



19 October 2019

## **Application for International Collaboration Corrosion Product Sampling, Analysis and Assessment**

### **Background**

Since its release in 2013, the IAPWS TGD on corrosion product sampling and analysis has taken a leadership position for conventional and combined cycle plants worldwide. Not only does this TGD provide details on how and where to take samples and how to analyse them properly to determine total iron and copper levels, but it also provides limits for iron and copper, which illustrate optimized cycle chemistry according to the IAPWS treatment TGD for AVT, OT, PT and CT. These levels have become standards worldwide. However, it is recognised that for heavily flexibly operating plant (fast start, cycling and two-shifting) these limits may not provide a rugged assessment of the cycle chemistry or whether FAC is under control. Therefore, this Corrosion Product Sampling and Analysis TGD is under revision with new assessment methodology being developed. This first requires cooperation with a range of power plants applying a variety of chemistry conditions that already conduct or are willing to conduct the corrosion product monitoring campaigns with parallel measurements of both classical analysis (as defined by the IAPWS TGD) and on-line methods during flexible load conditions and start-ups. Several organisations have already taken part, but they often lack resources and the right setup of monitors to cover the demands fully. IAPWS in NZ/AU, UK/EI, and the Nordic countries have formulated an approach, which will use a young scientist supported by an IAPWS International Collaborative Project. The Young Scientist will work under the direction of Karsten Thomsen, SIAPWS, and Paul McCann, BIAPWS, assisted by the other members of the task group (Barry Dooley, Michael Rziha, Germany, and David Addison, New Zealand) and cooperate with host plants that will conduct the field tests. It is planned that the Young Scientist will spend two weeks at 3-4 host sites in other IAPWS member countries. This will involve organising monitoring campaigns focused on start-up and flexible load conditions, securing proper sampling conditions, applying and testing on-line instrumentation, and overseeing that the data acquired and submitted have the best possible quality. Most the equipment to conduct the tests and the analyses will be provided by the host site. All the analysis will be conducted and/or quality assured by the Young Scientist under the direction of the IAPWS mentor in SIAPWS, which will involve spending at least two weeks at a SIAPWS laboratory. This project will follow-up on the corresponding project granted in 2017 and performed by Maja Skou Jensen in 2018-19. This led to a successful cooperation with Assistant Professor Marianne Glasius at the Chemistry Department, Aarhus University, Denmark, and she is interested in further cooperation with IAPWS. Compared to the first project, the new one will focus more on monitoring of start-ups of both all-ferrous and mixed-metallurgy plants to help acquiring the knowledge and experience base necessary for the IAPWS guidance to be included in the new, extended TGD. The primary guidance will introduce a simple but systematic approach to optimize shutdown chemistry and preservation measures. The outcome of the measurements introduced will be graded relative to the international experience condensed in the IAPWS Corrosion Product Decay Map. The present project will be a key factor in establishing the decay map on a scientific base of broad international experience.



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## **Technical Aspects and Goals**

This planned activity will keep IAPWS in the leadership position with regards to corrosion products monitoring and assessment. The final goal of the activity is to develop the IAPWS Corrosion Product Decay Map that will represent the first standardized method for quantification and comparison of the effects of operational and shutdown chemistry regimes. The field tests conducted to date have demonstrated that, provided correct sampling and subsequent sample handling, on-line measurements such as turbidity and particle number/distribution are useful and reliable means to follow particle levels and transport during start-up and flexible operation. The close relation between particle size distribution (PSD) and corrosion product (CP) distribution has been demonstrated both from basic principles and experimentally. Both PSD and CP distribution follow the log-normal distribution, and this new insight leads to a change in data processing of CP data and the use of new characteristic parameters to describe the level and variability of the CPs. These findings need to be further confirmed to cover all the different chemistries typically applied in various all-ferrous and mixed-metallurgy plants. The outcome of the project will be a master thesis and key reference for the final product: The extension to the present TGD covering sampling, analysis, and assessment of CPs for plants operating in flexible mode. This will allow further minimization of CP transport and the negative consequences during operation, but the most important guidance will be the systematic method to quantify CP transport during start-up and the IAPWS Decay Map defining the relevant guiding values. Of course, such values must be based on reliable and comparable data. Getting those within the next 1-1½ year is the focus of this project. There is a great demand for such guidance worldwide, because power plant operating in flexible mode are numerous, and the guidance so far has focused on plants in base load. The IAPWS Map will allow plants to determine whether both the operating and shutdown chemistry is optimized. For combined cycle plants, it will also link very closely with the IAPWS Map for HRSG HP Evaporator deposits (IAPWS TGD). The scientific content of the project will lead to a handful of publications describing the connection between the fundamental PSD and the levels and distribution of CPs measured, the application of on-line methods as valuable tools to optimise the layup and shutdown chemistry, and the new data model leading to a change in routine data processing of CP data. In many senses, new territory is discovered in this study.

### **Young Scientist**

IAPWS has through SIAPWS contact to Dr. Marianne Glasius at the Chemistry Department of Aarhus University. The Chemistry Department will support this project by access to in-house instrumentation and laboratory facilities for analysis as well as supervision. SIAPWS will support the project both technically and financially, and the engineering company COWI will support it by employing the Young Scientist as student trainee during the project. The host facilities will support the project by the funds needed to do their part and by staff assistance and guidance to run the measurements optimally. Dr. Marianne Glasius will help finding a suitable candidate who will conduct the project for the master thesis. The candidate must be a promising person who has very good competences in physical and analytical chemistry. Besides that, we are looking for an open-minded and communicative person that will be able to adapt and cooperate under foreign conditions.



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## **Budget**

Expenses to be covered:

1. Travel Scandinavia to UK and a Nordic country x 1 each
2. Travel to NZ/AU/JPN x 1
3. Travel to IAPWS meeting x 1
4. Living expenses during stays
5. Hire of scientific instrument for particle counting/particle size distribution

Additional analyses – the purpose is to supplement the analyses performed by/at the plants, such that all relevant measures are available for the evaluation in relation to the TGD development work. The young scientist will validate the relevant laboratory analysis at the Chemistry Department or at a SIAPWS Laboratory. Quality of the collected data will be a focus point, and only laboratories that are able to document appropriate quality assurance at least at the level of the current TGD will be used. Total budget as a rough initial estimate is 25.000 GBP. The budget will be further refined, once the precise extent of the field trials is known.

On behalf of IAPWS organisations in Australia, New Zealand, United Kingdom and Ireland, and the Nordic countries (Sweden, Norway, Denmark, Finland)

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