IAPWS Working Group Power Cycle Chemistry (PCC)

Minutes of IAPWS PCC WG Meetings
Niagara Falls, Canada, 19-22 July 2010.

Chairman: Robert Svoboda
Members present See PCC Attachment A

Agenda

Amendments / Adoption of Agenda

There were no amendments to the draft agenda.

Week program: split up of PCC for joint workshops and task groups.

R. Svoboda summarized the schedule. The workshops program is listed in Attachment B.

Appointment of Clerk of Minutes

G. Bignold agreed to act as Clerk of Minutes.

Approval of Minutes of PCC WG in Doorwerth, The Netherlands, 2009

The minutes were approved without any corrections.

Progress Reports on PCC Activities 2009 / 2010

International Collaboration

D. Lister reported continuing progress with the international collaboration on sampling. The appointed student from Japan had spent an initial two-week period at University of New Brunswick. The work plan had been established and the framework for CFD modeling of a sampling system had bee constructed. The experimental program is planned to start later in 2010 and the collaboration is planned to last until 2012. The potential for further work is anticipated. Meanwhile the progress is according to plan.

ICRN

New ICRN have been prepared since the last meeting
- #25 on Corrosion mechanisms that are related to the presence of contaminants
- #26 on Behavior of Aluminum in the Steam Water Cycle

ICRN that need to be updated
- #19 on Sampling of corrosion products
- #20 on High temperature sensors

ICRN that need to be closed (ICRN #13, 18)
- #13 on Surface tension.
- #18 on Thermal decomposition of ion exchange resins

These ICRN are discussed in detail in item 7.

PCC Task Groups

The three task groups currently constituted cover:

IAPWS Guidance documents

B. Dooley summarized the current position. The two issued guidance documents (on carry-over and on key instrumentation) are confirmed as being in widespread use worldwide. Final changes to the third document (on volatile treatments for steam/water circuits) were to be discussed in the task group before submission to the executive committee for approval on 23 July. The task group will next plan to develop a guidance document on non-volatile alkali boiler dosing. Future plans include coverage of sampling QA and QC, steam purity for steam turbines, volatile treatments for nuclear plants and there will be scope for updating of the established documents as and when necessary.

Quantification of chemistry related asset damage.

K.Daucik reported that the group activities were the production of an updated draft report and that it is anticipated that the work will be finished in 2010 / 2011.

European Standard EN 12952.

G.Bignold reported that the decisions to revise both of the CEN standards covering boiler water chemistry requirements (EN 12952 part 12 and EN12953 part 10) had been agreed at a meeting of CEN technical committee TC269 in March 2010. The TC269 working groups had been instructed to add these revisions into their programs. To date there had been only one further meeting (working group 2) which acknowledged the addition to its work program.

This position represents a successful outcome of the lobbying by European members of PCC. BIAPWS will maintain contact with the revision (via representation on BSi). No further defined action at this time.

PCC Public Relations

R. Svoboda noted that the PCC initiative on addition of key word to the IAPWS website is being implemented (see the EC minutes 2010).

PowerPlantChemistry is now under new ownership, which is closely allied with the Swiss national committee of IAPWS. A.Bursik continues to be editor..

B. Dooley noted that the widespread dissemination and use of the PCC Guidance Documents has raised the profile of PCC within the power industry worldwide.

Other Action List Items

There were no other items not covered on the agenda.

Priority List Review

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

PCC Task Groups

IAPWS Guidance Documents (B.Dooley, chair)

Guidance Documents Task Groups Work Plan
(assuming that the annual meeting is by begin of September)

- Initial draft/skeleton by Nov/Dec
- Circulated to Sub-Task Group Dec/Jan
- Circulated to PCC WG February
- Editorial Committee: April
- National Committees: May/June

Volatile Treatments

B. Dooley set out the modifications to the draft on Volatile treatments for steam/water circuits that had been requested by Japanese and Russian national committees. Four improvements had been suggested by the Japanese committee. Modifications to the document had been formulated and these were all endorsed by PCC.

The Russian delegation had requested reconsideration of the information covering behavior of aluminum in steam water circuits. PCC consensus was that generic coverage of this topic should be retained with added caveats covering the implications of aluminum components on pH ranges and on consequential risks. Specific mention of Heller cooling systems was agreed to be inappropriate.

The approach to SI units for conductivity were also discussed and a paragraph covering the current use of $\mu S.cm^{-1}$ (rather than $\mu S.m^{-1}$) was agreed.

On the basis of these final changes, the PCC agreed to the submission of the document to the IAPWS Executive for formal adoption.

Action R. Svoboda

Carry-over

An update to the Guidance Document on carry-over has been identified as necessary. This will cover sampling and QA/QC issues. F.Gabrielli agreed to set out a scope of amendment by November/December 2010.

Action F.Gabrielli (with assistance from B.Dooley, G.Bignold and M.Ball subject to confirmation)

Sampling

In view of ongoing international collaboration it was agreed that preparation of guidance on sampling QA/QC should be deferred for one year.

Nuclear Circuit Chemistry

To liaise with IAEA on potential for collaboration on a guidance document for circuit chemistry for nuclear plants and report back to PCC.

Action D. Lister, S. Uchida.

Boiler Chemistry using phosphates and hydroxides

Preparation of a new guideline on solid alkali boiler chemistries is proposed for the coming year. Coverage to include:

- Trisodium Phosphate use, effects of hide-out and of dry-out, influence of in-leakage of alkaline cooling waters, etc.
- Sodium hydroxide use, pressure range for applicability.
- Dosing and dosing control safeguards.

There was no immediate consensus on the coverage of commercial blended phosphate mixtures, on the pressure range for applicability of phosphates.

The use of mixtures containing other components (antifoaming agents, etc) cannot practicably be comprehensively covered.

B. Dooley will initiate the drafting and will produce a structural document by November 2010. Authors for individual components of the guideline will then be identified. The collaborating task group will include M.Rziha, R.Svoboda, S.-E. Therkildsen, G.Bignold, M. Ball (subject to confirmation).

Action B. Dooley

Steam Purity for Steam Turbines

J.Bellows and R.Svoboda have initiated the production of a guideline on steam purity for steam turbines. The work is estimated to be 20% completed. It was agreed that the document should cover:

- Silica behavior,
- Copper behavior,
- Chemically related failure mechanisms, including the relevance of processes during turbine shutdown
- Implications of contamination of spray water (attemperators and hood sprays).

No final decision on coverage of the behavior of aluminum in steam turbines was reached. The task group was set up with R.Svoboda, J. Bellows, and will be expanded by M. Rziha, B. Dooley, plus a representative from Japan (H. Takaku to nominate).It shall develop of a guidance document within the milestones set in the Task Group Work Plan..

Action R.Svoboda, J.Bellows and M.Rziha

Philosophy of Chemistry Control

The scope for this has effectively been incorporated into the other guidance documents. Presently, a separate document is not considered to be necessary.

Quantification of chemistry related asset damage (K.Daucik, chair)

K.Daucik presented the latest draft of the study, which was subsequently discussed within PCC. There was agreement that the work has advanced towards its final stage. B.Dooley suggested to coordinate the study with work that has been done for EPRI, respectively their consultant Lew Rubin. There was agreement that the final study should be a paper published in two or three differently orientated technical magazines.

Action: K.Daucik

European Standard EN 12952 (G.Bignold, chair)

No further defined action at this time. See 4.3.

ICRN

New ICRN

ICRN#25 on Corrosion mechanisms that are related to the presence of contaminants in steam/water circuits, particularly in boiler-water. Written comments had been received from Don Palmer, and Andy Rudge and a statement of support had been received from the Russian delegation. W. Cook agreed to be nominated as a new main contact for this ICRN in collaboration with G. Bignold. E. Maughan advocated that consideration be given to combinations of contaminants and to ionic balance. R.Svoboda agreed to send the ICRN template to W. Cook/ G. Bignold.

Actions: R. Svoboda, W.Cook

ICRN#26 on Behavior of Aluminum in the Steam Water Cycle of Power Plants. PCC aim to finalize this ICRN on the basis of comments that have been received from Don Palmer and Barry Dooley. It was agreed that a final version should be prepared by end of November 2010.

Action R. Svoboda/ M. Rziha

Existing ICRN to be updated

ICRN#19 on Sampling of corrosion products. In view of the intensive activities of this subject it was agreed that this ICRN should be extended for a further period. D. Lister submitted an update to the ICRN, which should be added to the ICRN on the IAPWS website

Action: R.Svoboda

ICRN #20 on High temperature sensors. It was agreed that this should be revised to avoid the impractical implications of application to very severe conditions (excessively high pressures and temperatures).

Action: S.Uchida

ICRN to be closed

ICRN#13 on Surface tension. F. Gabrielli to prepare a closure statement.

Action: F.Gabrielli

ICRN#18 on Thermal decomposition of ion exchange resins. A closure statement had been drafted by Karol Daucik although it was agreed that the problem remains in existence. The closure statement should be added to the IAPWS website

Action: R.Svoboda

Proposals for International Collaboration

The collaborators: R.Svoboda, S.Uchida, K.Daucik, P. Srisukvatanan, S.-E. Therkildsen and D.Lister met to discuss the first phase of the current project. The experimental procedures and objectives of the CFD modeling were discussed and agreed.

Other Business

The PCC Mission statement was reconsidered and minor updates were agreed. The revised version is attachment D.

Changes in Membership, election of Officers

Although these persons were not PCC members, PCC noted with regret the deaths of Mike Fountain, George Gyarmathy and Ulrich Staudt.

Membership withdrawn:

Jun Izumi	communication by the Japanese National Committee, that Mr. Inzumi is not any more active in IAPWS matters
Milan Zmitko	communication by the Czech National Committee, that Mr. Zmitko has changed field of work

PCC wants to thank Mr. Izumi and Mr. Zmitko for their former support and contributions.

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

- Proceed with ICRN #19, 20 (updates), 25, 26 (new), see 4.2
- Proceed with Task Group Work, see 6.

Preparation of PCC WG Report for Executive Meeting

- Technical Guidance Documents
- ICRN
- International Collaboration
- Members
- Mission statement (update)

Miscellaneous and Adjournment

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Those present at the PCC WG meeting were as follows:

O Bartos	Czech Republic	
J Bellows	USA	
G Bignold	UK	
W Cook	Canada	
K Daucik	Denmark	
B Dooley	Canada / USA	
F Gabrielli	USA	
I Hey	Canada	
J Jevec	USA	
I Jiricek	Czech Republic	
D Lister	Canada	
E Maughan	S.Africa	
J McLinney	USA	
M Miyajima	Japan	
M Myszczyszyn	Canada	
M Rziha	Germany	
P Safarik	Czech Republic	
P Srisukvatananan	Canada	
R Svoboda	Switzerland	(Chair PCC)
H Takaku	Japan	
S-E Therkildsen	Denmark	
S Uchida	Japan	

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

Thermodynamics, dynamics, and chemical reactions related to power cycle

1. G.Bignold: Draft for ICRN 25 "Corrosion mechanisms that are related to the presence of contaminants in steam/water circuits, particularly in boiler-water."

2. R.Svoboda: Draft for ICRN 26 "Behavior of Aluminum in the Steam Water Cycle of Power Plants"

3. H.Takaku, T. Nakane, Li-Bin Niu: "The combined effect of chloride and sulfate ions in simulated AVT waters on the electrochemical corrosion behavior and oxide film characteristics for LP steam turbine materials"

4. Andre Anderko: Thermodynamic Modeling of High-Temperature Aqueous Chemistry

5. Masaru Nakahara: Carbon Dioxide Fixation and Hydrogen Storage and Transportation in the Form of Formic Acid

PCC workshop (Tuesday 08:30-10:30 and Thursday 08:30-10:30)

Update on Power Cycle Chemistry Research and Experience

1. G.Bignold: "Discussion on "Processes that contribute to corrosion fatigue failures in economizers"

2. S.Uchida: "Evaluation of FAC simulation Code based on Verification and Validation"

3. P. Srisukvatananan: "Improved Sampling Techniques", activities related to IAPWS International Collaboration projects

4. E.Maughan: "Concept for an on-line analyzer network with full automation and chemical intelligence"

5. E.Maughan: "Concept for an Interactive Knowledge Management for long-term conservation of technical know-how and experience"

6. O.Bartoš: "Measurement of heterogeneous particles in superheated steam in turbines of coal-fired power plants"

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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 2010: Joint PPC/PCAS ICRN #21 is on the IAPWS website

2. Mechanism of Decomposition of Ion-exchange Resin

Operating conditions, quality control of resin; leak rates are slow, but sulphate is one of the products, organic leachables, oxidation
Additional information has to be researched
Status 2010: ICRN # 18 (use in condensate polishing) has been issued in 2006, no activities known in 2010, will be closed at the 2010 meeting

3. 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)

4. Improved analysis of low concentration of metals (Fe, Cu, Co, etc in the ppb range)
(merged into Priority List item #6)

5. * 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 2010: Geoff Bignold drafted ICRN #25 which should be finalized in 2010 (Bignold, Cook)

6. * 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 2010: ICRN #19 on sampling of corrosion products will be extended in 2010. International collaboration 2006/7 2010/2012. (Lister, Daucik, Svoboda, Uchida). 4 papers by Piti et al. IAPWS Guidance Document on sampling under consideration

7. * 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 2010: task group in progress

8. Improved understanding of condensation mechanisms

- drop-wise vs film-wise 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

ICRN #22 is on the IAPWS website

9. 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 2010: wide range of information available and research ongoing, opportunity for several ICRN

10. Radiation chemistry of water

Radiolysis, main importance for nuclear generation

2007 PCAS/PCC presentations have been made
Status 2010: activities related to supercritical water reactors ongoing (to be determined, Katsumura), 2010 International nuclear conference Quebec: Workshop on Radiolysis (Lister)

11. * Behavior of Aluminum in the steam / water cycle
    - **Al release under various water treatment regimes**
    - volatile carry-over and deposition in the turbine
    - deposition on boiler tubes,
    - solubility in water and steam
    - behavior in condensate purification
    - interaction of Al with boiler chemistry
    - specification 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 2010: topic still pending, practical data to define scope of problem incoming, ICRN #26 in processing (Rziha, Svoboda)

12. Water cooling of copper in electrical machines
- generator stators
- accelerators

Status 2010: paper at ICPWS 2008;EPRI guideline 2008, CIGRE guidance document to be published in 2010, new investigations Palmer/Svoboda considered

13. Water use outside the steam / water cycle
- cooling water
- waste water
- external process
- recycling for use as make-up
- etc.

For further consideration for 2011, possibly new IAPWS sub-committee.
PCC does not have the resources to take leadership on these items.

14. Chemistry in geothermal and oil / sand cycles

Behavior of water constituents, effects on system materials, geochemical and wastewater issues.

Status 2010: ICRN to be considered for 2011 (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)

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Mission and Working Process of PCC
07 Sep 2008, rev. 21 Jul 2010

MISSION

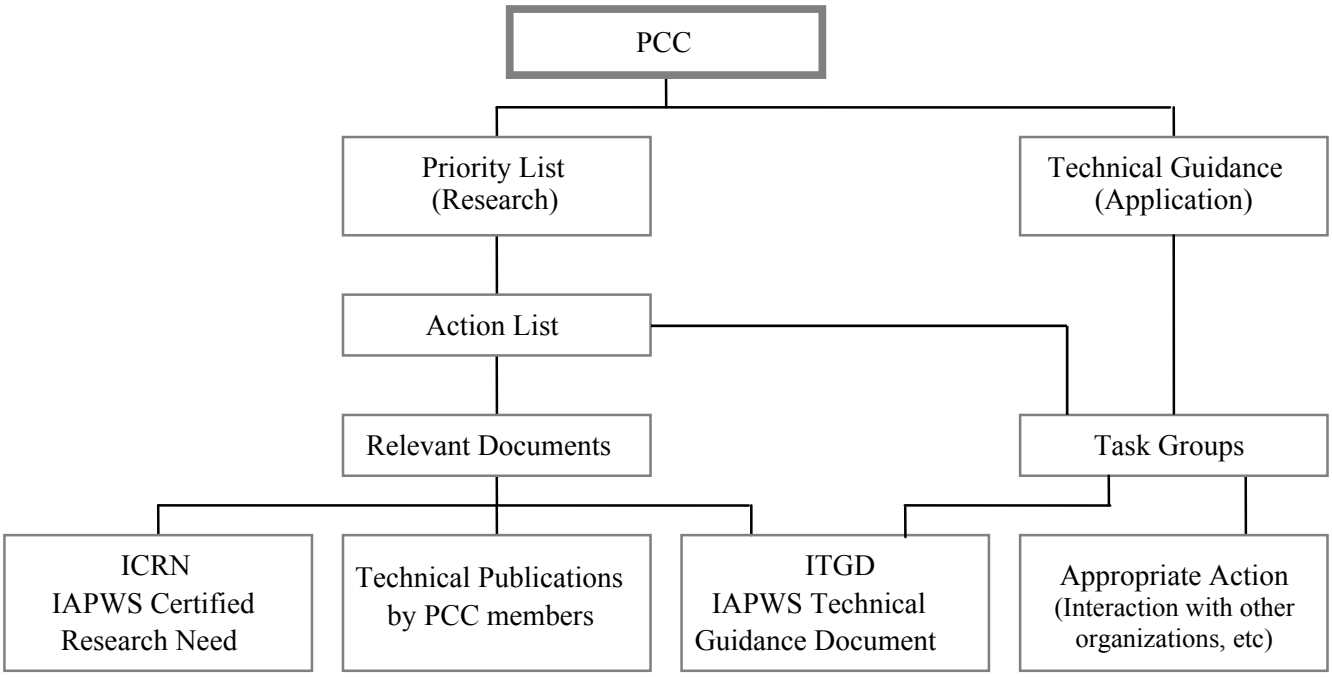
The Power Cycle Chemistry Working Group (PCC) brings together scientists and engineers from academia and research organizations, power plant operators, equipment manufacturers and other relevant interested parties from around the world with an interest in power cycle chemistry to

- Collaborate and share results of scientific and engineering research and experience
- Identify gaps in technical information relating to power cycle chemistry
- Seek resolution of these gaps through international cooperative projects and the release of appropriate documents

for the benefit of industry. Within IAPWS, it serves as a liaison between industrial needs and related research represented by PCAS Working Group.

PCC WORKING PROCESS

Workflow



Working Tools

- Discussions at annual IAPWS meeting (mainly for steering)
- Individual or group work on PCC assigned tasks throughout the year
- IAPWS International Collaboration