Attachment 7

IAPWS PCC Working Group

Prague Sept 2000

Minutes of Meeting

Monday 4 September

1. **Amendments - Adoption of Agenda**

Karol Daucik gave notice of two additions to the Agenda:
Discussion of Officers of the WG.
Discussion of the draft IEC guidelines on turbine steam chemistry.

2. **Election of Clerk of minutes**

KD invited Geoff Bignold to be clerk of minutes (no other nominations).

3. **Minutes of 1999 meeting in Toronto.**

Agreed without comment.

4. **International Collaborations.**

KD reported that no suggestions for international collaborations had been received from PCC WG members. The deadline was at 17:00.

5. **Priority List Review.**

There was a thorough debate of the priority list of research topics. Key points were as follows:

Prof. Petr emphasized the importance of work on nucleation in steam turbines as essential to the improvement in thermodynamic efficiency. He added that the effects of speciation of additives and impurities are relatively unknown.

Dr. Pflug advocated the addition to the list of work on redox measurements in plant cycles, particularly in terms of use and interpretation of plant measurements. Dr Petrova supported the need for work in this area. Mr. Rziha added that the interpretation remains particularly unclear in complex chemical regimes. Mr. Hughes strongly advocated the use of redox measurements in plant.

Dr. Jonas suggested that the topic of influence of organic materials is too broad, and requires subdivision in order to avoid researchers concentrating on the less important aspects. Dr Svoboda reminded the WG of the number of presentations on organic materials to be made in following sessions. He suggested postponement of discussions on priorities until after these presentations.

Mr. McGrath commented that prioritization would reflect the positions of those present at the meeting, rather than as overall power industry. Mr. Stodola agreed, indicating a higher importance to copper transport than to organic problems from his personal viewpoint.

Dr. Zeijseink asked for consideration of chemistry aspects of ultra-supercritical plant operation as a further topic. KD responded that this at the time being does not contribute a research issue.

Dr. Jonas referred to the recently published compilation of solubilities in steam, but also added that there are still speciation issues to be addressed .

Dr. Bellows commented that, year on year, there had only been minor changes in ranking order. What was really needed was an improvement in clarity. There was general agreement with this view. KD asked the following individuals to draft short subtask lists identifying the most important aspects of each item in the list:

1.	Release and transport of copper compounds in the steam/water cycle.	J. Stodola
2.	Origin, behavior and significance of organic compounds in power cycle.	A. Zeijseink
3.	Solubilities of impurities in steam	O. Jonas
4.	Nucleation and condensation in steam turbines	V.Petr
5.	Physical and chemical processes of concentration and deposition in the power cycle.	K. Daucik
6.	Interpretation of redox potential measurements in plant.	H. Pflug

6. IAPWS Certified Research Needs

There were no proposals for changes to certified research needs.

Joint Workshop with PCAS - Monday 4 September 2000 - p.m.

Papers presented:

Experience with the solution of organic problems - M. Rziha

Covered some of the work of the VGB working group in this area, including two case studies which emphasized the importance of identification of organic contaminants to avoid inappropriate expenditure.

Measurements of organics - J.B.Hughes

Practical experience at Teeside Power Station of identification of sources and fate of carbon dioxide in a unit with cyclohexylamine dosing. The turbine had suffered stress corrosion cracking, but no link with the relatively elevated conductivity after cation exchange (due primarily to carbon dioxide) and oxygen were identified. (Copy of presentation made available).

NMR studies on hydrothermal decomposition pathways of formic acid to carbon dioxide and monoxide.- M. Nakahara

Elegant laboratory study of decomposition pathways for formic acid. Two reaction schemes are demonstrated and their relative dominance shown to change between 250 and 300°C. At the lower temperatures CO is the dominant product, but at higher temperatures, CO_2 and hydrogen are more important.

Differentiated TOC analysis - S Huber

Description of the analytical techniques and examples of results that have provided the basis for the improvement in understanding of organic materials in the current VGB program. Further examples of studies that have helped identify the most cost effective modifications to water treatment plants to address organic contamination problems.

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Distribution of amines and organic acids in Embalse Nuclear Power Station. - H.Corti.

> Detailed description of studies of the practical fate of decomposition products of morpholine in a Candu Unit. The lack of fundamental data on distribution coefficients of key species was identified.

Technical presentations - 5 September 2000

Flow assisted corrosion - Chemistry Aspects - F.Gabrielli

> Review of recent experience particularly in low pressure circuits of drum boilers in combined cycle plants. In most cases where flow assisted corrosion problems had been found a combination of ammonia treatment of boiler water and organic materials (dispersants, amines and organic oxygen scavengers) has been used. Circuits that are seriously affected operate at < 8 bar.
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> There was substantial debate on this paper reflecting a high level of experience. Dr Dooley summarized the world wide nature of the problem, and emphasized the need to differentiate single phase and two phase attack. The widespread use of cascade blowdown was also recognized as an important contributing factor. Dr Bellows commented that plant designers can readily apply known solutions but may be limited by cost considerations. The issuing of prescriptive plant specification can overcome this problem.

Experience in operating combined cycles with air cooled condensers and once through boilers - R.Svoboda

> Recently commissioned plants have AVT dosed low pressure circuits (ammonia and no hydrazine) which also provide feedwater for once through high pressure boilers. There is no condensate polishing plant and water purity is maintained by intermittent blowdown via a Sultzer bottle. The design is intended to be tolerant of the presence of carbon dioxide. The early operation of the first of these units had required relatively frequent blowdown to prevent silica in steam rising above 60 ppb. A trial of operation of the Sultzer bottle with NaCl contamination of the water had shown that it effectively removed the contaminant within a reasonable period. Operation of the new plants with air cooled condensers has not yet provided substantial data, but experience from other units suggests that it is probable that high iron and silica levels at start-up and during early operation will need to be addressed.
>
> Dr Jonas commented that the use of condensate filters to remove particulate iron downstream of the air condenser may provide a further source of organic materials in the circuit.

Effect of acetic acid on distribution of sulfate between boiling water and steam. - A. Petrov

> Laboratory rig study showing that the presence of acetic acid increases the volatility of sulfate and slightly suppresses the volatility of sodium in steam. The work was conducted at pressures of 0.1 and 10.0 MPa and the relative increases in sulfate volatility at these two pressures was, respectively, 2.5 and 5.1 times.

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Early Condensate - A. Zeijseink

Study of the contamination of steam by acetate and formate in a cogeneration plant linked to a refinery. The experimental technique involved the use of the early condensate sampler that was developed by ABB. It was found that, although the conductivity after cation exchange was acceptably low (about 0.15 uS/cm) the acetate concentration in early condensate could reach 450 to 550 ppb. Formate levels were significantly lower than this.

Discussion Session - 5 September 2000 - p.m.

10. PCC Membership

Proposals to invite A.Banweg and Prof. Hiroshi Takaku to become members were discussed. Since neither was currently present, it was agreed that KD would write inviting them to attend next year. The proposals for their membership would be considered at that time.

M.Rziha was proposed for membership by KD and seconded by B.Dooley.
P.Colman was proposed for membership by M.Ball and seconded by B.Dooley.

Both proposals were adopted *nem con*.

Dr Izumiya had retired and offered his resignation from the PCC WG.

Other Business

IEC Steam Purity Standard

R. Svoboda described the history of the International Electrotechnical Commission, and of the development of a steam purity guideline. KD agreed to circulate by e-mail the latest draft to members for consideration. There was a general consensus of concern that a document, expressly written as a guideline, may become mandatory as a result of the link between IEC and the ISO. It was agreed that a positive and constructive response should be drafted, emphasizing that the guideline should not become an ISO standard.

Officers of the PCC WG

KD announced that he wished to stand down as chairman because he could not be sure of support for his future attendance. Dr Dooley recommended that a new vice chairman be elected with an anticipation of taking over from KD after 2001.

R.Svoboda was proposed as vice chairman by M.Ball, seconded by B. Dooley.
A.Zeijseink was proposed as vice chairman by K.Daucik, seconded by A.Bursik.
The proposals were agreed *nem con*.

Letter to IEC

A draft letter to IEC had been prepared by G.Bignold and KD. An additional point about the need for flexibility and current validity of guidance was suggested by Dr Svoboda. It was agreed that this should be put forward to the EC (Attachment B).

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Priority List - Further discussion of organic compounds issue

Dr Bellows proposed an approach to the problem of defining the necessary work on organic issues based on appreciation of whether corrosion risks may occur and on the cost of remedial actions. This promoted an active debate, the outcome of which was summarized by KD as follows:

Key areas where research on influence of organic species is needed:

Stress corrosion cracking and corrosion fatigue

Influence on solubility of oxides

Partitioning of organic materials between water and steam in realistic mixed systems.

Decomposition pathways and kinetics of organic agents.

Field identification of practical organic contamination speciation and concentration.

Atlas - PCC chapter authorship

Dr Dooley agreed to co-ordinate input from PCC members to the Atlas.

Agenda for the IAPWS PCC WG Meetings in Prague, Czech Republic 4 - 7 September, 2000

Monday, Sept 4, 10:30 a.m.

1. **Amendments/Adoption of Agenda**
2. **Election of Clerk of Minutes**
3. **Approval of Minutes of 1999 Meeting in Toronto**
4. **International Collaborations**
5. **Priority List Review**
6. **IAPWS Certified Research Needs**

Monday, Sept 4, 13:30 a.m.

7. **Joint Workshop with PCAS**
   Organics
   M.Rziha: Experience with Solution of Organic Problems
   A.Zeijseink: Developments on Organic contaminated Cycle
   K.McGrath, B.Hughes: Measurement of organics by ion chromatography
   S.Huber: Differentiated TOC-Analysis
   K.Daucik: Organic leachables from CPP

Tuesday, Sept 5, 9:00 a.m.

8. **Technical presentations**
   F.Gabrielli: Flow Assisted Corrosion/Chemistry Aspects
   R.Svoboda: Experiences in Operating CC with Air Cooled Condensers and OT Boilers
   T.Petrova:
   A.Petrov:
   A.Zeijseink: Early Condensate

Thursday, Sept 7, 9:00 a.m.

9. **Joint Meeting on Atlas**

Thursday, Sept 7, 10:30 a.m.

10. **Membership**
11. **Preparation of the Report to EC**
12. **Miscellaneous and Adjournment**

PCC ATTACHMENT B

Draft text of letter to IEC:

The Executive Committee of IAPWS has received committee draft 5/127/CD on steam turbines and hasasked the Power Cycle Chemistry Working Group of IAPWS to prepare a considered response. Copies have been forwarded to all members of the PCC WG and an initial response, pending detailed review, is as follows:

> There is support for appropriate and comprehensive guidance on the topic of turbine steam purity. However, we are concerned to ensure that the status of International Standard is not afforded to such advice. The draft document itself specifically states that it is to be regarded as "recommended guidelines", whereas the covering letter refers to it as an International Standard.
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> It is recognized that input from a number of major power utilities and turbine manufacturers has been obtained in the production of the document. However, we have concerns about its appropriateness for application to small systems and about the flexibility to accommodate future developments. Provided the document retains the status of guidance, this does not represent a problem. However, if it becomes a mandatory standard, its application outside the scope of large scale power production is likely to result in difficulties.

Thus we would urge IEC to confirm that it is the intention to issue this as a guideline document and not to put it forward as an ISO standard.

IAPWS will provide any additional technical comments from its PCC WG members on a timescale of one month.