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Work on the new TGD on Corrosion Product Sampling and Analysis

The task group preparing the new TGD on how to sample, analyze and interpret corrosion products for plant under flexible operation is working to have a white paper, a preliminary version of the TGD, ready for the meeting in Banff. The idea is to present the white paper for the PCC (Power Cycle Chemistry) group and ask the members to coordinate field test to collect a firm base of experience for the guidance that will become an essential part of the TGD. However, since many Nordic CHPs start up in September after the summer period, sending this request out after Banff in Mid-October will be too late. Thus, this newsletter explains the background for the field trials to come and invites you to take part by running a campaign during start-up of your units.

The main structure of the white paper (coming TGD) is summarized in the table below.

1	Nomenclature	Definition of abbreviations
2	Introduction	Main sections and relation to the existing TGD on CP Sampling and Analysis (base TGD)
3	Background	The flexible plant request
4	Sampling	Short summary of correct sampling from the baseTGD Sampling and monitoring with proxy methods (turbidity, particle monitors and particle counters) - use of the constant head device
5	Analytical methods	Extension of methods from the base TGD, introducing the filter method with digestion of particles accumulated on a membrane filter Proxy methods - pro and con's Turbidity Particle counters (number of particles per volume and size
6	Application of proxy methods	Where and when to use the proxy methods, e.g. monitoring CP transport under transient operation (load changes) monitoring CP transport under start-up
7	Monitoring start-up	The base procedure to quantify CP transport during a start-up Data processing and evaluation of the start-up data
8	IAPWS Guidance	The base case - the typical plant configuration used in the TGDs on conditioning Dependence of CP transport during start-up on chemistry during standstill, i.e. the effect of preservation measures The IAPWS Corrosion Product Decay Map - a means to compare start-up data, i.e. evaluate the preservation measures
9	Customization	How to adapt, if your plant is not one of the base cases
10	References	References and bibliography

The information necessary for writing the first seven sections is available, and we have a draft of the important section 8. The procedure for measuring the CP transport under start-up is expected to change only slightly in the remaining process, and the data acquired by use of it will be part of the experience base used for graduating the CP transport in relation to the preservation measures during lay-up. A large set of field trials covering different plant types and materials (all-ferrous or mixed metallurgy), feedwater chemistries, and preservation measures is needed to define what levels of CP transport may be expected depending on the measures taken to protect the plant against standstill corrosion. This is why we urge you to take part in the field trials by running the campaign at the coming start-up and submitting your specific data to the task group. By doing so,

you contribute to the development of this tool to quantitatively estimate how good the preservation measured in use actually are. Being out early will allow you to test your preservation measures early and possibly improve preservation procedures before next period of lay-up. It will help focusing the attention of the operators on the importance of preservation in preventing corrosion and loosing life-time.

The base procedure for monitoring CP transport during start-up is given below. It calls for a proxy instrument for on-line monitoring, but there is also a method using the conventional filter samples that are in widespread use in the Nordic countries. That means that you can provide valid and meaningful data for the purpose by use of standard equipment. Your preservation measures do not need to be first class either. We need data also for plants with less than optimal or no preservation at all. This is a good opportunity to focus attention on preservation and learn how to do it properly.

Please, register by Karsten Thomsen, if you are willing to participate. You will then receive a questionnaire covering the preservation measures applied, the base procedure, detailed procedures for the filter method, and data forms ready for data entry and with the data processing predefined. By use of the filter method, you collect the filter samples as usual, the digest them using your standard method for iron, and lastly analyze the content as usual using spectrophotometry or ICP.

Base Procedure for Monitoring Startup

This section covers the procedure for monitoring CP levels and transport during startup and gives guidance on the data treatment.

1. Procedure for Monitoring Startup

The procedure is the preliminary version of the coming authorized IAPWS procedure.

Proxy techniques

- Turbidity, particle monitoring or particle counting – i.e. methods suited for data acquisition. Recording of data with at least 1 min resolution. The methods are described in Section 5 of this document
- Babcock & Wilcox Membrane Filter Method – possibly in combination with the filter method, i.e. digestion and analysis afterwards. This method is possible but labor intensive.

Preparation

- Open the sample line and start flushing as soon as the feedwater pump is in operation and gives pressure. In the beginning, flush the sample line directly to drain until the first burst of particles/deposits has been flushed out. Then regulate the sample flow to the lowest flow giving turbulent conditions and keep flushing. The flow will gradually increase as feedwater pressure builds up.
- Attach the proxy instrument or open the valve to a permanent installed instrument. Adjust the sample flow to the proper setting by means of the constant head device upstream the instrument.
- Prepare sample bottles for filtered iron, if this is the proxy method of choice. This calls for 20-30 bottles. Otherwise, by use of an on-line method, around 10 samples are going to be taken in parallel. Alternatively, load the filter holders with filters so they are ready for use. It is an advantage to have several, so that there is time to change filters without time pressure.
- Check the sample flow as feedwater pressure is established, it may be necessary to reduce flow not to overload the sample cooler or the constant head device.

Measurement

- Start measuring at first fire and continue when the feedwater pressure builds up. Time of first fire is the starting point for measurements, so this should be precisely recorded.
- Note the time for start of by-pass operation (if applied at the plant), turbine run-up and generator synchronization.
- Watch the monitor response – most likely, the CP level increases towards a maximum and then starts decreasing in a slow decay. Note, the maximum value, and then take filter samples from the by-pass line of the constant head device for each 10 % change noting the exact start time and monitor output when sampling starts and stops.

- If no monitor is applied, take samples for each 5 % change or each 10 min noting the exact start time when sampling starts and stops. The idea is to take samples covering the slow decay towards the steady-state level. The level of oxides is preliminary estimated on-site by use of the Babcox & Wilson comparison charts.

Analysis

- Digest and analyze samples taken in parallel with the on-line monitor.
- If no monitor is applied, estimate the iron content from the color of the filters by comparison with the Babcock & Wilcox Membrane Filtration Charts . Save the filters for analysis later if the initial evaluation makes sense.

1. Evaluation of Startup Data

Monitor response recorded

- Estimate the factor between average detector response and filter iron during each sample period from a plot of filter iron versus response. If the factor has been evaluated earlier, aggregate the present values with the earlier to expand the statistical base for the factor.
- Scale the recorded monitor response to filter iron (µg/kg) by means of the estimated factor.

Construct the decay plot

- Plot the filter iron (µg/kg) either from the scaled monitor response or from filter analysis versus the time after first fire using a log-scale on the y-axis.
- Mark the milestones of the startup on the plot, e.g. by-pass operation, turbine run-up, and synchronization.
- Estimate the time since first fire to reach the steady-state or acceptable level (whichever comes first) of oxides in feedwater.
- Estimate the half life time for the decay from the largest peak towards the steady-state value from the graph.
- Estimate the area under the curve from time of first fire to time of steady-state. This is most easily done by numeric integration of the dataset behind the curve, i.e. by calculating the sum:

$$Fe_{trans} = ½\Delta t * Q_{fw} * (R_0 + R_n + 2 * \sum_{i=1}^{i=n-1} R_i) * 10^6 \ \mu g/g$$

Here:

Fe_{trans} is the iron transported in g

Δt is the time resolution of the responses in s

Q_{fw} is the average feedwater flow during the decay in kg/s

R_0 and R_n are the first and last scaled response value corresponding to first and last response, respectively

R_i are the scaled response values between the first and last response value, i.e. the response values for i = 1..n-1

If no monitor has been used, draw a smooth curve during the recorded data points and estimate the area by the "cut-and-weigh" method. i.e. cut the area under the curve out and weigh it. The area may then be found as the ratio between the weight of the area and a rectangle corresponding to constant filtered iron content, constant feedwater flow, and a known time span.