

Minutes of EFC WP 15

Corrosion in the Refinery Industry

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Acknowledgement

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1 Welcome

György Isaak from MOL opened the meeting. The MOL downstream group operates 5 refineries:

- DUNA (Capacity 8.1 Mtpa)
- BRATISLAVA (Capacity 6.1 Mtpa)
- MANTOVA (Capacity 2.6 Mtpa)
- RIJEKA (Capacity 4.5 Mtpa)
- SISAK (Capacity 2.2 Mtpa)

In 2006 the DUNA and BRATISLAVA refineries were respectively n°1 and n°2 in Europe and Russia for their net cash margin. For maintaining these high levels of asset availability, more and more efforts and resources are needed and MOL had to completely restructure its anti-corrosion management. In 2009 a comprehensive survey was made to assess efficiency of the anti-corrosion activities in the refineries of MOL Group and a 3A (Anti-Corrosion, Applications and Actions) initiative was launched. A new organization has been established with a corrosion control team and committee. To raise the level of corrosion related knowledge, collaboration with partners as EFC WP15 group is fully in line with MOL strategy for improvement its targets, mainly to:

- Increase operational safety of hydrotreaters
- Prevent corrosion failures in amine units
- Extend operational cycle of crude distillation units
- Find optimal solutions against CUI

More information on the MOL corrosion management strategy is included in Appendix 2

20 persons attended the meeting and briefly introduced themselves. Apologies were received from 42 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 & 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 WP15 web site](#), where the minutes of previous WP15 meetings minutes can be consulted and downloaded. More information is enclosed in Appendix 3.

2.2 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 Project for Future Publications

During the last meetings, some presentations and discussions were related to relaxation cracking of stainless steels that are mainly used for furnace applications. Within the activities of the high temperature group of the French Cefracor petroleum industry commission, some work is going on the elaboration of a procedure to evaluate the sensitivity of coupons to relaxation cracking and to propose guidelines to avoid this phenomenon. This work could potentially be published as an EFC guideline.

2.4 Collaboration with NACE

Opportunities for collaboration between EFC and NACE are fully supported by the board of administrators of the two associations.

2.4.1 Exchange of Information

Exchange of information between WP15 and the NACE groups dedicated to the same topics are encouraged.

2.5 Collaboration with other EFC Working Parties

Francois Ropital proposed that during the 2011 Eurocorr conference in Stockholm (5 to 8 September 2011), another joint workshop on "High temperature corrosion in refinery and petrochemical industries" could be held together with WP3 "High temperature corrosion" (similar to workshops during the Eurocorr 2004 and 2007 conferences). Francois Ropital will contact Michael Schütze, WP3 Chairman.

2.6 EUROCORR 2010

Eurocorr 2010 "From the Earth's depths to the Space heights" will take place in Moscow, Russia from 13-17 September 2010.

The web site for this conference is: [EUROCORR 2010](#)

The refinery corrosion sessions will be on Tuesday 14 September (11h00 – 17h30) and Wednesday 15 September (9h55 – 14h50).

The annual working party will take place from 14h50 to 18h20 after the Wednesday 15 September refinery conference session.

The draft program for the refinery sessions is attached in Appendix 3.

The complete program can be downloaded from: [EUROCORR 2010 Program](#)

2.7 EUROCORR 2011

Eurocorr 2011 will take place in Stockholm (Sweden) from 5 to 8 September 2011. Some proposals of topics on joint sessions with other Working Parties have been discussed (see paragraph 2.5). Other proposals are always still welcome.

2.8 List of congress related with refinery corrosion

Pascale Sotto Vangeli suggested to provide a list of congress that will deal with refinery corrosion for the next 18 months. Francois Ropital will built this document.

3 Stress Relaxation Cracking of Stainless Steels

3.1 Advancement of the Cefracor Survey

The relaxation cracking phenomenon had been previously discussed in WP15 meetings (especially during the 2007 spring and 2009 annual meetings). Many WP15 participants supported the proposal to establish a standard test method and a guideline to prevent these failures that could be published in the EFC guidelines series. Under the auspices of the Oil and Gas Committee of Cefracor (French corrosion association) with François Dupouiron as a task leader, a group is currently working on this subject in order to propose a characterisation test and to have discussions with steel providers and with Codes authorities.

A Joint Industrial Project is in preparation with the proposed objectives:

- Correlation determination from data banks (from "plant results" and main parameters) in order to affect severity factors
- Experimental validations of the correlations to study:
 - Variation of the composition and microstructure
 - Variation of residual stresses
 - Variation of welding parameters
 - Hardening to simulate hot forming
 - Validation of the effect of thermal treatments
- Modeling

From the previous steps establishment of a risk evaluation matrix and definition of a methodology to evaluate the sensitivity for new steel grades or a new elaboration process.

A JIP is in discussion and for further information, contact Francois Dupouiron (<mailto:francois.dupouiron@total.com>).

A resume of the advancement of this task force is included in Appendix 4.

4 Failure Cases

4.1 Amine unit failure

György Isaak (MOL) reported a failure case of an amine (MDEA) unit regenerator. During start up after turnaround, a horizontal crack was observed on the regenerator

column at the height of the evaporating zone. Turbulences and accumulation of heat stable salts (HSS) were the primary causes of this erosion-corrosion phenomenon. The remedial actions were to design and fabricate the amine regeneration column from duplex SS and to operate with frequent checks of amine quality, strict control of APU operation, seeking opportunities to reduce temperatures, control addition of caustic for neutralization and regular inspection of column wall thickness.

More information is provided in Appendix 5.

4.2 Two failures cases in refineries in overhead condensers and sea water heat exchangers

The first failure presented by Jonas Höwing (Sandvik) concerns a 22% Cr duplex overhead condenser. Corrosion damage has been detected in the tube wall of the bottom row of tubes, resulting in tube leaks. NH_4Cl salts have been accumulated and high temperature in combination with the high local chloride concentration under the deposits has led to under deposit corrosion. Better desalting, water washes and the use of an upgraded duplex stainless steels SAF 2797 (UNS S32707) have been considered as remedies.

The second failure occurred in a duplex SAF 2507 (UNS S32750) seawater cooled exchanger located in the Middle East. A large hole and several small areas of corrosion attack have been observed inside the tube where a 1.5 mm thick brown scale of carbonates has been deposited due to seawater heated above 60°C. The heat exchanger has been operated at too high temperature with too low flow and poor maintenance procedures. The use of a super duplex SAF 2707 (UNS S32707) should have been more resistant. A copy of the presentation is included in Appendix 6.

4.3 Cracks on the effluent nozzle of a HDS reactor

Martin Richez (Total) reported a product leak on the vent hole of the reinforcing pad of an HDS reactor. The crack initiated at the root of the weld (that was not fully fused) as the weld was not a full penetration weld. This nozzle configuration was especially unfavourable, and thermal fatigue was the main cause of the crack propagation. More information on this failure is provided in Appendix 7.

5 Outokumpu stainless steels

Pascale Sotto Vangeli presented the different classes of stainless steels produced by Outokumpu. Some focus has been made on application for storage and transportation. The participants have been informed that a new edition (10th) of the Outokumpu Corrosion Handbook has been issued and is available from [Pascale Sotto Vangeli](#). The complete presentation is provided in Appendix 8.

6 Duplex stainless steels

6.1 Financial considerations of use of duplex/super duplex steels with two cases taken from refinery applications

Miklos Kantor (Sandvik) presented two cases of use of duplex stainless steels in order to reduce the corrosion costs in refineries. The first case concerned atmospheric column overhead condensers. For 6 units, the replacement of carbon steel condensers to duplex stainless steel SAF 2507 (UNS S32750) can lead of a cost save of 4.2 Million \$ during a 4 years period.

The second case was about HDS finned tube reactor effluent air coolers (REAC). For a 28 months period, the use of duplex stainless steel SAF 2507 (UNS S32750) can save 2.1 Million \$.

More information is provided in Appendix 9.

6.2 Material acceptance criteria for standard NACE MR0103

A discussion was launched by Jonas Höwing (Sandvik) on the test qualification procedure to pass the NACE MR0103 standard. This standard requires testing with NACE TM0177 that has been developed for oil and gas down hole services. It can be considered that the environment in refineries is quite different and discussion on a refinery specific test procedure could be proposed to the NACE MR0103 committee.

Jonas has undertaken to investigate the possibility of drafting a proposal. The slides presented by Jonas Höwing are included in Appendix 10

6.3 Lean Duplex Steels in Refineries?

To conclude on the duplex stainless steel topic, György Isaak (MOL) proposed a discussion on why lean duplex stainless steels are sporadically used in refineries. Some figures of comparison of costs are enclosed in Appendix 11.

7 Metallurgical problems with valves

Martin Richez (Total) reported some metallurgical problems with valves. At the beginning of 2009, during start up of a new styrene unit of Gonfreville, valves were found leaking. The mechanical test made on defective valve bodies have shown low impact toughness results (despite MTR showing good values), lack or incorrect thermal treatment, weld repairs without heat treatment and numerous metallurgical defects (cracks, porosities, shrinkage cavities). Valves were officially made by a European manufacturer with CE conformity attestation, but they were really made in China. The heat treatment was incorrect and resulted in too high grain size, improper structure and low impact toughness. Nearly all manufacturers were affected. As PED and the intervention of notified bodies is not an effective barrier, PED will be modified to define criteria for the nomination of notified body and to increase their supervision activity. More information is provided in Appendix 12.

8 Monitoring

8.1 Corrosion and erosion monitoring using permanently installed sensor technology for continuous wall thickness monitoring

Claudia Lavarde (GE) reported on the Rightrax corrosion monitoring system that uses permanently installed ultrasonic sensors and that permits remote monitoring of restricted or high-temperature areas (350-500°C). Specific high temperature sensor clamps have been developed. Application on crude lines has also been presented.

More information is provided in Appendix 13.

8.2 Microbiologically Influenced Corrosion - Association with Biofilm, Monitoring and Removal

After a presentation of the MIC phenomena in cooling water systems, Davor Kesner (GE) detailed the Bioscan approach that associates biofilm removal and biodispersant injection. The slides presented are included in Appendix 14.

9 Inspection

9.1 Effectiveness of NDT methods for corrosion/erosion monitoring and diagnostic

Miroslav Michvocík and Gerard Zima (SLOVNAFT) launched a discussion on the effectiveness of NDT methods for corrosion/erosion monitoring. To evaluate thinning by UT, three examples were reported on the difficulties to localize and detect the corrosion.

More information is provided in Appendix 15.

10 Next Meeting

*The annual meeting will take place in **Moscow (Russia)** during the Eurocorr 2010 conference. The meeting is scheduled for **Wednesday 15 September from 14h50 – 18h20.***

The final agenda is in preparation and will be sent to WP15 members by 15 July 2010.