

# **Minutes of EFC WP 15**

## **Corrosion in the Refinery Industry**

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Part 1-11

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## 1 Welcome

The meeting was opened by Francois Ropital.

25 persons attended the meeting and shortly introduced themselves. Apologies were received from 15 persons. The lists of the participants and the excused persons are enclosed in Appendix 1.

## 2 EFC WP 15 Activities

### 2.1 EFC WP 15 Activities and Minutes of Meetings

Information on the activities of EFC WP 15, Corrosion in the Refinery Industry was presented by Francois Ropital. This information can also be found on the EFC web-site [http://www.efcweb.org/WP\\_on\\_Corrosion\\_in\\_the\\_Refinery\\_Industry-design-.html](http://www.efcweb.org/WP_on_Corrosion_in_the_Refinery_Industry-design-.html) where the minutes of previous WP15 meetings minutes can be consulted and downloaded. More information is enclosed in Appendix 2.

### 2.2 Publications from WP15

The following publication is available:

- EFC Guideline no. 40: "Prevention of Corrosion by Cooling Waters"

Two EFC WP 15 publications are in preparation by the new editor Woodhead Publishing that is currently taking over the publication of EFC guidelines in replacement of Maney. The entire backlog of publication of EFC guidelines should be cleared by July 2007 and the new documents should be edited in normal time.

- EFC Guideline no. 42: A Collection of Selected Papers (ed. John Harston) that will be available in July 2007.
- EFC Guideline n°46: "Amine Unit Corrosion Survey" (managed J. Harston) that will be available in February 2007.

More information on the availability of these EFC guidelines and how to order them, can be obtained with the following web link

<http://www.woodheadpublishing.com/en/search.aspx?basic=EFC>

Publications in preparation by WP15 group:

- Corrosion under insulation issues in modern refinery and petrochemical plants. This new guideline has been discussed during specific meetings of the CUI task force on 31 January in Fawley (UK) and 26 September 2006 in Maastricht (NL). The document is presented in section n°10 of the minutes. It will be sent to the publisher by the end of 2006 in order to be issued within the next 6 months.
- During the 2005 annual, Francois Ropital proposed to elaborate a typical refinery failure cases Atlas as it appears that such type of document dedicated to the refinery industry does not exist. The proposed EFC WP15 corrosion atlas will follow the API 571 classification of corrosion phenomena. In October 2005, an inquiry form had been sent to the members of the group in order to get an overview of the failure cases that can be collected. As only very few replies had been returned, Francois Ropital will contact some WP15 members in order to create a task force of a limited number of persons to collect the data of failure cases.

### **2.3 Collaboration between EFC and NACE**

Opportunities of collaborations between EFC and NACE are fully supported by the board of administrators of the two associations. The collaborations can be:

- Joint sessions or workshops during Eurocorr or NACE conferences. For Eurocorr 2007 (Freiburg-D), contact will be established by Michael Schutze and Francois Ropital with NACE STG 37 group in order to co-organise the workshop on high temperature corrosion in the refining and petrochemical industry.

For Eurocorr 2008 (Edinburgh UK), Stefan Winnik proposed the topic "detailed RBI case study" as a joint session. Francois Ropital will contact NACE offices in order to identify the proper STG group for preparing a joint session on the topic.

- Common recommendations, guideline, publications. One proposal from NACE is the management of corrosion for cooling water systems. On this topic EFC has published in 2004 the guideline n°40 which aims to give to end users the theoretical and technical background in order to be in position to enter effectively into dialogue with the water treatment providers. In 2006 NACE has issued the report 11106 "Monitoring and adjustment of cooling water treatment operating parameters" that is a compilation of common practices and the report 11206 "Biocide monitoring and control in cooling towers". Francois Ropital got into contact with Prof. Schmidt, chairman of EFC WP1 (Corrosion and scale inhibition) in order to create a task force to work on these topics with NACE. On 27 September, a specific meeting has been held in Maastricht with WP1 and G. Hays as representative of NACE. The creation of the task force has been decided and representatives of WP15 group are looking for to join the task force. The first official meeting of the task force will be held during NACE 2007 Conference. An extract from the minutes of this specific meeting are included within Appendix 3.

## 2.4 EUROCORR 2006

This annual working party meeting was held in Maastricht during the Eurocorr 2006 conference "Reliability management of technical systems".

Two sessions dealing with refinery corrosion have been held:

Session M "Refinery corrosion" on 25 and 26 September.

Joint session T between WP1 and WP15 "Inhibition of corrosion and scaling in cooling water systems" on 28 September.

## 2.5 EUROCORR 2007

Eurocorr 2007 "Progress by corrosion control" will take place in Freiburg, Germany from 9-13 September 2007.

Its web site is [http://www.eurocorr.org/EUROCORN\\_2007.html](http://www.eurocorr.org/EUROCORN_2007.html)

A joint workshop will be organised with working party 3 ("High temperature corrosion") on "High Temperature Corrosion in the Chemical, Refinery and Petrochemical Industries". As indicated in paragraph 2.3, contacts will be taken with NACE in order to hold a joint EFC NACE workshop.

A session related to corrosion in the refinery industry will also take place.

For both refinery session and high temperature workshop, **abstracts are welcomed and the deadline for submission is 15 January 2007.**

[http://www.eurocorr.org/Submission\\_of\\_Abstracts.html](http://www.eurocorr.org/Submission_of_Abstracts.html)

## 2.6 New plans for the working party

Francois Ropital presented some proposals that could be discussed during the next WP15 meetings in order to enlarge the activities of the group.

### Eurocorr Sessions

- Implements of Eurocorr sessions or workshops with other EFC WP and NACE STG groups. Workshops can be held without formal presentations.
- Implication of young Masters, PhD students working on refinery corrosion related topics. An issue could be a dedicated poster session at Eurocorr and a dedicated meeting with them.

### Working Party Meetings

- Establishment of task forces on dedicated topics (refinery failure cases atlas, cooling water,...),
- Facilitating student trainings outside their countries in our companies, universities,
- Presentation of UE funding projects in our area (if there are),

- Collaborations on standards.

### **3 Artificial Neural Network for corrosion control and data management**

S. Trasatti (University of Milan) presented the advancement of the development of artificial neural network (ANN) for corrosion control. More information is provided in Appendix 4. After a review of the application of ANN for the evaluation of laboratory tests of crevice corrosion, CO<sub>2</sub> or naphthenic corrosion, a project dealing with an on site implement to estimate the residual life of refinery plants has been detailed.

### **4 Latest development on Pulsed Eddy Current Inspection**

Maarten Lorenz (Shell Global Solutions) gave a presentation on the latest development of the pulsed eddy current (PEC) technique for both thickness measurements, and corrosion monitoring. PEC functions by setting up a magnetic field in ferro-magnetic materials, and then measures the eddy current decay when the field is switched off. It can be applied on non prepared surface which temperature is up to 420°C. The probe does not need to have direct contact with the steel surface under measurement. Examples of applications through fireproofing of column skirts and sphere legs have been presented. Flat PEC probes can also be inserted in for in-service inspection of annular rings of storage tanks. Fixed PEC probes can be implanted at position with difficult access as for instance to monitor distillation towers operating opportunity crude. PEC can be used as a profiler mode (variations of the sensors position) in order to be more sensitive to defects. PEC is a Shell propriety technique which has licensees in UK, NL, Far East, South Africa,.... The slides that have been presented are enclosed in appendix 5.

### **5 Development in high temperature hydrogen flux measurements applications**

Frank Dean (Ion Science) presented some applications of hydrogen flux measurements to monitor high temperature active corrosion. After a presentation of the principles of this technique, some indications have been given on where hydrogen flux is measurable through permeable alloys or coating for refinery equipments. Laboratory evaluation of correlation between hydrogen flux and high temperature corrosion rates has been performed (F. Dean, S. Powell, Corrosion 2006, NACE, Paper 6346). On site flux measurements has also been registered from equipment subject to NAC / sulfidic corrosion. Typical 'maps' of high temperature hydrogen flux associated with naphthenic acid corrosion have been recorded on pipe bends. More extended field investigations are in progress. Future laboratory work should also take into account fluid sheer stress typically associated with naphthenic acid corrosion.

More information is provided in Appendix 6.

## **6 New Technology for Prediction and Assessment of Corrosion in Refinery Operations**

Russell Kane presented some results from Honeywell completed JIP on H<sub>2</sub>S dominated NH<sub>4</sub>HS corrosion. A classification of the corrosion resistance of several alloys has been established, for with carbon steel and Monel 400 alloy are the less resistant. This JIP program had developed data that served as the basis for a new predictive model and software tool for evaluation of NH<sub>4</sub>HS corrosion.

NH<sub>3</sub> dominated NH<sub>4</sub>HS corrosion is still in progress during the phase II of a sour water JIP focused on the parametric effects of higher pressure of NH<sub>3</sub>, temperature and cyanide. The reversion of the corrosion rate versus the pH was confirmed and a model developed to predict corrosion.

On the naphthenic acid corrosion topic, Honeywell is launching a new JIP that will integrate parametric studies of TAN, wall shear stress, temperature, and sulfur species. The JIP results will integrate into a new software tool to define corrosion and operational risks.

For the amine corrosion JIP, the phase I dedicated to rich amine will be completed by the end of 2006. A new phase will be proposed in 2007 on lean amine resulting from plant experiences that indicates that lean amine corrosion is most severe due to heat transfer and high local wall shear stress during gases desorption from rich amine solutions. Also over-stripping of H<sub>2</sub>S can result in more corrosive conditions.

More information is provided in Appendix 7 and can be obtained by contacting Russell Kane

## **7 Control of process instability and corrosion in a hot lean amine system**

R. Kane presented some experience from Shell Canada on amine reboiler corrosion problems that were not detected by the conventional off line NDT monitoring program until a leak occurred associated with an important internal corrosion. The implantation of a real time SmartCET electrochemical monitoring program indicated that high corrosivity events were correlated to specific periods of process instabilities (related to amine polymer residue). The problem has been then resolved by amine reclamation. The reduction of the corrosion rate was also latter confirmed by NDE. Since resolution of this situation, the unit remains remotely monitored using the same system.

The slides that have been presented are enclosed in appendix 8.

## **8 Stress corrosion cracking in fuel ethanol**

R. Kane presented the advancement of the API joint program on stress corrosion cracking of steel in fuel ethanol tanks. As the global production of fuel ethanol is projected to double in the next 5 years, recommendations are necessary to minimize risk of SCC failures. In US, most of ethanol is derived from corn but all around the world, others sources can be sugar cane, grapes and biomass. The aim of the API program is to document failures cases of fuel ethanol SCC in order to find what could



be the sources of the cracks. A compilation of the results of various laboratory experiments has been performed. From this work, API has already published the 939D technical white paper entitled "SCC of carbon steel in fuel grade ethanol: review and survey". API is developing a guideline document (API 939E) to present current experience and details on prevention, inspection and remediation methods for ethanol SCC. In order to accurate the API program, R. Kane is looking for SCC failure cases by fuel ethanol from non US regions such as Brazil (sugar cane) and Europe (wine): information from EFC WP15 members who have such experience should be transmitted to R. Kane. The slides that have been presented and R. Kane contact address are enclosed in appendix 9.

## **9 Opened technical discussions**

### **9.1 Chloride corrosion of a hydrotreater reactor effluent**

Isaak György (MOL Company) shared a failure case of a hydrotreater reactor effluent due to an important concentration of chlorides. These chlorides could be organic "phantom chlorides". One way of remedy could be to monitor the chloride level at the water neutralizer injection point.

### **9.2 Relaxation cracking of stainless steels**

Martin Richez (Total) and François Dupouiron (Total Petrochemical) reported some reheat cracking of welding of stainless and refractory steels in petrochemical plants such SMR or FCC. These intergranular cracks appear within a 2 year period of operation in the temperature range 550-750°C in stress areas of HAZ or weld metal. The cracking is due to a progressive relaxation of the residual stresses that were created by the welding. A collaborative work has been managed by TNO on this subject. Recommendations to prevent these reheat cracks could be proposed in a recognized professional document such an EFC guideline. This point will be discussed in more details during next WP15 spring meeting.

## **10 Corrosion Under Insulation EFC Guideline**

Stefan Winnik, technical editor of the guideline, presented the final version of the Corrosion Under Insulation (CUI) document. A diagram of presentation of the guideline is incorporated in Appendix 10. For registered members, this final version can also been downloaded from the CUI project web page <http://project.ifp.fr/cui-efc-wp15> . The last comments should be sent to Stefan before the 1 December 2006: then the document will be sent to the publisher in order to be issued within the next 6 months.

## 11 Next Meetings

### 2007 Spring WP15 Meeting

Total proposed to hosted the spring meeting in **Paris La Defense on Thursday 26 April 2007.**

The full agenda will be established later with the following topics: monitoring, inspection, failure cases, relaxation cracking of stainless steels, acid gas amine units treatment, cooling water treatment, caustic SCC of carbon steel in FCC units, others subjects...

### 2007 Autumn Full WP 15 Meeting:

This meeting will take place in Freiburg Germany from 9-13 September 2007 during the Eurocorr 2007 conference.