Appendix 1

List of participants

Participants EFC WP15 meeting 9th April 2013 Paris (France)

Alessandro Demma	A3 Monitoring Ltd	UK
Andrea Galvagni	A3 Monitoring Ltd	UK
Ridha Yahyaoui	AXENS - IFP Technology Group	FRANCE
Martin Hofmeister	Bayernoil Raffineriegesellschaft mbH	GERMANY
Amin Nateghi	Böhler Welding Holding GmbH	GERMANY
Volker Gross	Böhler Welding Holding GmbH	GERMANY
Pierre Alexandre Legait	Bohler welding group	FRANCE
John Pugh	BP	UK
Hermenegildo Ruiz	CEPSA	SPAIN
Pedro Rangel	CEPSA	SPAIN
Dr Stefan Winnik	Exxon Mobil Chemical	UK
Alain Pothuaud	GE Betz	FRANCE
Claudia Lavarde	GE Measurement & Control	FRANCE
Michael MeLampy	Hi-Temp Coatings Technology	USA
Francois Ropital	IFP Energies nouvelles	FRANCE
Adam Ovington	International Paint Ldt	UK
Neil Wilds	International Paint Ldt	UK
Hennie de Bruyn	Johnson Matthey Catalysts	UK
Jerome Dufour	Nalco	FRANCE
Valerie Bour Beucler	Nalco Energy Services	FRANCE
Francois Weisang-Hoinard	Outokumpu	FRANCE
Grzegorz Sielski	Sandvik Poland	POLAND
Johan van Roij	Shell Global Solutions International B.V.	NETHERLANDS
Mathieu Decherf	Soudokay s.a.	BELGIUM
Steve Mc Coy	Special Metals / PCC energy EP	UK
Andres Rivero	Statoil ASA	NORWAY
Fred Van Rodijnene	Sulzer Metco Europe GmbH	GERMANY
Johan Sentjens	Temati	NETHERLANDS
John Thirkettle	Thor Corrosion	UK
Martin Richez	Total Refining & Chemicals	FRANCE
François Dupoiron	Total Refining & Chemicals	FRANCE
Christel Augustin	Total Refining & Chemicals	FRANCE
Albert Veld	Wintech Global	FRANCE
Debohra Demiaux	Wintech Global	FRANCE

Appendix 2

EFC WP15 Activities

(F. Ropital)

Presentation of the activities of WP15

European Federation of Corrosion (EFC)

- Federation of 31 National Associations
- 20 Working Parties (WP)
- Annual Corrosion congress « Eurocorr »
- Thematic workshops and symposiums
- Working Party meetings (for WP15 twice a year)
- Publications
- EFC - NACE agreement (20% discount on books price)
- for more information http://www.efcweb.org

EFC Working Party 15 « Corrosion in Refinery » Activities

http://www.efcweb.org/Working+Parties-p-104085/WP%2B15-p-104111.html

Chairman: Francois Ropital Deputy Chairman: Hennie de Bruyn

The following are the main areas being pursued by the Working Party:

Information Exchange
Sharing of refinery materials /corrosion experiences by operating company representatives.

Forum for Technology
Sharing materials/ corrosion/ protection/ monitoring information by providers

Eurocorr Conferences

WP Meetings
One WP 15 working party meeting in Spring,
One meeting at Eurocorr in September in conjunction with the conference,

Publications - Guidelines

Publications from WP15

• EFC Guideline n°40 « Prevention of corrosion by cooling waters » available from http://www.woodheadpublishing.com/en/book.aspx?bookID=1193

Update in relation with Nace document 11106 "Monitoring and adjustment of cooling water treatment operating parameters" Task Group 152 on cooling water systems

• EFC Guideline n° 46 on corrosion in amine units http://www.woodheadpublishing.com/en/book.aspx?bookID=1299

•EFC Guideline n° 42 Collection of selected papers http://www.woodheadpublishing.com/en/book.aspx?bookID=1295

•EFC Guideline n° 55 Corrosion Under Insulation http://www.woodheadpublishing.com/en/book.aspx?bookID=1486

•Future publications : suggestions ?

- best practice guideline to avoid and characterize stress relaxation cracking ?

EFC Working Party 15 plan work 2011-2013

. Collaboration with Nace : exchange of minutes of meetings
"NACE TEG 205X information exchange -corrosion in refineries "

. Sessions with other EFC WP at Eurocorr (2014 Pisa-Italy, 2015 Graz-Austria) on which topics?
High temperature corrosion in with WP3 ?

• Update of publications
  • CUI guideline

• New Publications: best practice guideline to avoid and characterize stress relaxation cracking ?

• Education – qualification – certification
List of "corrosion refinery" related courses on EFC website ?
Proposal of courses within Eurocorr ?

WP15 Corrosion Atlas Web page

http://www.efcweb.org/Working+Parties/WP+Corrosion+in+the+Refinery+Industry/WP+15+Refinery+Corrosion+Atlas.html

Thank you to Martin Hofmeister for proposing a new case (n°9)

Eurocorr 2013

Estoril 1-5 September 2013

Authors have been informed by mid April

Refinery corrosion session with 17 oral presentations
(Tuesday 3- Wednesday 5 Sept – to be confirmed)

Joint session with WP19 on polymeric and composite materials in the refinery and chemical industries with 5 oral presentations (may be more)
(Thursday morning 5 Sept – to be confirmed)

Annual WP15 working party meeting during Eurocorr
(date to be fixed)

http://www.eurocorr2013.org/?page=default

Joint NACE-EFC BOTH Conference

Estoril 5-6 September 2013

Bring On The Heat conferences all over the World
-India 18-19 April, New Orleans 4-6 June

-for Europe NACE and EFC decided to co-organize it in Estoril 5-6 September 2013

A program has to be proposed that should include:
-Insulation
-Corrosion Under Insulation (CUI) / Thermal Spray Aluminum (TSA)
-Passive Fire Protection (PFP)

Information :
Future conferences related to refinery corrosion

•1-5 September 2013
EUROCORR 2013 Estoril Portugal Website: www.efcweb.org/Events

•8-10 October 2013
ESOPE Paris France
(construction technologies, Codes, Standards and European Directives for stationary and transportable Pressure Equipment)

•12-14 November 2013
Stainless Steel World conference Maastricht NL

•9-13 March 2014
Nace Conference 2014 San Antonio USA

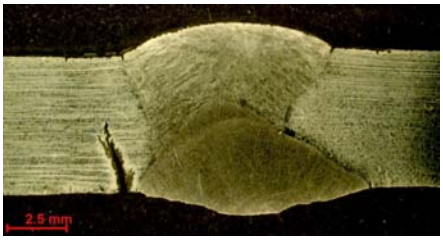
•8-12 September 2014
EUROCORR 2014 Pisa Italy

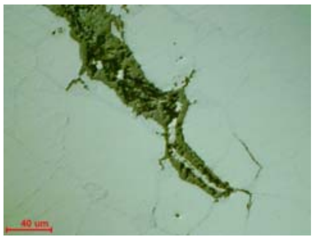
Appendix 3

Information on the JIP on Stress Relaxation Cracking

(F. Dupoiron)

Stress Relaxation Cracking





TNO JIP proposal

WP 15

JIP SRC objectifs

- **Why a JIP :**
  - Failures are difficult to predict
  - The only reliable method is Hight temperature heat treatment : long , expensive , complex
  - Need of a general SRC indicator.
  - Avoid heat treatment specifications as for 800H in ASME.

.

	METAL TEMPERATURE in °C:								
	500	550	600	650	700	750	800	850	900
AISI 304H	*Welded with matching consumables* **The same guideline holds for stabilised base material (at 875°C)**								
As welded, no PWHT									
+ PWHT: 875°C/3h									
316H	*Welded with 316H consumables*								
As welded, no PWHT									
+ PWHT: 875°C/3h									
321H	*Welded with 347 consumables*								
As welded, no PWHT									
+ PWHT: 875C/3h									
347H	*Welded with 347 consumables*								
As welded, no PWHT									
+ PWHT: 875C/3h									
1.4910	*Welded with 16/13 consumables*								
As welded, no PWHT			Weld metal only						
+ PWHT: 750°C/3h [1]									
+ PWHT: 875°C/3h [1]									

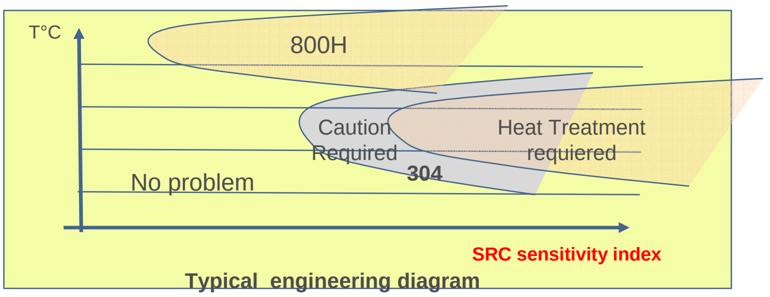
1) A PWHT seems to be conservative

JIP SRC at TNO :

- Les participants
  - ArcelorMital,
  - BASF,
  - Borsig,
  - CBI,
  - Dupont,
  - Fluor,
  - Haldor Topsoe,
  - Johnson Matthey,
  - Laborelec ,
  - NEM,
  - Sabic,
  - Schmidt&Clemens,
  - Shell,
  - Sumitomo Metals,
  - **Technip,**
  - ThyssenKrupp-VDM,
  - **Total,**
  - Uhde.
  - Linde and Boehler-Welding are expected to sign shortly.

W**ork **P**ackage **WP1: Refinement of recommended practices

- Determine a SRC sensitivity index for each grade , taking in account the stress (residual and primary) levels from the parameters design , welding parameters (heat input, filler..), thickness, T°C range.



Typical engineering diagram

- Investigated grades : 304H (possible for 321 and 347) ,Alloy 800H , Alloy 617.

WP 2: Physico-chemical and mechanical understanding

- Modelling the SRC phenomenon using :
  - Metallurgical model (Phase Field model) to predict the phases precipitations, chromium diffusion and depletion and the mechanical properties for bulk zone , depleted zone, grain boundaries.
  - Mechanical model (Finite element model / Sysweld ,) to predict the phases and stresses evolution depending on design and welding thermal cycle
  - Model validation versus WP 1

Grades : 304H , 304L , 304LN

TOTAL

WP3: Alternative remediation strategies

- Investigate and develop alternative procedures not based on heat treatment to reduce internal stresses and sensitivity to SRC for new and existing components on site .
- Investigate the effect of heat treatment parameters :
  - cooling and heating rate
  - Improvement of the heat treatment : lower temperature + longer time
  - Effect of heat treatments on properties

TOTAL

WP 4: Effect of heat treatment on creep life time

- *Answer to notified bodies question about the creep reduction factor .*
- *.Works on 800H with and without heat treatments*
- *Possible additional works on : 347*

WP 5: Sensitivity to and prevention of SRC in new alloys and weldments.

- *Investigate the SRC sensitivity of seven new* alloys : super 304 , Sumitomo 696 , cast 20Cr32Ni ; Cast 25Cr35Ni, Cast 35Cr45Ni Et Micro*
  - *Phase diagram TTT and or CCC*
  - *SRC heat treatment program and test*
  - *Determine optimal treatment parameters*
- *.Availlability of the results of " old " TNO tests.*
- *Same proposal on aged cast material 20Cr 33Ni Nb welded will be proposed by Technip , Total , Boehler welding and S+C. In or out of scope to be discussed.*
- * new alloy = not SRC tested

WP6 : SRC in dissimilar welded materials

- *Assessing two types of dissimilar welds on their SRC sensitivity*
- *Exploring the best remediation practices for reducing SRC sensitivity using :*
  - *Heat treatment s compatible with both materials*
  - *Alternative way (cf WP3)*
- *Configuration tested :*
  - *1- Cast 20Cr32Ni / Filler 617 / 800H*
  - *2- P91/filler P87/ super 304*

WP 7: Dissemination

- **Goal : To spread the knowledge on SRC, and anticipate rules .**
  - Public recommended practice on SRC with a part of the knowledge (not all !!!) of the JIP.
  - EFC document and possible NACE and/or API to be discuss after the first year

€€€€€ ?

WP1	Refin the RP	90000
WP2	Modelling	90000
WP3	alternative remediations	75000
WP4	effect of HT on creep	50000
WP5	New alloys and weldments	40000
WP6	SRC of dissimilar welds	40000
WP7	Dissemination	40000
Total		**425000**

Per partner	25000

TOTAL

Appendix 4

Excessive corrosion of carbon steel in semi-closed cooling water system

(A. Veld)

Excellence serving

your Technology

WINTECH GLOBAL™
Reliability as your energy

Cooling water exchanger

Carbon steel/Fouling

Do you recognize this image?

I bet you do!

WINTECH GLOBAL™
Reliability as your energy

Cooling water exchanger

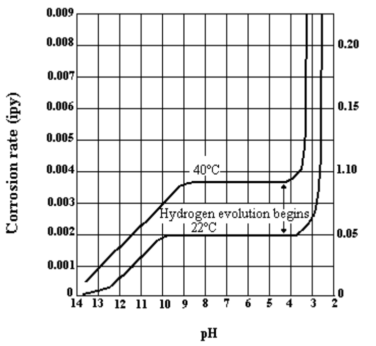
Corrosion and Fouling

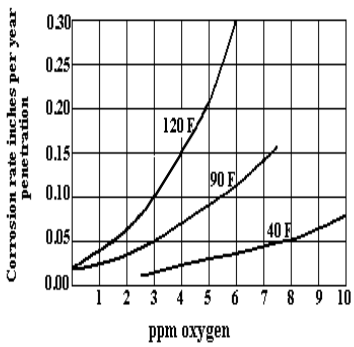
Too often this is what we get when opening a CW exchanger!

Corrosion in Cooling Water Systems

Carbon Steel

- **Degradation Mechanism**

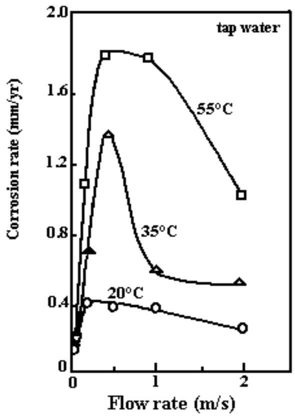


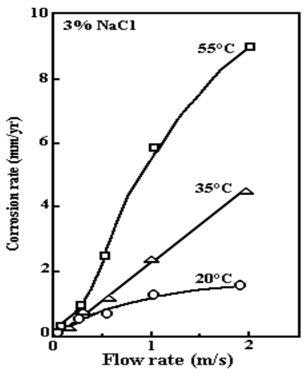


Corrosion in Cooling Water Systems

Carbon Steel

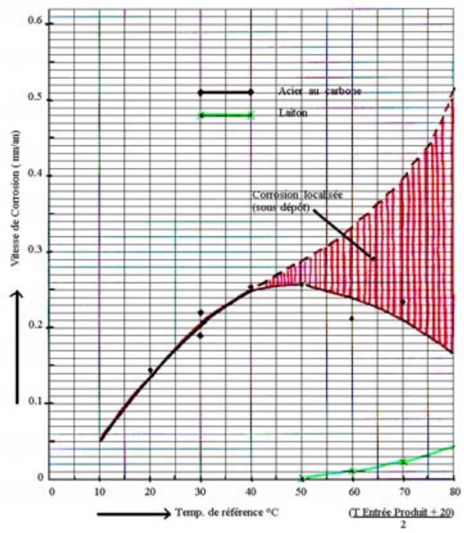
- ## Corrosion mechanisms





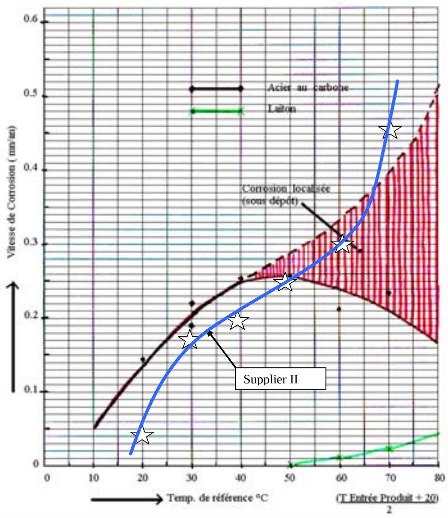
Prediction Model

Carbon steel /Brass



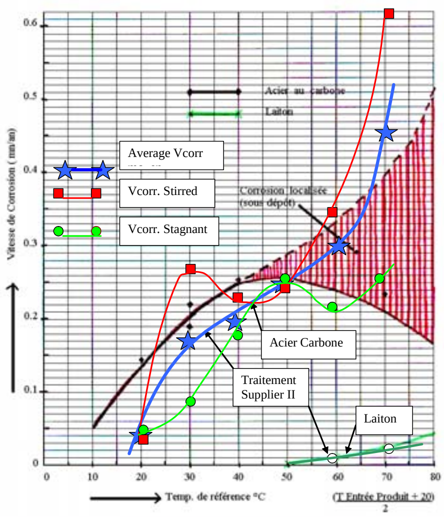
Prediction Model

Carbon steel /Brass



Prediction Model

Carbon steel /Brass



Cooling water systems

Conclusions/Experience

- The prediction model has been confirmed by extensive feedback from Cooling Water systems on Petrochemical sites in Europe and in South America
- The experience shows the difficulties that are persisting in the area of treatment of Cooling Water in semi-closed CW circuits.

- **YOUR EXPERIENCE ???**

Appendix 5

Cooling water corrosion inhibitors update, advantages and inconvenient on cooling water treatment

(V. Bour Beucler)

NALCO
An Ecolab Company

Essential Expertise
for Water, Energy and Air

Recirculating cooling water corrosion inhibitors update,advantages and inconveniences on cooling water treatment

EFC WP15 Spring Meeting

Valerie BOUR BEUCLER *2013 April 9th*

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An Ecolab Company

Overview

Cooling water treatment, what changes ?

REACH, Legionella and cooling system impact Biocidal Product Directive / Regulation BPD/R

Corrosion inhibitors update

Future and green chemistry

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An Ecolab Company

Recirculating cooling water systems… What kind of change ?

Legionella control, regulation in 2004

REACH (European Commity Regulation on Chemical and their safe Use (EC 1907/2006)

Biocidal Product Directive / Regulation BPD/R started in 1998

Local Environmental regulation (heavy metals but also zinc)

Innovative chemistry

Monitoring and control

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Legionella control and regulation

- ✓ Legionellosis infection that emerged in the second half of 20th century. From febril illness to fatal pneumonia
- ✓ Caused by Legionella pmeumophila (around 20°c – 50°C)
- ✓ Bacteria present in water, transmission through contaminated aerosols
- ✓ Temperature is a important parameter for legionella growth
- ✓ The presence of biofilm, scaling and iron (corrosion) are important for them to survive and growth.

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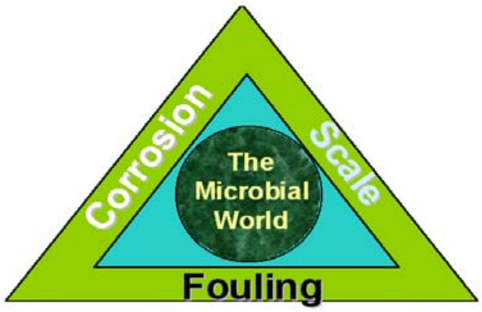
…greater emphasis on need to manage surface-fouling processes in water treatment



Water Treatment Model

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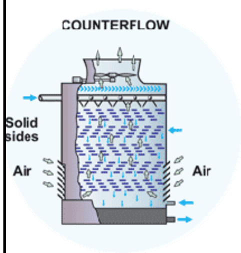
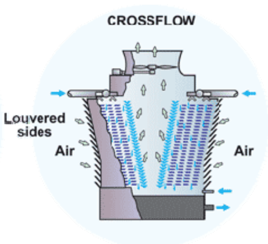
…





- Control of:
  - SCALE
  - CORROSION
  - FOULING
  - LP CONTROL

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…action levels following microbial monitoring

AEROBIC COUNT cfu / ml at 30°C 48 h	LEGIONELLA cfu / L	ACTION REQUIRED
10 000 or less	100 or less	System under control
more than 10 000 and up to 100 000	more than 100 and up to 1000	Review programme opération Review control measures and RA Immediately resample
more than 100 000	more than 1000	Implement corrective actions Immediately resample Shot dose appropriate biocide Consider cleaning / disinfection Review control measures and RA

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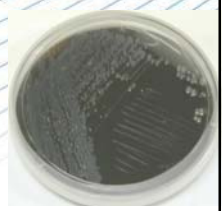
Risk management of Legionella

- ✓ Assemble a team
- ✓ Draw and describe the system
- ✓ Asset hazard and priority risks (dead legs, low flow, stagnation)
- ✓ Cooling system treatments and dosage
- ✓ Risk audit on site
- ✓ People training
- ✓ Best Practices manual, review
- ✓ Control and monitoring
- ✓ Communication
- ✓ Surveillance



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Impact on cooling system

- Continuously operated systems
- More frequent micro & LP testing
- Side Stream Filtration
- Use of dispersants/detergents
- Continuous biocide addition Instead of shock dosage
- Continuous monitoring of treatment reserves.etc
- More key parameters under control
- More galvanic corrosion on carbon steel (copper)

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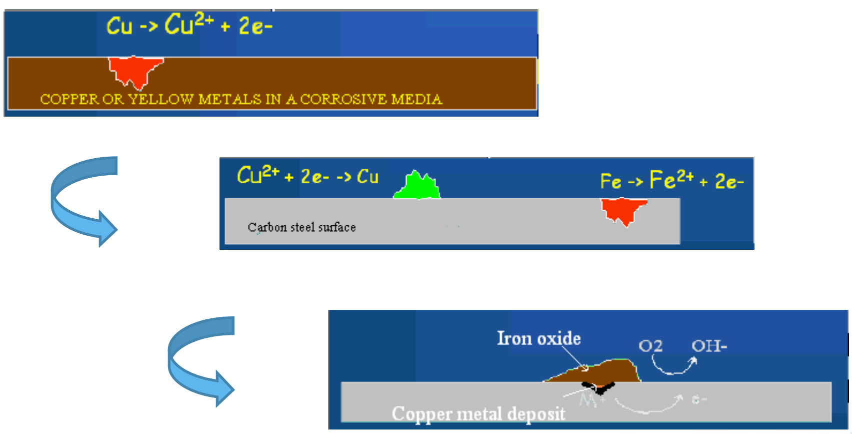
Copper galvanic corrosion on carbon steel



DELIVERING ESSENTIAL EXPERTISE

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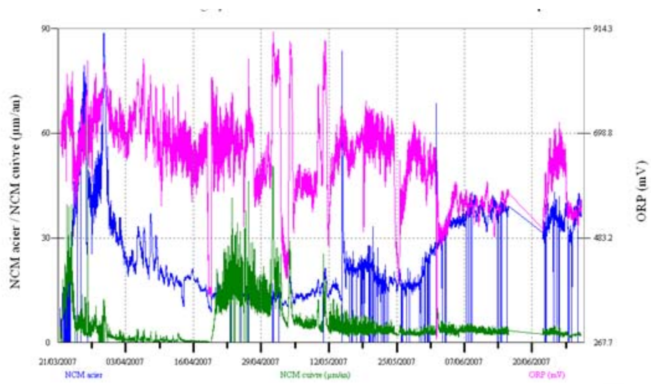
Effect of over chlorination



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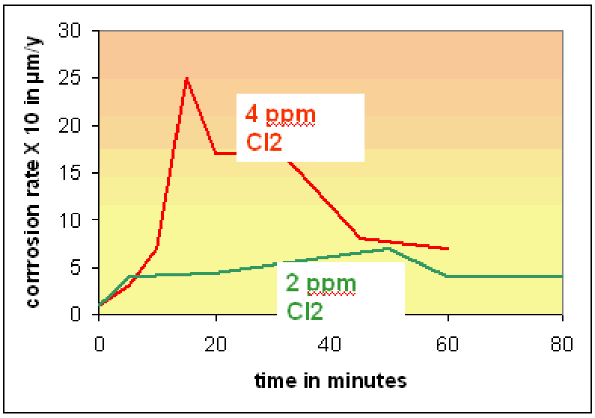
Effect of oxidizing biocide shock dosage



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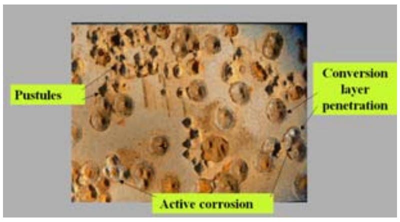
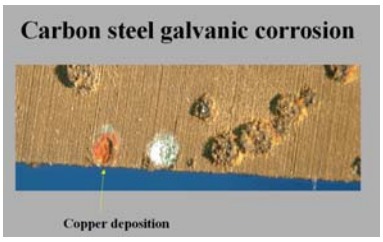
Case study





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REACH

REACH (European Commity Regulation on Chemical and their safe Use (EC 1907/2006)

This directive is designed to provide the highest possible level of protection for health and the environment in respect of the harmful effects of hazardous chemicals.

It deals the Registration Evaluation Authorisation and Restriction of Chemical substances

It started on 2007 June 1st

European Chemical Agency (ECHA) in Helsinki

The companies affected by the REACH directive are those engaged in exporting more than one tonne/year of the substances (in as in form, in a blend, present in product) to EU countries, either directly or through their customers

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Biocidal Product Directive / Regulation

Started in 1998 updated end of 2010

The Biocidal Product Directive aims to harmonise the European market for biocidal products and their active substances.

it aims to provide a high level of protection for humans, animals and the environment.

Reduce the number of available biocides

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Local European Environment Regulation

Depending of the country and the location

Focus on heavy metal

Enviromental Permitting

Example in Germany

- Limited P level, no zinc

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Recirculating Corrosion Inhibitor Update

Anodic inhibitors

➢Mineral phosphate (OPO4) (pH, Ca, OPO4, Temp sensitives)

➢Molybdates (Under dosage sensitive, exp.)

➢Carboxylates (bio sensitive)

Cathodic inhibitors

➢Zinc (pH sensitive)

➢Polyphosphates (reversion sensitive)

➢PSO

➢Organic phosphates (oxidizing biocide sensitive)

Others

➢Silicates (efficiency),

➢Azoles (Oxidizing biocide and bio sensitive)

➢Filming amines or polyamines (surface sensitive)

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Mechanical stress parameters

Operational parameters	Low	Moderate	High	Severe
Skin Temperature (°C)	< 50	50 – 60	60 – 70	➢ 70
Velocity (ms^{-1})	➢ 1	0.6 – 1.0	0.6 – 0.3	< 0.3
Heat Flux ($MJm^{-2}.hr^{-1}$)	< 25	25 - 50	50 - 75	> 75
Chemical parameters				
Langelier	< 0.5	0.5 – 1.5	1.5 – 2.5	➢ 2.5
Ryznar	➢ 6.0	4.5 – 6.0	3.5 – 4.5	< 3.5
TCP SSI	< 20	20 –1000	1000 – 1500	>1500
Iron (mgl^{-1})	< 1.0	1.0 – 3.0	3.0 – 5.0	➢ 5.0

Increase corrosion and scaling risk

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Future ….. Green chemistry

- Answer to a new environmental regulation and need,
- Green substances but not only also the manufacturing steps and solvents
- Polymers, innovative molecules
- Biodegradability
- Research

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QUESTIONS

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Appendix 6

New approach for corrosion monitoring: from concept to prototype

(A. Demma, A. Galvagni)

A New Approach to Corrosion Monitoring

from Concept to Prototype

A. Galvagni, A. Demma

A³ Monitoring Ltd

www.a3monitoring.com

Introduction

- A^3 Monitoring was founded with the specific goals of:
  1. Reduce the cost of corrosion monitoring.
  2. Improve the reliability of corrosion monitoring.
- A^3 Monitoring plans to achieve its goals by making better use of information from permanent sensors, manual inspection results, and corrosion models.
- A^3 Monitoring can help you optimise the cost and reliability of your corrosion monitoring strategy on the basis of actual data from your specific plant.

shieldCube

- shieldCube is the innovative software platform conceived by A^3 Monitoring to optimise corrosion monitoring.
  - It is an open cloud platform that can be hosted by any server and can be accessed at any time by any device without installing any software.
- It has an advanced monitoring capability.
  - To maximise information value from permanent sensors.
- It has a unique data fusion capability.
  - To combine information from permanent sensors, manual inspection and corrosion models into a unified representation of the health of a pipeline.
  - To utilise your existing inspection database in a new way.
- It can tailor inspection plans utilising real refinery data.

shieldCube Monitoring

- The advanced monitoring capabilities of shieldCube result from cutting-edge research at Imperial College London.
  - These capabilities have been extensively tested over the past four years in actual operational scenarios in collaboration with major petrochemical companies.
- shieldCube delivers cost and reliability benefits by:

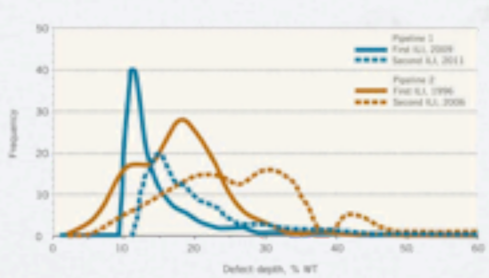
1. Efficient sensor sampling.
   - How many samples are needed to detect a given change in the rate of corrosion with set probabilities of detection and of false call? Over what period of time?
   - How does the sampling rate affect the confidence on remaining life estimates?
2. Sensor measurements reliability assessment.
   - How repeatable and accurate are sensor measurements?
   - Is a sensor measurement tracking corrosion growth or environmental effects?

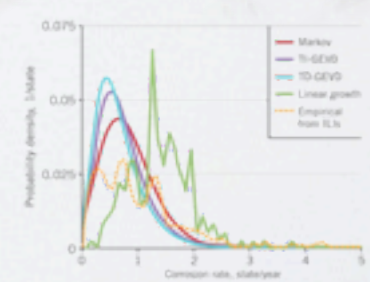
shieldCube Guided Wave Monitoring

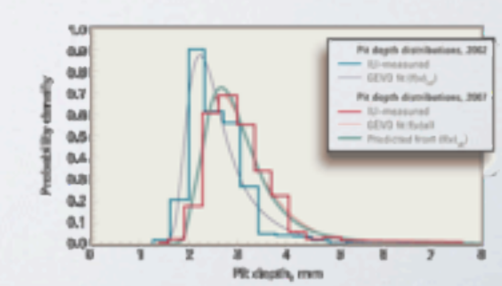
- shieldCube is the industry's first and only software solution for practical guided wave pipeline monitoring.
  - Developed at Imperial College London and extensively field tested over the past four years in collaboration with major petrochemical companies, shieldCube is the only solution proven and documented capable of removing the impact of environmental effects.
- shieldCube automatically highlights zones of concern along the pipeline and reports estimated cross-sectional area loss rates.
- It has been proven during field trials that:
  - shieldCube maximises the probability of detecting damage and corrosion.
  - shieldCube can predict in advance the minimum cross-sectional area loss rate that can be detected within a given period of time, allowing to predict and assess in advance the sensitivity of the installed guided wave monitoring sensors.

shieldCube Data Fusion

- The data fusion concept stems from the recognition that corrosion monitoring must rely on many different tools.
  - As in medical science, no single test can diagnose all possible
- Tools include:
  - Non-Intrusive Sensors
    - UT, UTGW, FSM, etc.
  - Intrusive Sensors
    - ER, LPR, Galvanic, Coupons, etc.
  - Corrosion Models







shieldCube Data Fusion

- Each tool provides different corrosion information.
  - Different tools measure different quantities, and may have very different sensitivities to damage, e.g. UT & UTGW.
  - There is limited compatibility between measurements, e.g. UT measures spot thickness, UTGW measures cross-sectional area changes.
  - Different measurements can be complex and difficult to cross-check.
- Assessing the integrity of a pipeline is very challenging.
  - Many different sources of information need to be manually compared and weighted by operators who may be biased or not know one technology well.
- Importantly, each tool provides corrosion information.
  - The combined information from multiple sensors/measurements is highly valuable.
- Addressing the issue of data fusion is key.

shieldCube Data Fusion Benefits

- shieldCube data fusion produces a unified, unbiased and consistent representation of the health of a pipeline.
    - Data from all measurements are unified on the same scale, cross-checked, and appropriately weighted for their relative significance.
- The health representation and the risk of unplanned downtime are updated in real-time as data arrives.
- shieldCube delivers cost and reliability benefits through:
    1. Maximised usage of the existing inspection database.
    2. Efficient, customised inspection planning.
    3. Reliable information for remaining life forecasts.

shieldCube Data Fusion Benefits

- shieldCube data fusion can be used to re-analyse existing inspection and monitoring databases.
  - It is possible to mix together data from corrosion models, UT, UTGW, etc., and derive improved historical information.
  - It is possible to remove the bias and error of operators who may not know all techniques well or have sufficient experience with them.
- The vast historical inspection and monitoring databases available in refineries and plants could be used to:
  1. Improve corrosion models and validate sensor data.
  2. Actively compare the performance of different sensors and evaluate suitability to specific detection problems.

shieldCube Data Fusion Benefits

- Future inspection plans can be efficiently customised by:
  1. Evaluating the trade-off between inspection costs and the probability of detecting anomalous corrosion.
     - What is the impact of collecting 200 instead of 250 measurements? Where should measurements be taken?
     - What is the impact of installing permanent sensors?
     - Which sensors should be used? How many should be used? Where should they be placed? How often should sensor measurements be collected?
     - What is the impact of substituting intrusive with non-intrusive sensors?
  2. Planning based on target detection probabilities.
  3. Planning for target corrosion detection thresholds.
  4. Relax compliance testing where possible.

shieldCube Data Fusion Limitations

- shieldCube data fusion is still at prototype stage.
- The data fusion concept need to be proven and validated for refinery applications.
  - We are actively looking for partners open to testing the concept in parallel with the existing corrosion monitoring plans.
  - We are actively looking for *anonymous* historical inspection databases.
- The data fusion concept will require manual adjustments when conditions change radically over time.
  - e.g. when petrochemical processes and fluid contents change drastically.
  - Different operational modes could be defined as a function of the current petrochemical process and fluid content, and manually switched as needed.

Conclusion

- shieldCube is the innovative software platform conceived by A^3 Monitoring to optimise corrosion monitoring.
  1. It has an advanced monitoring capability.
     - Commercially available.
  2. It has a unique data fusion capability.
     - Prototype, we are actively looking for partners to test the concept.
- shieldCube delivers cost and reliability benefits through:
  1. Maximised usage of the existing inspection database.
  2. Efficient, customised inspection planning.
  3. Reliable information for remaining life forecasts.
  4. Tailored inspection plans utilising real refinery data.

Appendix 7

Update of the corrosion under insulation guide

EFC CUI guideline update

	Update	Full	Partial	Volunteer(s)
Chapters				
Chapter 1- Introduction	y		y	S. Winnik
Chapter 2 – Economic Consideration	y	y		S. Winnik
Chapter 3 – Ownership and Responsibility	Y	Y		S. Winnik
Chapter 4 - RBI Methodology for CUI Unit Prioritisation	Y	Y		H. de Bruyn, J. Van Roij, J. Pugh
Chapter 5 – Inspection Activities/ Strategy	Y			H. de Bruyn, J. Van Roij
Chapter 6 – NDE/NDT Screening Techniques for CUI	Y			A. Demma
Chapter 7 – Recommended Practice to Mitigate CUI	Y		Y	S. Winnik , M. MeLampy, J. Pugh
Chapter 8 – Design for the Prevention of CUI	N			H. de Bruyn, M. MeLampy, A. Ovington
Appendices				
A NDE/NDT Techniques	Y	Y		A. Demma, S. WinniK
B Cost-Economic Evaluation	Y		Y	S. Winnik
C Application of TSA	Y		Y	S. Winnik, F. Van Rodijnene
D Use of Protective Guards	Y		Y	xxx
E Additional Guidelines of the Implementation of CUI Best Practice	?			H. de Bruyn
F Coatings	Y	Y		M. MeLampy, A. Ovington
G Quality Assurance	?			J. Thirkettle
H Insulation Material Types and Forms	?			J. Sentjens
I Cladding/ Jacketing Materials	?			
J Case Studies	Y		Y	