**Minutes of the IAPWS working group IRS,**
**Rotorua, New Zealand, Nov. 27 - Dec. 2, 2022**
(Numbering of topics follows TPWS agenda, except where denoted "…-IRS")

1. The Chair, Nobuo Okita, opened the IRS (joint with TPWS) at 10:30 am, 28. November 2022. Agenda was adopted without changes.
2. Appointed Adam Nový as a clerk of minutes for IRS

**3. Potential International Collaborative Project**

Young scientist project has been proposed by A. Harvey, R. Span and J. Hrubý. The project is for 2023-2024 for young scientist Aleš Blahut from Czech Institute of Thermomechanics – Czech Academy Of Sciences. The work should be a preliminary preparation for IAPWS-95 replacement and will be focused on review of available data, identifying possible problems and preparing the structure for equations. IAPWS funding of 9.300 GBP will be used for foreign stay.

The following discussion:

D. Friend recommended to openly communicating the proposal to all national committees to avoid collisions with other proposals. The proposal was unanimously agreed to pass to EC.

**TODO:**

Move proposal to EC

4. State of Development of a New Formulation for the Thermodynamic Properties of Ordinary Water (Replacement of IAPWS-95)

**4.1 Report of Task Group (A. Harvey, D. Friend, J. Hrubý, N. Okita, K. Orlov, R. Span)**

A. Harvey summarized known problems to be reviewed like EOS deficiencies, unphysical behavior, oscillating and extrapolation problems. Also considered availability of new data and in parallel identifying regions where data are needed. Summary of collected information and considering possible preliminary EOS.

The following discussion:

K. Mayer considerations about time frame about 2 years and then decide how to move on. Other discussed super cooled water region, low temperatures (high Mach) below triple point ($H_2$ combustion). D. Friend mentioned uncertainties, but it was concluded, to be determined later.

5. IAPWS Certified Research Needs (ICRNs)

**5.1 ICRN 16: Thermophysical Properties of Seawater (R. Pawlowicz)**

R. Pawlowicz not present and no other member of SCSW, ICRN expired

**5.2 ICRN 30: Thermophysical Properties of Supercooled Water (O. Hellmuth)**

O. Hellmuth also not present and no other member of SCSW, ICRN expired

Both ICRNs are expired and both are related to SCSW, which is now not active because of personal reasons of the members.

The following discussion to both ICRNs:

D. Friend suggested that there is no problem leave it as is until next year. After broader discussion, the TPWS and IRS members agreed to take no action and wait until the next

meeting whether there will be any activity and possible personal changes in SCSW. The JCS is active, but now the link to IAPWS is missing.

**TODO:**

The TPWS and IRS members concluded to contact Chair and Vice-chair of SCSW and/or S. Seitz, who might be interested.

6. Industrial Requirements and Solutions for Property Calculations, joint with WG TPWS [Monday afternoon]

**6.1 Report of the Task Group "Categories of industrial requirements" (N. Okita, chairs or representatives of other WG)**

N. Okita presented the status of gathered categories and highlighted new items. N. Okita accented the most relevant categories like condensation, corrosion and geothermal steam. The grouping of categories into A, B, C groups according to the IAPWS distance. Then the modified part were overviewed. There were new categories added namely, hydrogen combustion, clouds micro and macrophysics related to aviation, ammonia and water-ammonia mixtures, which were brought to discussion. Short-term topics 1y Industrial calculation needs (CFD), Wet steam data/simulation, ASME cooperation. Long-term 3y mixtures $H_2O$ plus some substance, $CO_2$ cycles. New possible mission including PCAS, wet steam, non-condensable gases and scrubbing/moisture removal.

The following discussion:

A. Harvey asked, what is expected from ASME and the answer was to attract industry people to IAPWS to bring new challenges relevant to IAPWS. J. Hruby suggested to avoid clouds physics as it is the topic covered by other groups within ocean, weather and climate modeling. K. Meier suggested $N+H_2O$ mixtures and also pure helium used in primary thermometers. Later K. Meier also suggested sharing the categories list within all IAPWS members because it is a very complete and complex work. A. Harvey mentioned, that hydrogen combustion can be understand in two ways, hydrogen clean or included for example in LNG combustion. D. Friend mentioned possible activity for ICPWS 2024. Consider whitepaper on wet steam properties and also on mixtures in the farther future.

Continuing discussion separately in IRS (as item 9-IRS). H. J. Kretzschmar noted that power industry in Germany is moving away from the coal and nuclear. H. J. Kretzschmar also commented the ammonia and ammonia-water mixtures used for Kalina cycle, desalination and in heat pumps. Regarding the hydrogen combustion, there was also mentioned that within ASME there exist combustion committee. It was concluded, that wet steam is still the most important topic followed by the geothermal steam. Next can be the hydrogen combustion and clouds micro-macrophysics related to aviation industry. The lowest relevance has the ammonia and ammonia-water mixtures (Kalina, desalination heat pumps), The idea of contact with ASME has been accepted. Panel discussion in ASME conference is also useful if it can be held. After the program of ASME Turbo Expo 2023 (June 26-30) is submitted, we can survey which items are attracted. Same for other ASME conferences.

**TODO:**

Get involved in ASME Turbo Expo 2023 in Boston to observe the industry needs.

**6.2 Report of the Task Group "Wet steam properties Calculation" (A. Nový, J. Hrubý, K. Orlov, R. Span, K. Meier, Francesca di Mare, S. Senoo, M. Kunick)**

A. Novy reported no progress on the theoretical models and calculations. Presented new measurement nozzle for wet steam measurements, which will be operational in next year within Doosan Skoda company's R&D.

The following discussion:
Possible forms of funding for providing experiments and possible forms of support from IAPWS (ICRNs, International Collaborative Projects). Possible connection with International Wet Steam Modeling Project
**TODO:**
Get in touch with the International Wet Steam Modeling Project possible contact should be Markus Schatz.

7. Heavy Water Properties (joint with WG TPWS)

**7.1 Progress on a Formulation for the Static Dielectric Constant of Heavy Water (J. Cox, J. Young, A. Harvey, and P. Tremaine)**

A. Harvey gave the summary of work done, two formulations suggested first for solution chemist with limited region and second completely new and flawless. The work will resume in 2023

The following discussion:

D. Friend asked for the result for if it should be one or two equations. A. Harvey concluded that it will be determined, when finished. Refer to the TPWS minutes more in detail.

**7.2 Appointment of a Task Group for the Evaluation of the Formulation of the Static Dielectric Constant of Heavy Water**

Refer to the TPWS minutes.

**8. Report of Task Group on Surface Tension of Ordinary Water (joint with WG TPWS and SC SW) (J. Kalová, V. Vinš, A. Harvey, O. Hellmuth, V. Holten, J. Hrubý, R. Mareš, F. Caupin)**

J. Hrubý presented on behalf of J. Kalova, who is not active due personal reasons, basic information. Refer to the TPWS minutes more in detail.

**9-IRS -New item for considering IRS task group (Francesca di Mare, N. Okita)**

Refer to the item 6-1 (included in the latter half of item 6-1)

13. TPWS/IRS/PCAS/PCC joint session

**13.1 Electrode Boiler Chemistry Issues Update and Possible TGD Discussions (D. Addison, Monika Nielson)**

D. Addison gave overview of real operation problems in e-boiler regarding corrosion of electrodes and their surroundings. D. Addison accented limited technical knowledge, no scientific literature and no industry published data regarding this kind of problems. Finally, the problems were treated by adjusting the design and operation modus. H2 levels are monitored and kept at normal levels. For the hydrogen, levels there are also no knowledge about the levels. Refer to the PCC minutes more in detail.

**13.2 ICRN 32 Conductivity of Electrolytes in Aqueous Solutions Presentation and Discussion**

Refer to the TPWS/PCC minutes.

**13.3 Strategies to improve criteria on steam for steam turbine (geothermal) (S. Terada)**

S Terada gave overview in focus of balancing purity vs operating costs. Limits for steam purity needs to be revised to avoid corrosive substances, scale and possible erosion and/or corrosion.

**13.4 Report of the joint Task Group "White paper on geothermal plant issues" (N. Okita, Francesca di Mare, D. Addison, S. Terada)**

D. Addison summarized the status of the prepared Whitepaper on Geothermal Steam Purity and Recent Data Collection Update. Overview of scaling, corrosion, erosion and steam purity problems. There were auxiliary devices described (separators, scrubber, condensing traps). There was also servicing and revision scheme of geothermal turbines discussed. The purity limits are being discussed and adjusted between NZAPWS and JPAPWS 2nd draft is expected by January 2023 and possible approval of final document in 2023 Italy.

**13.5 Report of the joint Task Group "Wet Steam Data from Operating Turbines" (S. Senoo, N. Okita, A. Anderko)**

S. Senoo gave overview of problematic of coarse droplets causing erosion of the last stages in steam turbines. There were measurements of droplets spectrum presented. The key is to understand the film forming on stator blade and forming droplets from the water film. The film was measured and visualized. The measurements were done on Mitsubishi experimental turbine.

The following discussion:

B. Dooly noted, that erosion can be also related to electrostatic discharge and that works on this topic are published. J. Hruby added that on the similar topic there is another group of people working at the Czech Technical University in Prague (O. Bartoš)

**13.6 Report of the joint Task Group on ICRN for acid gas dew points (N. Okita, S. Senoo, T. Němec) [Joint with PCAS]**

N. Okita presented an update on the topic, the theoretical model for dew point ASPEN Model-3 was found to be sufficient, as there were not big differences between model and application at existing plants condition. Consider simulation of wider range of SO3 concentration to lower SO3 contents than 0.08ppm. However, ICRN is now not necessary as the exhaust temperature is decided by other factors such as draft forth of exhaust gas in case of lower than 0.01ppm SO3. Possible TGD on reliability against corrosion and on high efficiency case by case in operation and types. Discussed with PCC chair D. Addison.

**TODO:**

White paper for the TGD to be prepared until the next annual meeting.

10-IRS. Other Business

**10.1 Report on New Item for considering IRS Task Group**

IRS continue to investigate "wet steam" including geothermal steam.
Then, IRS would extend the mission such as hydrogen combustion and clouds micro-macrophysics related to aviation industry, and ammonia and ammonia-water mixtures.
IRS agree to contact with ASME members to collaborate for new topics.

**10.2 Nomination for Gibbs Award committee**

N. Okita has been nominated by the IRS WG

11-IRS. Membership

**11.1. Election of new chair and new vice chair of IRS**

It was unanimously confirmed to propose Francesca di Mare as new chair and Richard Harwood as new vice-chair to EC.

12-IRS. Preparation of the Formal Motion to the EC

Propose Francesca di Mare as new chair and Richard Harwood as new vice-chair to EC

15-IRS. Contribution to Press release will be done by the WG chair.

15-IRS. Adjournment

Adjourned at about 17:00 November 29, 2022