

**Minutes of EFC WP15
Corrosion in the Refinery Industry**

**Mechelen (Belgium)
8 April 2014**

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Acknowledgement

The EFC WP 15 Refinery Corrosion Group would like to express thanks to Borealis for hosting this meeting in Mechelen with special thanks to Gino De Landtsheer for organising the meeting.

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1 Welcome & Introduction

The current EFC WP15 chairman, Francois Ropital, opened the meeting and introduced Gino De Landtsheer (Borealis).

Gino presented an overview of the current Borealis ownership, company values, and world-wide locations. Borealis mainly produces polyolefins (polyethylene & polypropylene) for specialist applications ranging from components in the automotive industry to highly specialized wire-and-cable insulation products. The company is also operating fertilizer plants in Austria and France.

31 persons attended the meeting and briefly introduced themselves. The list of the participants is enclosed in Appendix 1.

2 EFC WP15 Activities

2.1 EFC WP15 Activities & Minutes of Meetings

Information about the activities of EFC WP15, Corrosion in the Refinery Industry was presented by Francois Ropital. This information can also be found on the EFC WP15 website, where the minutes of previous WP15 meetings minutes can be viewed and downloaded. More information is enclosed in Appendix 2.

2.2 Existing Publications

The following publications from WP15 are available:

- EFC Guideline no. 40: Prevention of Corrosion by Cooling Waters
- EFC Guideline n° 42: A Collection of Selected Papers.
- EFC Guideline °46: Amine Unit Survey.
- EFC Guideline n° 55: Corrosion under insulation (CUI) guidelines.

2.3 Future and Updated Publications

Stress Relaxation Cracking

This document could be a guideline to avoid stress relaxation cracking failures. WP15 members are participating in a TNO led joint industry project that was launched in April 2012. This project will, at its conclusion, make information available that could be used in the development of a guideline.

Corrosion-Under-Insulation (CUI)

A specific task force works on an update of EFC Guideline n°55 (Corrosion under Insulation) with Stefan Winnik (SW Materials And Corrosion Ltd.) as editor. More information on the project is provided in Section 9.2 of these minutes.

2.4 Next Meetings & Conferences

Eurocorr 2014 (Pisa, Italy)

The next Eurocorr-conference will take place in Pisa, Italy from 9 -12 September 2014. There will be Refinery Corrosion Session on Wednesday, 10th September 2014. Thirteen (13) papers were accepted for oral presentations, and ten (10) posters. There will also be a joint WP3/WP15 session on High Temperature Corrosion in the Refinery Industry, for which four (4) papers were accepted.

The next WP15 business meeting will take place during the Eurocorr 2014 conference, most probably on Tuesday afternoon, 9th September 2014. All dates will be confirmed.

2015 Conferences

- NACE CORROSION 2015: 15 – 19 March 2015 (Dallas, Tx, USA)
- EUROCORN 2015: 6 – 10 September 2015 (Graz, Austria)

3 JIP on Stress Relaxation Cracking

Francois Dupoirion (Total) provided a brief update on the status of the TNO-led joint industry project on Stress Relaxation Cracking (SRC).

There was a steering committee meeting in October 2013, during which some progress was presented. Hans Van Wortel has been appointed as technical manager of the project, which now has 27 participating companies.

Some preliminary results for Work Package 1 (Refinement of Recommendations for Local vs General Stresses) were presented at the steering committee meeting.

Regarding dissemination of previous research results, no further discussion occurred. This means that EFC WP15 does not have any research material available for a guideline on the prevention of SRC.

Additional information can be found in Appendix 3.

4 Corrosion in Cooling Waters

4.1 Corrosion Problems in Heat Exchanger due to Cooling Water

Maria J. Yanes Guardado (Repsol) presented a case of serious microbiological fouling and associated corrosion damage to carbon steel heat exchangers in the vacuum column overhead system at the Repsol Coruna refinery. These carbon steel heat exchanger bundles have been replaced every five (5) years. Low flow through the exchanger tubes, and inadequate control of the cooling water system (fed from a recycled water system) were cited as the main causes for the observed damage. Repsol is investigating means to improve flow velocities in the exchangers.

4.2 New Heat Exchanger Materials

Valerie Bour Beucler (Nalco) presented an overview of problems and issues associated with the use of new materials of construction for water cooler heat exchangers. Galvanic corrosion issues are observed with the use duplex stainless steel if due consideration is not given to other materials of construction in the same system. There could also be other issues as the current trends are to reduce the use of non-oxidizing biocides, and increase the use of oxidizing biocides. More information can be found in Appendix 5.

5 High Temperature Hydrogen Attack (HTHA)

5.1 Comments on CSB Reports about API RP941

Christoph Scharsching (OMV) presented some highlights of a US Chemical Safety Board (CSB) report on a heat exchanger shell failure that occurred at the Tesoro Refinery in 2012. This failure of the 38 year old C-0.5Mo shell was ascribed to high temperature hydrogen attack.

This report has raised serious concerns in the OMV refineries, as there are numerous cases where the use of C-0.5Mo steel is based on Nelson curves from API RP 941 that are now obsolete. OMV has proposed a mitigation strategy to find and check C-0.5Mo steel equipment operating in high temperature hydrogen environments. Two papers discussed during the meeting can be found in Appendix 6.

Hennie Debruyne (Saudi Aramco) presented one slide showing the P_V -factor from API TR 941 and API RP 581. Many people are forgetting that HTHA is also a time-based degradation mechanism. It is therefore not correct to only check the position of process conditions on the current Nelson-curves when assessing susceptibility to HTHA. It is recommended that the P_V -factor be considered, even if there are many criticisms against this approach.

During the discussion it was mentioned that ExxonMobil published a paper on HTHA inspection techniques in 2007 at an ASME conference. There was also mention of a Belgian nuclear research project that is aiming to develop a NDT technique to find trapped hydrogen in steel and other alloys.

6 Failure Cases

6.1 Corrosion by High Temperature in an Acid Gas Burner

Maria J. Yanes Guardado (Repsol) presented a failure case concerning an acid gas burner. The carbon steel flange and type 310 stainless steel parts of this burner suffered catastrophic high temperature sulfidation. Most of the damage appears to be related to damage of the refractory lining of the combustion zone of the reactor.

6.2 Damage to FCC Regenerator Hex Mesh

Christel Augustin (Total) presented this failure case concerning type 304H stainless steel. The hex mesh has loosened (weld failure) in numerous places in the FCC regenerator, causing refractory collapse and hot spots. Examination of the damaged hex mesh has so far failed to identify the root cause of these failures. The hex mesh material appears to be carburized, and does not exhibit any sulfur species in corrosion product.

6.3 Failure of the hydrogen recycle line of an HDS unit

Martin Richez (Total) presented a failure case where a 10" carbon steel elbow was thinned by erosion corrosion in ammonium bisulfide (NH₄HS). This failure caused a serious incident, but there were fortunately no fire or explosion, or personnel injuries. The failure occurred on carbon steel during VGO processing when the water wash was turned off. The fluid still contained water and up to an estimated 45% NH₄HS. More information can be found in Appendix 8.

6.4 Overlay Cracking in Hydrocracking Reactors

Maria J. Yanes Guardado (Repsol) presented a failure case that occurred in a UOP IsoMax (mid hydrocracker) unit. The type 347 weld overlay was applied as a single overlay without a buttering layer. This has resulted in a brittle overlay that was damaged by hydrogen assisted cracking. The 2.25Cr-1.0Mo reactors will now be replaced with reactors in 2.25Cr-1.0Mo-V steel overlaid with type 347 stainless steel. A welding process that will generate less heat will be used.

7 Technical Issues

7.1 Sulfide Stress Cracking

Repsol (Maria J. Yanes Guardado) presented a classification of process environments containing hydrogen sulfide (H₂S). Repsol will in future distinguish between "permanent" and "non-permanent" H₂S service. Carbon steel where the exposure to wet H₂S is only intermittent, will not be post-weld heat treated. This will help to save costs associated with piping repairs and replacements. Concerns were expressed during the meeting about the increased risks associated with this practice.

7.2 Thermal Spray Cladding

Hennie Debruyne (Saudi Aramco) mentioned that Saudi Aramco intends launching a discussion group (TEG) at NACE as a forum to discuss the use of thermal spray cladding as a mean to mitigate corrosion in process equipment. This resulted in a 10 minute discussion about the advantages and possible disadvantages of using thermal spray cladding in process corrosion applications. More information can be obtained by contacting Saudi Aramco (todd.byrnes@aramco.com)

8 Inspection

8.1 Advances in High Accuracy Measurements in Remote Visual Inspection

Claudia Laverde and Johan Van De Vijvere (GE Inspection Technologies) presented an overview of measurement techniques used in remote visual inspection. New methods to measure corrosion damage (pit depths, etc.) have been developed and are deployed in inspection equipment supplied by GE Inspection Technologies. More information can be found in Appendix 11.

9 Corrosion-under-Insulation

9.1 Liquid Insulation for Oil & Gas Refining

Steve Reynolds (Performance Polymers) presented advances made in recent years with liquid insulative coatings. New technology silicon-based aerogels are now available for applications up to 180°C. Research is being conducted to improve the temperature rating of these coatings to 360°C. More information can be found in Appendix 12.

9.2 Update of the EFC CUI Guidelines

Stefan Winnik (SW Materials and Corrosion Ltd.) presented a short overview of the status of the update process for these guidelines. This is essentially a short overview of the work-process that occurred the day before the meeting, when he met with Hennie Debruyne (Saudi Aramco), Gino De Landtsheer (Borealis), and Francois Ropital (IFP) to review all comments and proposed changes to the document.

Final versions of the individual chapters and appendixes will be made available through DropBox. Final comments should be submitted before 16 May 2014. After that the document update will be finalized and the manuscript prepared for publication.

10 Good-bye

Martin Richez (Total) announced that he is taking early retirement and that he will in future most probably not attend the EFC WP15 meetings. Francois Ropital used the opportunity to thank Martin for his useful and informative contributions.