Minutes

IAPWS Subcommittee on Seawater (SCSW)

Niagara Falls, Canada, July 19-22, 2010

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, July 19 by the SCSW Chair, Rainer Feistel. The agenda (Attachment A) was adopted after minor additions (attachment reflects additions). The Chair gave a brief appreciation of the life and contributions of Dan Wright, a member of the SCSW who had died earlier in July. This was followed by a moment of silence.

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

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

4. (humid air with seawater & ice) (included as item #5 in TPWS Minutes)

5. (IAPWS-IF97 editorial changes) (included as item #6 in TPWS Minutes)

6. (IAPWS-95 editorial changes) (included as item #7 in TPWS Minutes)

7. (melting/sublimation) (included as item #8 in TPWS Minutes)

8. (thermal conductivity) (included as item #9 in TPWS Minutes)

9. (humid gases) (included as item #12 in TPWS Minutes)

10.1. On behalf of T. McDougall, R. Feistel reported on the status of the new oceanographic standards that IAPWS has been involved in. The suite of formulations known as TEOS-10 has been adopted by the International Oceanographic Commission, and the manual has been published along with articles describing the formulations and their implementation. Details are available at www.TEOS-10.org.

Since the time period for the SCOR/IAPSO Working Group WG127 will expire soon, the question arises about long-term coordination and cooperation in these activities. Additional areas for cooperation include metrological traceability to the SI, development of a dynamic salinity model, and uncertainties. **A letter is being drafted from IAPWS to the Presidents of IAPSO and SCOR inviting continuing cooperation in some form of a joint task group.**

10.2. **It was voted to add T. McDougall as an additional Vice-Chair for SCSW, effective immediately.**

10.3. On behalf of D. Wright, R. Feistel summarized the implementation of the TEOS-10 SIA (Seawater, Ice, Air) library. Two papers describing this have been published in *Ocean Science*.

10.4. M. Hiegemann (with contributions from H. Glade who was not present) reported on industrial requirements for seawater properties in desalination (by membrane and two distillation procedures), in power station cooling, and LNG evaporation. To meet the needs of these industries, the current IAPWS seawater formulation has an insufficient range in some cases (particularly in temperature). Temperature requirements may reach 120 °C, and to allow for future developments it would be desirable for temperatures up to 150 °C to be covered. Salinities may go to 70, but it would be desirable to have values covered to 100. Pressures are not so high compared to oceanographic conditions. Some initial thoughts were presented about desired accuracy in properties; uncertainty of 0.1% in the saturation pressure-temperature relationship was singled out as especially desirable. There are probably not major speed requirements. Requirements may also exist for description of osmotic pressure and surface tension. It was decided that more clarity on the requirements from industry are needed before a new formulation can be pursued.

10.5. J. Cooper reported that no progress had been made on the Advisory Note describing the use of IAPWS-IF97 in industrial calculations with seawater within the limits of validity of the current seawater formulation (which will exclude some applications). **This document should now be prepared on a schedule allowing for approval at the 2011 IAPWS meeting. The members of the Task Group for this (from the 2009 Minutes) are Cooper (Chair), Feistel, and Hiegemann, with authorization for one more industrial member to be added later by agreement of the existing members. An Evaluation Task Group consists of Hruby (Chair), Mareš, and Miyagawa.**

10.6. A. Anderko presented his work with P. Wang on modeling the thermal conductivity of seawater. The results are good for well-defined systems; the limited data available for seawater are scattered and sometimes not physically reasonable. **The Task Group on Transport Properties appointed in item 6 of the 2009 SCSW minutes was encouraged to continue toward developing a final formulation (to become an IAPWS Guideline), interacting with the effort to produce a new pure-water thermal conductivity correlation so that the new seawater correlation will meet this pure-water limit.**

R. Pawlowicz presented his modeling of the electrical conductivity of natural waters and seawater. While for seawater the model is not nearly as accurate as good conductivity measurements, it may be possible to use the model to look at composition variations. In combination with existing measurements of seawater conductivity, **a progress report on the work on a future IAPWS formulation on the electrical conductivity of seawater is intended to be prepared for 2011 by the task group**.

10.7. R. Feistel presented a summary of some new experimental data for density of seawater (some of which are outside the range of validity of the seawater release, extending up to 195 °C). A publication with complete description of the work is needed before we can assess the usefulness of this work in extending the Gibbs function of seawater. With regard to

extending the range of available data, it was mentioned that some heat-capacity data are forthcoming, and that speed-of-sound data would be desirable.

10.8. ICRN-16 on thermophysical property needs for seawater was discussed. R. Feistel presented some minor suggested updates. It was suggested that some numbers in the ICRN should change to reflect the report in Minute 10.4 above. J. Cooper and M. Hiegemann were appointed to review the document and make any necessary adjustments. These adjustments were made, and **the revised ICRN-16 was approved by the Subcommittee, with new expiration date of 2013**.

10.9. P. Spitzer (with input from S. Seitz who was not present) gave a progress report from the Task Group "Traceability of Salinity." There is work in progress to use standard seawater to calibrate conductivity sensors, and to correlate accurate density measurements with the salinity.

10.10. G. Marion presented a summary of different conventions for defining pH and for extracting pH from measurements (including the "total" scale for seawater work that includes other ions), and discussed their effects for seawater and other aqueous electrolyte solutions. It was pointed in discussion out that IUPAC has established a standard definition, and that it might be useful to distinguish between the thermodynamic definition and various conventions for realizing that definition. There is also interest in pH in the PCAS WG, and Dr. Marion was encouraged to discuss the issue with PCAS members.

10.11. Regarding the Mission Statement requested by the President, the following was agreed upon as an initial statement to bring to the EC, with the understanding that it would be subjected to further editing and work to harmonize with the mission statement of other Working Groups:

Intended for application in oceanography, marine technology and industry, it is the aim of the IAPWS 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.

11. (uncertainties) (included as item #17 in the TPWS Minutes)

12. (CIPM MRA) (included as item #18 in the TPWS Minutes)

13.1-13.3 (included under item 19 of the TPWS Minutes)

13.4. R. Pawlowicz gave a presentation about standardization of nomenclature for salinity and salinity anomalies, where the many different definitions and notations in use cause some differences that can be significant in some contexts. A paper describing these issues has been submitted to Ocean Science.

13.5. F. Millero presented on seawater anomalies in the oceans, with effects due to $CaCO_3$ and silica from organisms and possible effects of dissolved organic carbon (DOC). New data will be forthcoming in the coming years.

13.6. R. Feistel presented on seawater anomalies in the Baltic Sea, where he modeled anomalies in terms of the Gibbs function and the electrical conductivity. The anomalies do not significantly affect most thermophysical properties, but they can be significant (compared to measurement uncertainties) for the density and the speed of sound.

13.7. P. Spitzer presented on a European metrology research project getting underway on "Metrology for Oceanic Salinity and Acidification." Topics of the proposed work packages include density, sound speed, and salinity.

13.8, 13.9 (included under item 19 of the TPWS Minutes)

14. **It was voted to accept R. Pawlowicz (University of British Columbia, Canada) to membership in SCSW.**

15. There was no additional business presented.

16. The Chair and Clerk of Minutes were appointed to prepare the formal motion of the TPWS/IRS WGs to the EC.

17. The meeting was adjourned at 4:58 PM on Thursday, July 22.

Preliminary Agenda
IAPWS Subcommittee on Seawater SC SW
Niagara Falls, Canada. 18-23 July 2010

1. Opening Remarks; Adoption of Agenda
2. Appointment of Clerk of Minutes
3. Web Space for Working Material for WGs TPWS, IRS, and SC SW, joint with WG TPWS
4. Guideline on an Equation of State for Humid Air in Contact with Seawater and Ice, Consistent with the IAPWS Formulation 2008 for the Thermodynamic Properties of Seawater, joint with WGs TPWS, IRS
   - Report (R. Feistel)
   - Test Report (K. Miyagawa, J. Hruby, V. Vins, V.F. Ochkov)
   - Formal consideration of the Guideline
5. Editorial Changes on the Revised Release on the Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam (IAPWS-IF97), joint with WGs TPWS and IRS
   - Report (W. Wagner)
   - Test Report (K. Miyagawa)
   - Formal consideration of the Editorial Changes
6. Editorial Changes on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (IAPWS-95), joint with WGs TPWS and IRS
   - Report (W. Wagner)
   - Test Report (K. Miyagawa)
   - Formal consideration of the Editorial Changes
7. Revision of the Revised Release on the Pressure along the Melting and Sublimation Curves of Water, joint with WGs TPWS and IRS
   - Report (W. Wagner, R. Feistel)
   - Test Report (K. Miyagawa, A.H.Harvey)
   - Formal consideration of the Revised Release
8. Transport Properties of Water and Steam, joint with WGs TPWS and IRS
   - Progress Report on the Thermal Conductivity of H_2O (J.V. Sengers, E. Vogel, R.A. Perkins, M.L. Huber, D.G. Friend, M.J. Assael, I.N. Metaxa)
9. Properties of Humid Air and Humid Combustion Gases, joint with WGs TPWS, IRS and PCAS
   - Revision of ICRN-14 on Thermophysical Properties of Humid Air and Combustion-Gas Mixtures (M. Wendland, R. Span, A.H. Harvey)
10. Properties of Seawater, joint with WGs TPWS and IRS

10.1 Task Group Report “Oceanographic Standards” (T.J. McDougall, R. Feistel)

10.2 Change of the Vice Chair of SC SW

10.3 Implementation of the "TEOS-10 SIA Library" (D.G. Wright, R. Feistel)

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

10.5 Task Group Report "Advisory Note on Industrial Formulation" (J. Cooper)

10.6 Task Group Report "Transport Properties", joint with WG PCAS

- Development of a Model for Calculating Thermal Conductivity of Seawater (A. Anderko)
- The Accuracy of Electrical Conductivity Models when Applied to Natural Waters (R. Pawlowicz)

10.7 Recent Measurements of Seawater Properties (R. Feistel, J. Safarov, F.J. Millero)

10.8 Renewal of ICRN-16 on Thermophysical Properties of Seawater (R. Feistel)

10.9 Task Group Report "Traceability of Salinity" (S. Seitz, H. Wolf)

10.10 Task Group Report "pH Values" (G. M. Marion, F. Camoes)

10.11 Mission Statement of SC SW

11. Uncertainty of Properties Derived from Thermodynamic Potentials
    - Report (R. Feistel)

12. CIPM Mutual Recognition Arrangement – to be recognized by IAPWS?
    - Report (R. Feistel, P. Spitzer)

13. Reports on Other SC SW Activities

13.1 Guideline on Fundamental Constants (A.H. Harvey) joint with WGs TPWS, IRS

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

13.3 Web presentation of Releases, etc. (A.H. Harvey), joint with WGs TPWS, IRS

13.4 Standard Nomenclature of Salinities and Anomalies (D.G. Wright, R. Pawlowicz)

13.5 Seawater Anomalies in the Ocean (F.J. Millero, T.J. McDougall)

13.6 Seawater Anomalies in the Baltic Sea (R. Feistel, R. Pawlowicz)

13.7 Metrology for Oceanic Salinity and Acidification - a Selected Research Topic within the European Metrology Research Programme (P. Spitzer)

13.8 Report on the WMO/BIPM Meeting in Geneva, April 2010 (P. Spitzer, R. Feistel) joint with WG TPWS

13.9 Report on the Tempmeko & ISHM Conference in Portorož, June 2010 (R. Feistel, S. Rudtsch) joint with WG TPWS

14. Membership

15. Other Business

16. Preparation of the Formal Motion to the EC

17. Adjournment

21 July 2010, R. Feistel (Chair)