

Minutes of EFC WP 15

Corrosion in the Refinery Industry

Eni Technologie Research Centre, San Donato Milanese Italy

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- Nace Italia Section and its President Carmelo Aiello for their collaboration,
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1 Welcome

The meeting was opened by Giovanna Gabetta (Eni) and Francois Ropital (chairman of EFC WP15 party), who welcomed the participants. 41 persons attended the meeting and shortly introduced themselves. Apologies was received from 27 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 have been presented by Francois Ropital (Appendix 2). These information can also be found on the EFC web-site (<http://www.efcweb.org/englisch/wp15.htm>) where the minutes of previous WP15 meetings minutes can be consulted and downloaded.

2.2 Publications

Two EFC WP 15 publications that should have been available last year, were slightly delayed.

- EFC Guideline no. 40: Prevention of Corrosion by Cooling Waters.
- EFC Guideline no. 42: A Collection of Selected Papers (ed. John Harston).

The "*Amine Unit Corrosion Survey*" managed by John Harston will also be published.

New proposals for further publications were presented:

- Corrosion under insulation issues in modern refinery and petrochemical plants. This new guideline has been discussed during the special meeting on CUI. Its headlines are presented in section 5 of these minutes.
- Collection of selected papers of the joined workshop "Corrosion by hot gases and combustion products with emphasis on high temperature corrosion in the chemical and petrochemical industries" that will be hold with WP3 during Eurocorr 2004.

2.3 EUROCORR 2004

Eurocorr 2004 (EFC event No. 266) will take place from 12 to 16 September 2004 in Nice, France. The emphasis at Eurocorr 2004 will be "Long Term Prediction and

Modelling”, a crucially important subject to which every EFC Working Party should be able to contribute. More information can be found on the conference web-site: <http://www.scifrance.org/congres/eurocorr2004>

A focussed workshop between WP3 (Corrosion by Hot Gases) that is entitled "Corrosion by hot gases and combustion products with emphasis on high temperature corrosion in the chemical and petrochemical industries" (13-14 September) and a WP15 session (16 September) will be organised during Eurocorr 2004. More information is available at the Conference Web site.

2.4 EUROCORR 2005

Eurocorr 2005 will take place in Lisbon, Portugal from 4-8 September 2005. Its web site is <http://congress.topatlantico.com/eurocorr2005>

The working party agrees to continue the discussion with WP1 (inhibitor) and WP13 (oil & gas production) for a joint session on corrosion inhibitors.

3 Nace Italia section activities

3.1 Nace Italia section

Giovanna Gabetta (Eni) and Carmelo Aiello (chairman) presented the activities of the Nace Italia section. Since 1997 one or two per year thematic meeting is organised on the following topics

- Review on naphthenic acid corrosion phenomena
- Refinery inspection - qualification of inspectors
- Corrosion under insulation: monitoring, use of Nace standard
- Materials for use in "difficult environments"

The next annual meeting will take place in June in Porto Marghera (Venezia). A two days conference is also organised in Genoa on 25-26 November with sponsorship of Istituto Italiano della Saldatura. The announcement of this conference is enclosed in Appendix 11.

3.2 EFC-NACE Agreement

An agreement on cooperation between EFC and NACE International has been established. that brings important benefits both to members of NACE International and to those who belong to EFC Member Societies. Members of NACE International are entitled to a 20% discount on all EFC publications, the same as is available to EFC Member Societies. Reciprocally, NACE will provide the same discounted prices provided to NACE members on books, standards and journal subscriptions to all members of the EFC Member Societies. Information exchange has also taken place on the progress of the activities of Nace Technical Groups and EFC Working Parties.

4 Discussion on review of literature on refinery corrosion

Hennie de Bruyn (Statoil) presented the Access data base that he built on main papers and publications dealing with refinery corrosion. The base is divided in 3 sections: process, environmental and external corrosion. Some information on this data base are included in Appendix 3. As Giovanna Gabetta (Eni) has also developed a data base on literature on naphthenic acid corrosion, the data of this last base have been included. A copy of this literature database file is enclosed in the WP15 members email distribution of these minutes. In the future, the data base will be placed on EFC web site in order that users can download it.

5 Corrosion Under Insulation specific meeting minutes

5.1 Introduction

The presentation of goals and way forward was done by Francois Ropital, including a summary of the meeting at Shell Pernis on 10 April 2003. The current objectives are to produce a consensus European document from WP15 on corrosion under insulation. The reasons are that NACE and API are dealing in a structured way with other major plant problems and that the European refining and petrochemical industry is relatively divided technically and requires a unifying project. The CUI issue involves heavy financial losses to all plants and no particular proprietary technical issues are involved to the end-user.

5.2 CUI presentation by Chevron Texaco (Andrew Kettle)

Andrew Kettle presented the CUI losses to date which include some 25 leaks/year solely due to CUI with IANs running at around 75/year. The lost profit opportunities are >£2.5M/year (3.7Meuro, 4.5M\$). The use of Furmanite clamps currently costs £250k/year with line replacement and painting maintenance at around £1M/year and inspection costs at £30k (excluding scaffolding). The total costs of CUI in this one medium sized refinery is some £7.78 M/year (11.5Meuro, 14M\$). Chevron-Texaco now has a program in place to examine their exposure to CUI and has established a 10 year rolling proactive program with a budget of £4.5M/year. The CUI inspection and treatment program is strictly cost driven and not “probability” driven. The current program needs P&ID reviews where the insulation is removed if not needed for process reasons. The aim is zero accident and failure. Chevron-Texaco has determined that there is no panacea technique and the new approaches (eg. LORUS, Guided wave US) are improvements but cannot provide 100 % coverage. A cultural change is required to accept “full strip” as plant policy. No action is not an option since it increases the risk of failure. The slides of the presentation are enclosed in Appendix 4.1.

5.3 CUI presentation by Shell Global Solutions (Maarten Lorentz)

Shell regards CUI as a management issue. The programs are driven by a perceived risk and CUI is subject to an RBI program. The main problem is that CUI locations are impossible to predict. Elimination of CUI entails: cages for personal protection, paints/coatings application, choices of insulation material, ventilation where possible, and reduction of water vapour transmission under/through insulation (polymer), drains to let water out. The principal issues for CUI monitoring are: good maintenance of the insulation system, inspection for CUI (method? thermographs?), monitoring for water, process temperatures, coating type and integrity all managed by an RBI program. The serious concerns deal with: related to the CUI invisibility, no reliable detection technique, may start/stop at any time, impossible to predict, absence of consistent corrosion rate, absence of continued budget (maintenance issues) and ownership of an endless program. The best route is to identify a rational and results-delivering program which can be proposed to management as a continuing cost-reduction effort and not a “problem-is-solved-now” direction. The slides of the presentation are enclosed in Appendix 4.1.

5.4 Information on the January 2004 Conference organised by IOM al

Stefan Winnick (Exxon-Mobil) informed us about the one-day conference on corrosion under insulation to be held in Sheffield, UK on 14 January 2004 organised by the Corrosion Committee of the Institute of Materials, Minerals and Mining, HSL and HSE. The conference papers will be available on the IOM website: <http://www.iom3.org>

5.5 General discussion on a consensus European program on CUI

After some preamble it was recognised that the European refining and petrochemical plants shared a common problem which is consuming a very large proportion of the maintenance budgets. A common document would be welcomed however it must be a joint effort with sections being delivered by different organisations in an effort to divide up the work load but also have buy-in/adhesion from as wide an organisational base as possible.

The work breakdown was agreed as follows:

Section I: Introduction (Francois Ropital, IFP)

- Discussion of needs and widespread maintenance costs for plants mostly built in late 1960s and early 1970's. Ageing equipment where replacement rates of piping and vessels due to external corrosion is becoming an epidemic (concept of “finite life of equipment”). Strategies required to identify zones and material at risk and devise new means of planning equipment retirement and/or refurbishment.

Section II: Cost analysis (Andrew Kettle, Chevron-Texaco)

- Scaffolding costs in different countries, size of issue, simple calculation methods (estimated annual Euro equivalent per barrel of crude oil processed: circa 24Euros/BPD?). Manpower costs for maintenance, sandblasting, painting costs, costs

of down time (lost production), knock on effect to country/state costs of importing lost product.

Section III: Ownership and responsibility: (Staffan Olsson, Scanraff)

Everyone in the organisation has his task list and role to play (maintenance mgr, inspection, operations, oil movements engineer etc). Cultural change required. Proposal of task organisation.

Section IV: Unit prioritization (Andrew Kettle, Chevron-Texaco)

High level risk assessment.

Section V: Reality check (Nicholas Dowling, Shell)

Verify operations. Is equipment still in fact insulated? Is it still used? Is the analysis relevant to future needs (if not then remove it from the plan). Needs for mothballed equipment.

Section VI: Risk analysis (Ray Owens, Total; Maarten Lorenz, Shell; ENI/AGIP)

Methodology to assess risk based solely on COST.

Section VII: Challenge (Hennie de Bryn, Statoil; Stefan Winnik, Exxon-Mobil)

Alternatives to accepted plan (what can we do different). Challenge need for insulation at all. Personal protection options. Be very careful in complete removal options (energy problems).

Section VIII: Evaluation plan (Ray Owens, Total)

High risk: 100% delag; Medium high risk selective delag; medium low risk do NDT. Low risk run to failure (RTF).

Section IX: NDT screening techniques (ENI/AGIP)

Evaluation of screening techniques available and their pros and cons (technical/commercial information is put in appendix (i). MTI list is available.

Section X: Implementation (Steffen Winnik, Exxon-Mobil)

Maintenance and remediation issues. Sandblasting, painting, Al sheet wrap and metal spray issues for stainless, carbon and low alloy steels. Life cycle cost analysis in terms of blasting coating every 20 years or change to stainless. Incorporate S. Winnik's document on this important issue on viable long term choices for materials replacement and life extension.

Section XI: Feedback of findings into main implementation plan (Charles Droz, Exxon-Mobil; Maarten Lorenz, Shell)

Problem areas (specific lists of areas specially attacked by CUI and to be examined in a systematic way in a "hit list"). In vacuum column stiffening rings, painted welds etc. as well as means of dealing with them.

Appendix (i): NDT technique listing (ENI/AGIP)

Appendix (ii): Monitoring techniques (Maarten Lorenz, Shell)

Appendix (iii): Application of new insulation and refurbishment issues (Stefan Winnik, Exxon-Mobil).

During next WP meeting on Wednesday 15 September in Nice during the Eurocorr conference, the draft contributions on each section written by their contributor will be discussed. Before this meeting, a draft guideline will be diffused to the persons that are involved and interested by this task. In order to follow this plan schedule, the contributions have to be send to Francois Ropital (IFP) before the 1 August.

6 Presentations during the general spring meeting

6.1 Monitoring and Inspection

6.1.1 *Optimised inspection planning is more than Risk Based Inspection – M. Lorenz (Shell Global Solutions)*

Maarten Lorenz gave a presentation on what assistance is needed on RBI in order to propose more efficient inspection programme, higher plant reliability, availability and safety. RBI needs to be followed up by determining potential benefits of various inspection techniques. Detailed inspection plan needs to be designed to reduce intrusive inspections and improved confidence on conventional non intrusive inspection. Shell has developed an non intrusive inspection methodology (S-NII) that integrates knowledge. The slides included in Appendix 5, present S-NII implementation and software supports.

6.2 Failure cases

6.2.1 *Deaerator Cracking – N. Dowling (Shell Global Solutions)*

Nicholas Dowling presented a failure case by cracks in a deaerator. From the examination of the rupture faces several failure hypothesis have been proposed: hydrogen cracking from the cathodic protection reduction of water, trace of oxidation fatigue. The low stress fluctuation lead to fatigue corrosion with propagation at the head of the crack. Some operators specify a stress relieving of the deaerator.

6.2.2 *PWHT of alloy clad vessels – A. Kettle (Chevron Texaco)*

Andrew Kettle presented Chevron Texaco's approach on Thermal Heat Treatments for 304L stainless steel clad vessels (fabricated sections and weld seams). The sensitisation of cladding and nozzle material is evaluated in order to estimate their sensitivity to polythionic acid stress corrosion cracking. The question of the accuracy and reliability of the ASTM G35-76 test has also been raised. More information can be found in the attached presentation (Appendix 6).

6.3 Non Destructive Techniques

6.3.1 *State of the art for new portable diffractometres for NDT X Ray analysis – G. Berti (University of Pisa)*

Professor G. Berti presented the progress performed by Pisa University in order to develop a new movable diffractometre for NDT application as on site measurement of residual local stresses or analyses of corrosion deposits. The challenge this new proposed device is to bring XRD measurement directly on the industrial plants (possibly in services). More information can be found in the attached abstract and presentation (Appendix 7).

6.4 Hydrotreatment units

6.4.1 *Stainless steel lining types of hydrotreatment of gas oil containing naphthenic acids – N. Dowling (Shell Global Solutions)*

Nicholas Dowling gave a presentation on Shell approach on the effects for 317 stainless steel overlay or 321 and 347 internals on the condensation of naphthenic acids from a moderate acidic feed ($1 < \text{TAN} < 2$).

6.4.2 *Assessing operating limits for C-0,5Mo steel in high temperature H₂ service - Case study – H. de Bruyn (Statoil)*

Hennie de Bruyn presented an approach for the metallurgical evaluation of C-0,5 Mo steel grade in order to consider future increased pressure and temperature conditions for a coker distillate hydrotreating unit. Reactors and by-pas line conditions have been investigated. To take into account ageing effects the High Temperature Hydrogen Attack (HTTA) technical module of Appendix I API 581 was used to propose restricted temperature and pressure values. More information can be found in the attached presentation (Appendix 8).

6.5 Naphtenic acid corrosion

6.5.1 *Naphtenic acid corrosion of 9Cr-1Mo steel - R. Riva (EniTechnologie)*

Roberto Riva presented the experimental work performed by EniTechnologie to predict corrosion rates and to test models that describes interaction between naphtenic acids and sulphur. Autoclave tests with rotating specimens were run. The experimental results are roughly in agreement with Naphtenic Acid Corrosion Index model (Craig 1995). These results have also been compared by refinery plant data. In order to get better agreement between laboratory tests and plant experience some modification of the lab equipment have been considered. The complete presentation is enclosed in Appendix 9.

6.5.2 *A neural approach - S. Tasatti (University of Milan)*

Dr Stefano Trasatti gave a presentation on the application of neural network to predict naphthenic acid corrosion. This work has been performed in collaboration with EniTechnologie. A review of different applications of neural network for corrosion process was presented. For the present work on naphthenic acid corrosion prediction, the variables that were selected as input and output and the validation steps were also presented. More information on this subject can be found in the attached presentation (Appendix 8).

7 **Next Meeting**

The next autumn meeting will take place during the Eurocorr 2004 Congress in Nice (France) on Wednesday 15 September 2004.

This one day meeting will be fully dedicated to the Corrosion Under Insulation topic with the review and discussion on the draft EFC guideline.

The Eurocorr 2004 sessions dealing with refinery corrosion will be:

Monday 13 and Thursday 14 September for the Workshop "Corrosion by hot gases and combustion products with emphasis on high temperature corrosion in the chemical and petrochemical industries"

Thursday morning 16 September for the Corrosion in Refinery session

2005 Spring WP Meeting:

Hennie de Bruyn from Statoil kindly offers to host it in Trondheim, Norway. The precise date will be decided during the Nice meeting.