment of waste water containing organochloride compounds such as chlorobenzene [A. Shimokawa, N. Kometani,

Y. Yonezawa, "Degradation of chlorobenzene by the hybrid process of supercritical water oxidation and TiO_2 photocatalysis", *Sep. Sci. Tech.*, **45**(11), 1538-1545 (2010)] as well as the effective gasification of glucose [A. Nakatani, N. Kometani, "Photocatalytic Effect of TiO_2 on the Hydrothermal Gasification of Glucose", *J. Phys.: Conf. Seri.*, **215**, 012091 (2010)]. The same group also examined the hydrothermal synthesis of size-controlled metal nanoparticles [N. Kometani, T. Teranishi, Y. Yonezawa, "Development of the Metal Nanoparticle Synthesis Method by means of the Hydrothermal Technique", *J. Soc. Mater. Sci. Jpn.*, **58**, 481-485 (2009); N. Kometani, T. Teranishi, "Preparation of size-controlled silver nanoparticles by the hydrothermal method", *Phys. Stat. Soli. C*, **7**, 2644-2647 (2010)]. [Contact: Dr. N. Kometani; kometani@a-chem.eng.osaka-cu.ac.jp]

At the Department of Mechanical Engineering, Kyushu University, Prof. Y. Takata and their group are continuously developing a program package for thermophysical properties of fluids: PROPATH. The current version is 13.1 and the package contains 78 pure substances, moist air, binary mixtures and ideal gases. Information on this package is available through the website: http://www2.mech.nagasaki-u.ac.jp/PROPATH/. In addition, his research group is studying thermophysical properties of hydrogen at ultra-high pressures. They are measuring PVT relation up to 100MPa, viscosity and thermal conductivity of hydrogen up to 100MPa. ["A Capillary Tube Viscometer Designed for Measurements of Hydrogen Gas Viscosity at High Pressure and High Temperature", E. Yusibani, et al., *Int. J. Thermophysics*, 32-6, 1111-1124(2011); "Thermal Conductivity Measuremet of Gases by the Transient Short-Hot-Wire Method", S. Moroe, et. al., Experimental Heat Transfer, 24-2, 168-178(2011)]
[contact: Prof. Y. Takata; E-mail: takata@mech.kyushu-u.ac.jp]

The following research projects on the thermophysical and physicochemical properties of water substances including various aqueous systems of technological importance are currently in progress at several universities and institutions in Japan. At the Department of Applied Chemistry and Biochemistry, Kumamoto University, Kumamoto, Prof. M. GOTO, Assoc. Prof. M. SASAKI, Assistant Prof. Armando T. QUITAIN, and their group are working on reaction kinetics and mechanism of biomass-related materials in sub- and supercritical water. Biomass and its model compounds such as phenolic compounds and carbohydrates were reacted to obtain added-value chemical intermediates with a batch or semi-batch reactors [Wahyudiono, M. Sasaki and M. Goto, accepted for publication in *Journal of Material Cycles and Waste Management* (2010); T. Saito, Y. Yoshino, H. Kawanabe, M. Sasaki, M. Goto, *Separation Science and Technology*, **44**, 1228-1239 (2009)]. Electrochemical oxidation of biomass and its model compounds has been investigated under hydrothermal conditions for elucidating a reaction pathway for glucose, and for recovering added-value chemicals [M. Sasaki, T. Oshikawa, H. Watanabe, Wahyudiono, M. Goto, *Research on Chemical Intermediates*, **37**(2-5), 457-466 (2011); A. Yuksel, M. Sasaki, M. Goto, *Ind. Eng. Chem. Res.*, **50**(2), 2227-2235 (2011); M. Sasaki, Wahyudiono, A. Yuksel, M. Goto, *Fuel Processing Technology,* **91**(9), 1125-1132 (2010); A. Yuksel, H. Koga, M. Sasaki, M. Goto, *Ind. Eng. Chem. Res.*, **49**(4), 1520-1525 (2010)]. The metal removal from bitumen and its model compounds were carried out at temperatures of 673 K – 763 K. These results suggest that supercritical water have a capability to remove metals by decomposing them [P. C. Mandal, Wahyudiono, M. Sasaki and M. Goto. *Proceeding of*

International conference on Mechanical, Industrial and Energy Engineering, KUET, Khulna, Bangladesh (2010); P. C. Mandal, Wahyudiono, M. Sasaki, and M. Goto, *J. Hazard. Mater.* **187**, 600-603 (2011); P. C. Mandal, Wahyudiono, M. Sasaki, and M. Goto, *Fuel*, accepted on July 01, 2011; P. C. Mandal, Wahyudiono, M. Sasaki, and M. Goto, *Fuel Processing Technology*, accepted on July 9, 2011]. The results of sulfur removal from bitumen and its model compounds revealed that supercritical water can also be removed sulfur from bitumen and its model compounds. The manuscripts based on desulfurization of bitumen are being prepared to submit in international journals. The upgrading of bitumen and the decomposition of its model compounds were carried out in near- and supercritical water. These results suggest that supercritical water can be an effective on the visbreaking of bitumen and extraction of sulfer from bitumen or its model sulfer-containing compounds with supercritical water [T. Sato, S. Mori, M. Watanabe, M. Sasaki, N. Itoh, *The Journal or Supercritical Fluids,* **55**(1), 232-240 (2010); P. C. Mandal, T. Shiraishi, Wahyudiono, M. Sasaki, M. Goto, *J. Chem. Eng. Jpn.*, **44**(7), 486-493 (2011); Wahyudiono, T. Shiraishi, M. Sasaki, M. Goto, *Research on Chemical Intermediates*, **37**(2-5), 375-381 (2011)]. They are also studying about various natural materials in collaboration with universities and companies [M. Tanaka, A. Takamizu, M. Hoshino, M. Sasaki, M. Goto, *Food and Bioproducts Processing*, in press (2011); L. Qadariyah, M. Sumarno, M. Siti, Wahyudiono, M. Sasaki, M. Goto, *Bioresource Technology*, in press (2011); R. Askin, M. Sasaki and M. Goto, *Food and Bioproducts Processing*, 88(2-3), 291-297 (2010); M. Siti, K. Kitada, M. Sasaki, M. Goto, J. Munemasa, M. Yamagata, *Ind. Eng. Chem. Res.*, **50**(4), 2227-2235 (2010)] Application of microwave irradiation to hydrothermal extraction of bioactive compounds from natural resources such as marine algae and herbal plants were also carried out [T. Kai, Armando T. Quitain, M. Sasaki and M. Goto, *Proceedings of 2011 AIChE Annual Meeting* (2011); Tayyebeh Zohourian Haleh, Armando T. Quitain, M. Sasaki and M. Goto, *Separation Science and Technology*, *submitted for publication*]. Researches on microwave-assisted solvothermal synthesis of biofuels are also in progress. [Armando T. Quitain, S. Katoh and M. Goto; *Biofuels/Book 2*, in press (2011); Armando T. Quitain, S. Katoh, M. Sasaki and M. Goto, *Proceedings of 2011 AIChE Annual Meeting* (2011)] As a part of Kumamoto University Global COE program "Global Initiative Center for Pulsed Power Engineering", developments of an evolutional reaction / material processing methods were conducted. Electrospinning is one of the simple techniques to produce nanofibers and we challenged electrospinning of combined polymers in supercritical fluid [M. Goto, K. Murakami, Wahyudiono, and M. Sasaki, *Proceeding of 9th Conference on Supercritical Fluids and Their Applications*, Sorrento, Napoli, Italy (2010)]. Pulsed discharge plasma irradiation of various organic compounds in sub- and supercritical fluids has been investigated to synthesize valuable materials and chemical intermediates [M. Goto, M. Sasaki, Wahyudiono, K. Nagafuchi, H. Watanabe, T. Kiyan, T. Namihira, H. Akiyama, *Proceedings of AIChE Annual Meeting 2010* (2010); M. Sasaki, Wahyudiono, T. Kiyan, H. Akiyama, M. Goto, Y. Suga, W. Toshiyuki, *IEEE Region 10 Annual International Conference, Proceedings/TENCON*, art. No. 5686632, 2108-2112 (2010); M. Mitsugi *et al.*, *J. Physics: Conference Series*, 215, art. No 012088 (2010)] Pulsed laser ablation of various metals in supercritical fluid has been developed and morphology of ablated plates and generated nanoparticle were examined and some kinds of metal nanoparticles have been successfully generated by laser ablation in supercritical fluid [S. Machmudah, Wahyudiono, Y. Kuwahara,

M. Sasaki, M. Goto, *J. Supercrit. Fluids*, in press (2011); S. Machmudah, M. Goto, Wahyudiono, Y. Kuwahara, M. Sasaki, *Research on Chemical Intermediates*, **37**(2-5), 515-522 (2011); Y. Kuwahara, M. Morita, H. Endo, K. Yoshimori, T. Nagami, K. Kumamaru, T. Iwanaga, T. Sawada, M. Sasaki, M. Goto, *Materials Research Innovations*, **14**(1), 16-18 (2010)]. [contact: Prof. M. Goto; E-mail: mgoto@kumamoto-u.ac.jp, Assoc. Prof. M. Sasaki; E-mail: msasaki@ kumamoto-u.ac.jp, Assistant Prof. Armando T. Quitain; E-mail: quitain@kumamoto-u.ac.jp]

International Association for the Properties of Water and Steam
Russian National Committee (RNC)

Report 2010-2011

1. RNC active participation in organization of 4-rd Water-Chemistry Forum, April 2011, Moscow, MPEI (TU).
2. Two meetings of RNC have been held. Current problems are investigated.

Publications list

1. Alexandrov A.A., Dzhuraeva E.V., Utenkov V.F. Temperature depression and solubility in aqueous solutions of sodium chloride. Novoe v rossiyskoy elektroenergetike (New in Russian elektroenergetiks), 2010, No 10, P. 24.
2. Alexandrov A.A., Dzhuraeva E.V., Utenkov V.F. The saturated steam pressure and surfase tension of aqueous solutions of the sodium sulfate. Vestnik MEI, 2011, No 3, P. 5.
3. Larin B.M., Larin A.B. Korotkov A.N., Oparin M.Y. Water chemistry of the cooling system of the electric generator stator on TPP. Thermal Engineering, #07, 2011, pp. 17-20.
4. Mulev Y.V., Belyaeva O.V., Mulev M.Y., Saplitsa V.V., Zayatc T.A. The dielectric constant as one of the main parameters controlling the state of the working fluid. Thermal Engineering, #07, 2011, pp. 36-40.
5. Ochkov V.F. Water chemistry for TPP and NPP – a new level of information support. Thermal Engineering, #07, 2011, pp. 76-77.
6. V.A. Voloschuk, V.F. Ochkov, K.A. Orlov. Thermodynamic optimization cycles of some gas turbines and CCGT using modern information technology (part 1)// // New in the Russian electric-power industry, #7, 2011, pp. 23-42.
7. V.A. Voloschuk, V.F. Ochkov, K.A. Orlov. Thermodynamic optimization cycles of some gas turbines and CCGT using modern information technology (part 2) // New in the Russian electric-power industry, #8, 2011, pp. 15-25.
8. V.F. Ochkov, E.E. Ustuzhanin, V.E. Znamenskiy, I.M. Abdulagatov, M. Frenkel. Information on the thermophysical properties of the Internet: problems and technologies. Abstracts of the 13th Russian Conference on Thermophysical substances. Novosibirsk, Russia, June 28–July 1, 2011, ISNB 978-5-89017-030-9, pp. 128 – 129
9. Ochkov V.F., Orlov K.A., Znamenskiy V.E. Thermal calculations based on the Internet functions on the properties of thermal power plants working fluids // New in the Russian electric-power industry, #6, 2011. pp. 40-49.
10. Voloshchuk V.A., Ochkov V., Orlov K. Thermodynamic optimization of cycles of some schemes of gas and gas-steam turbine power plants with the help of modern IT // Доклад на 10th conference on Power System Engineering, Thermodynamics & Fluid Flow - ES 2011, June 16 - 17, 2011, Pilsen, Czech Republic.
11. Ochkov V.F. , Ustuzhanin E.E. , Znamenskiy V.E. Analysis of Internet sites containing information on the thermophysical properties of working fluids // Proceedings of the Academenergo, #1, 2011, pp.110-123.
12. Voloschuk V.A., Ochkov V.F., Orlov K.A. Investigation of combined-cycle power plants using modern information technology // Aerospace engineering and technology. #5 (72), Kharkiv, HAI, 2010. pp. 71-76.
13. Ochkov V.F., Frenkel M., Khusnullin A.S. Interactive open thermotechnical network reference data: problems and solutions // Proceedings of the VII Summer School of young scientists and Academician V.E. Alimasova "Problems of heat and mass transfer and hydrodynamics in power, 15-17 September 2010, Kazan, Russia. pp. 281-284.
14. A.E.Verchovsky, D.G.Bucharov, A.A.Zonov at al.Automatization of Phosphate introducing in the high pressure boiler. New in Russia Electrical Power, 3, 2011, p.25-32.

U.S. National Committee to IAPWS
2011 Report on Activities of Potential Interest to IAPWS

Communicated from the National Institute of Standards and Technology, Boulder, CO and Gaithersburg, MD:

In collaboration with Prof. Richard Wheatley at the University of Nottingham, a pair potential was developed for the water-CO_2 binary pair, and used for the quantitative calculation of second virial coefficients. Results from this and previous water/gas systems are being incorporated into a software model for thermodynamics of moist gases.

Reference: Wheatley, R.J., and Harvey, A.H., Intermolecular potential energy surface and second virial coefficients for the water-CO_2 dimer, *J. Chem. Phys.* **134**, 134309 (2011).

In collaboration with researchers in Greece and Germany and at the University of Maryland, a new formulation has been developed for the thermal conductivity of water and steam. The complete correlation, which covers a wider range of conditions than the existing IAPWS formulation and is consistent with IAPWS-95 and the new IAPWS viscosity correlation, was presented for evaluation by IAPWS.

In NIST's Chemical and Biochemical Reference Data Division (Gaithersburg, MD), the vapor pressure of ice has been measured over the temperature range 173 K to 273 K. These measurements were made using cavity ring-down spectroscopy to probe the output of a standard humidity generator which contains isothermal samples of ice in a nitrogen atmosphere. The measurement is relative to the known triple-point pressure, and is corrected for the enhancement factor. A preliminary analysis indicates good agreement over this temperature range between the measured ice vapor pressure and the new IAPWS formulation for the sublimation pressure.

Reference: Bielska, K., Havey, D.K., Scace, G.E., Lisak, D., and Hodges, J.T., Spectroscopic Measurement of the Vapor Pressure of Ice, *Proc. Royal Soc. A*, in press.

NIST's Experimental Properties of Fluids group has built apparatus for two projects to measure thermophysical properties of aqueous gas mixtures at high temperatures. One apparatus is a high-temperature magnetic-suspension densimeter, which has been used to measure H_2O-N_2 and H_2O-CO_2 mixtures up to 620 K. The cross second virial coefficients from this work agree reasonably well with those determined from theory as described above. A high-temperature thermal conductivity apparatus (using the transient hot-wire technique) has been converted to alternating-current operation (needed for polar fluids like water) and used to measure the thermal conductivity of H_2O-N_2 and H_2O-CO_2 mixtures up to 740 K.

Communicated from the University of Maryland

The thermodynamic behavior of supercooled water was investigated at the University of Maryland as a continuation of a previous project supported by IAPWS in 2010:

C.E. Bertrand and M.A. Anisimov, *The peculiar thermodynamics of the second critical point in supercooled water*, J. Phys. Chem. B, in press (doi: 10.1021/jp204011z).

J. Kalova, R. Mareš, M.A. Anisimov, and J.V. Sengers, *Scaled equation of state for supercooled water in the mean-field approximation*, Technical Report prepared for the International Association for the Properties of Water and Steam (September 2011).

V. Holten, C.E. Bertrand, M.A. Anisimov, and J.V. Sengers, *Thermodynamic modeling of supercooled water*, Technical Report prepared for the International Association for the Properties of Water and Steam (September 2011).

Communicated from Don Palmer

I thought that the PCC in particular *might* be interested in the three publications listed below. I have also been engaged with the OECD NEA Headquarters in Paris (TDB projects) together with many others in producing volumes on the thermodynamic properties of elements of prime importance in nuclear waste storage. A list of those already published is available on their Web site. We have after long delays almost finished the first book on iron (solids and solution species) which should go to press by the end of the year. Work on a second iron book has just started as has others on (aluminum, magnesium, calcium, iodine and other minor topics), as well as one on molybdenum in which I am not evolved. These books are an excellent source of recommended thermodynamic properties (as well as a source of the available literature) in which each paper is reviewed and critiqued in an Appendix and the values recalculated in a consistent and up to date manner.

D.A. Palmer, H. Gamsjäger, "Solubility Measurements of Crystalline β-$Ni(OH)_2$ in Aqueous Solution as a Function of Temperature and pH," *J. Coord. Chem*., **63**, 2888-2908 (2010).

D.A. Palmer, P. Bénézeth, C. Xiao, D.J. Wesolowski and L.M. Anovitz, Solubility Measurements of Crystalline NiO in Aqueous Solution as a Function of Temperature and pH", J. Solution Chem., 40, 680-702 (2011).

D.A. Palmer, "Solubility Measurements of Crystalline Cu_2O in Aqueous Solution as a Function of Temperature and pH," J. Solution Chem., 40, 1067-1093 (2011).

Communicated from Andre Anderko, OLI Systems

In 2010-2011, the work at OLI Systems was focused on:

(1) Finalizing a comprehensive model for surface tension of electrolyte solutions in wide ranges of concentrations and temperature
(2) Developing a thermodynamic model for predicting the behavior of mixtures composed of carbon dioxide and various salts containing the Na, K, Mg, Ca, Cl, SO4, and CO3 ions. Further, work was initiated on applying this model to predict the interactions between CO2-rich phases and minerals, which may be of interest for understanding the behavior of CO2 in sequestration environments
(3) Developing a thermodynamic model for aqueous systems containing various alkanolamines and carbon dioxide and hydrogen sulfide. This model combines phase and chemical equilibria and is designed for applications such as CO2 capture and gas processing.
(4) Developing an electrochemical model for predicting general and localized corrosion of copper and alloy CuNi9010 in a variety of aqueous environments as a function of solution chemistry, temperature and flow conditions. Currently, this model is being extended to alloy CuNi7030.
(5) Initiating the development of a model for predicting interfacial tension.

In the past year, the following two articles have been published:

P. Wang, A. Anderko and R.D. Young, "Modeling Surface Tension of Concentrated and Mixed-Solvent Electrolyte Systems", Ind. Eng. Chem. Res., 50 (2011) 4086-4098.

P. Wang and A. Anderko, “Modeling Chemical Equilibria, Phase Behavior, and Transport Properties in Ionic Liquid Systems”, Fluid Phase Equilibria, 302 (2011) 74-82.

IAPWS 2011 Annual Meeting Participants (89 people)

Hertanto Adidharma	University of Wyoming	USA
Alexei A. Alexandrov	Moscow Power Engineering Institute	Russian Federation
Andre Anderko	OLI Systems Inc.	USA
Mikhail Anisimov	University of Maryland	USA
James Bellows	Siemens Energy, Inc.	USA
Geoffrey Bignold		United Kingdom
Francisco Blangetti	Alstom Power	Switzerland
Julien Bonifay	Siemens AG	Germany
Albert Bursík	PowerPlant Chemistry Journal	Germany
Patrick Colman	ESB Energy International	Ireland
William Cook	University of New Brunswick	Canada
Jeff Cooper	Queen Mary University of London	United Kingdom
Karol Daucik	Larok, s. r. o.	Slovakia
Frank de Vos	KEMA	The Netherlands
Georg Doleisch	Zittau/Goerlitz University of Applied Sciences	Germany
Barry Dooley	Structural Integrity	USA
Andreas Drexler	AREVA NP GmbH	Germany
Jana Ehlerová	Technical University of Liberec	Czech Republic
Rainer Feistel	IOW	Germany
Anders Fredrikson	Tekniska Verken in Linköping AB	Sweden
Daniel G. Friend	National Institute of Standards and Technology (NIST)	USA
John Gallagher	National Institute of Standards and Technology (NIST)	USA
Pavel Gotovtsev	Moscow Power Engineering Institute	Russian Federation
Detlef Günzel	STEAG Energy Services	Germany
David Guzonas	Atomic Energy of Canada Limited	Canada
Satoshi Hanawa	Japan Atomic Energy Agency	Japan
Václav Hanus	ČEZ, a.s. - Chemistry Unit of Temelín	Czech Republic
Allan Harvey	National Institute of Standards and Technology (NIST)	USA
Mats Hellman	Hellman Vatten AB	Sweden
Olaf Hellmuth	Leibniz Institute for Tropospheric Research	Germany
Ian Hey	CANDU Owners Group	Canada
Michael Hiegemann	Alstom Ltd.	Switzerland
Vincent Holten	Institute for Physical Science and Technology	USA
Jan Hrubý	Institute of Thermomechanics AS CR, v.v.i.	Czech Republic
Taro Ichihara	Mitsubishi Heavy Industries, Ltd.	Japan
Gary Joy	CS Energy	Australia

Jana Kalová	University of West Bohemia in Pilsen	Czech Republic
Haruka Kido	Mitsubishi Heavy Industries, Ltd.	Japan
Petr Konáš	University of West Bohemia in Pilsen	Czech Republic
Hans-Joachim Kretzschmar	Zittau/Goerlitz University of Applied Sciences	Germany
Barbara Laky	Anton Paar GmbH	Austria
Boris Larin	Moscow Power Engineering Institute	Russian Federation
Frank Udo Leidich	Alstom Power Systems GmbH	Germany
Anneke Levelt Sengers	National Institute of Standards and Technology (NIST)	USA
Derek Lister	University of New Brunswick	Canada
Radim Mareš	University of West Bohemia in Pilsen	Czech Republic
František Maršík	Institute of Thermomechanics AS CR, v.v.i.	Czech Republic
Nobuyuki Matubayasi	Kyoto University	Japan
Masamichi Miyajima	Chubu Electric Power Co., Inc.	Japan
Peter Murphy	General Electric Company	USA
Melonie Myszczyszyn	Canadian Natural Resources Ltd.	Canada
Masaru Nakahara	Kyoto University	Japan
Tomáš Němec	Institute of Thermomechanics AS CR, v.v.i.	Czech Republic
Adam Nový	ŠKODA POWER s.r.o.	Czech Republic
Nobuo Okita	Toshiba Corporation	Japan
Konstantin Orlov	Moscow Power Engineering Institute	Russian Federation
Reiner Pawellek	STEAG Energy Services	Germany
Tamara Petrova	Moscow Power Engineering Institute	Russian Federation
Jiří Polanský	University of West Bohemia in Pilsen	Czech Republic
Vít Pospíšil	University of West Bohemia in Pilsen	Czech Republic
Pavla Rudasová	ŠKODA POWER s.r.o.	Czech Republic
Bert Rukes	Siemens AG	Germany
Michael Rziha	Siemens AG – Energy	Germany
Javid Safarov	University of Rostock, Institute of Technical Thermodynamics	Germany
Milan Sedlář	SIGMA Výzkumný a vývojový ústav s.r.o.	Czech Republic
Steffen Seitz	Physikalisch-Technische Bundesanstalt (PTB)	Germany
Jan Sengers	University of Maryland	USA
Anurag Singh	GE Energy	USA
Roland Span	Ruhr-Universitaet Bochum	Germany
Petra Spitzer	Physikalisch-Technische Bundesanstalt (PTB)	Germany
Robert Svoboda	Svoboda Consulting	Switzerland
Pavel Šafařík	Czech Technical University in Prague	Czech Republic
Josef Šedlbauer	Technical University of Liberec	Czech Republic

Oldřich Šifner	Institute of Thermomechanics AS CR, v.v.i.	Czech Republic
Miroslav Šťastný	University of West Bohemia in Pilsen	Czech Republic
Hiroshi Takaku	Shinshu University	Japan
Karsten Thomsen	Vattenfall DK	Denmark
Peter Tremaine	University of Guelph	Canada
Masakatsu Ueno	Doshisha University	Japan
Shunsuke Uchida	Japan Atomic Energy Agency	Japan
Sonja Vidojkovic	Serbian Power Generation	Serbia
Václav Vinš	Institute of Thermomechanics AS CR, v.v.i.	Czech Republic
Wolfgang Wagner	Ruhr-Universitaet Bochum	Germany
Koichi Watanabe	Keio University	Japan
Ingo Weber	Siemens Energy	Germany
Kenji Yasuoka	Keio University	Japan
Masaki Yoshida	Naigai Chemical Products Co. Ltd.	Japan
Patrik Zima	Institute of Thermomechanics AS CR, v.v.i.	Czech Republic
Markéta Zychová	Research Centre Rez Ltd.	Czech Republic

Participants attending attending only Symposium (not included in the above list) - 22 people

Jan Budjač	TECHNOPROCUR CZ, s. r.o.	Czech Republic
Josef Glazer	Glazer	Czech Republic
Jan Halama	ČVUT Praha	Czech Republic
Michal Hoznedl	ŠKODA POWER s.r.o.	Czech Republic
Jaroslav Katolický	Vysoké učení technické Brno	Czech Republic
Petr Kovařík	University of West Bohemia in Pilsen	Czech Republic
Vladimír Křenek	University of West Bohemia in Pilsen	Czech Republic
Jan Kysela	Research Centre Rez Ltd.	Czech Republic
David Lávička	University of West Bohemia in Pilsen	Czech Republic
Jiří Linhart	University of West Bohemia in Pilsen	Czech Republic
Petr Martinec	University of West Bohemia in Pilsen	Czech Republic
Ivo Nezbeda	Jan Evangelista Purkyně University in Ústí nad Labem	Czech Republic
Milan Pavelek	Vysoké učení technické Brno	Czech Republic
Petra Píclová	University of West Bohemia in Pilsen	Czech Republic
Josef Pišan	TECHNOPROCUR CZ, s. r.o.	Czech Republic
Luboš Prchlík	ŠKODA POWER s.r.o.	Czech Republic
Martin Prokš	ŠKODA JS a.s.	Czech Republic
Marie Svobodová	University of West Bohemia in Pilsen	Czech Republic
Jaroslav Štěch	University of West Bohemia in Pilsen	Czech Republic
Ladislav Tajč	ŠKODA POWER s.r.o.	Czech Republic

Jana Viktorinová	Vysoké učení technické Brno	Czech Republic
Pavel Žitek	University of West Bohemia in Pilsen	Czech Republic

Accompanying persons (14 people)

Fujiko Watanabe, Japan
Ms. Sayako Ueno, Japan
Ms. Naoko Ueno, Japan
Mr. Yohei Ueno, Japan
Sabine Feistel, Germany
Elena Jouravleva, USA
June Hey, Canada
Anneliese Wagner, Germany
Lisbeth Svoboda, Switzerland
Mrs Tea Joy, Australia
Karin Tremaine, Canada
Judith Colman, Ireland
Barbara Bellows, USA
Ulrike Hiegemann, Switzerland

Total of 125 people