Appendix 1

List of participants and excused persons

Participants EFC WP15 meeting 8th September 2008 Edinburgh

Name	Surname	Company	Country
Baas	Jan	CB&I Lummus B.V.	NETHERLANDS
Babic	Ksenija	Baker Petrolite	USA
Blendin-Fuelz	Dagmar	Bayernoil Raffineriegesellschaft mbH	GERMANY
Bracho	Yeire	PDVSA / Rafineria El Palito	VENEZUELA
Cafissi	Alessandro	University of Milan	ITALY
Carrol	Richard	BG Group	UNITED KINGDOM
Carrasquero	Ana	PDVSA / Rafineria El Palito	VENEZUELA
Chambers	Brian	Honeywell	USA
Claesen	Chris J	Nalco	BELGIUM
de Bruyn	Hennie	Borealis AS	NORWAY
Deves	Jean Marie	AXENS	FRANCE
Groysman	Alec	Oil Refineries Ltd	ISRAEL
Invernizzi	Andrea	University of Milan	ITALY
Isaak	György	MOL Hungarian Oil & Gas Co	HUNGARY
Kiiski	Arto	Neste Jacobs Oy	FINLAND
Lambert	Larry	Nynas AB	SWEDEN
Locati	Francesco	Snamprogetti	ITALY
Loukachenko	Natalia	Arcelor Mittal Industeel	FRANCE
Michvocik	Miroslav	SLOVNAFT	SLOVAKIA
Moares	Paulo	Petrobras / Refap	BRAZIL
Nordstrom	Sofi	Nynas AB	SWEDEN
Owens	David	GE Betz	UNITED KINGDOM
Ropital	Francois	IFP	FRANCE

...../.....

Participants EFC WP15 meeting 8th September 2008 Edinburgh

Continuation

Name	Surname	Company	Country
Roumeau	Xavier	TOTAL	FRANCE
Sasaki	Hidetsugu	Japan Society of Corrosion Engineering	JAPAN
Saarinen	Kari	Zerust Oy	FINLAND
Scanlan	Rob	Conoco Phillips	UK
Terms	Robin	Saudi Aramco	SAUDI ARABIA
Torkkeli	Janne	Neste Jacobs Oy	FINLAND
Trasatti	Stefano	University of Milan	ITALY
Vanacore	Mario	Nalco	ITALY
Visgaard Nielsen	Anni	Statoil Refinery, Kalundborg,	DENMARK
Winnik	Stefan	Exxon Mobil Chemical	UK
Wodarcyk	John	Conoco Phillips	USA
Zetlmeisl	Mike	Baker Petrolite	USA

Excuses received for the EFC WP15 meeting 8th September 2008 Edinburgh

Name	Surname	Company	Country
Aiello	Carmelo	Eni	ITALY
Dupoiron	François	Totalpetrochemicals	FRANCE
Farina	Carlo	CEFIT Corrosion Consultant	ITALY
Hofmeister	Martin	Bayernoil Raffineriegesellschaft mbH	GERMANY
Huchinska	Joanna	Gdansk University of Technology	POLAND
Pothuaud	Alain	GE Betz	FRANCE
Richez	Martin	Total	FRANCE
Riva	Roberto	Eni R&M	ITALY
van Loenhout	Marjolein	Fluor BV	NETHERLANDS

Appendix 2

EFC WP15 Activities

Presentation of the activities of WP15

European Federation of Corrosion (EFC)

- Federation of 31 National Associations
- 18 Working Parties (WP) + 1 Task Force
- 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 Parties

http://www.efcweb.org

- WP 1: Corrosion Inhibition
- WP 3: High Temperature
- WP 4: Nuclear Corrosion
- WP 5: Environmental Sensitive Fracture
- WP 6: Surface Science and Mechanisms of corrosion and protection
- WP 7: Education
- WP 8: Testing
- WP 9: Marine Corrosion
- WP 10: Microbial Corrosion
- WP 11: Corrosion of reinforcement in concrete
- WP 12: Computer based information systems
- WP 13: Corrosion in oil and gas production
- WP 14: Coatings
- WP 15: Corrosion in the refinery industry
  (created in sept. 96 with John Harston as first chairman)
- WP 16: Cathodic protection
- WP 17: Automotive
- WP 18: Tribocorrosion
- WP 19: Corrosion of polymer materials
- WP 20: Corrosion by drinking waters

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 ?
  - collection of selected papers from the Eurocorr 2005 and 2008 Naphtenic Corrosion sessions ?
  - best practice guideline to avoid and characterize stress relaxation cracking ?

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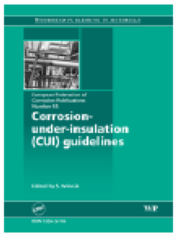
Corrosion under insulation (CUI) guidelines: (EFC 55)

Edited by S Winnik, ExxonMobil, UK



- guidelines cover inspection methodology for CUI, inspection techniques, including non-destructive evaluation methods and recommended best practice
- case studies are included illustrating key points in the book

Corrosion under insulation (CUI) refers to the external corrosion of piping and vessels that occurs underneath externally clad/jacketed insulation as a result of the penetration of water. By its very nature CUI tends to remain undetected until the insulation and cladding/jacketing is removed to allow inspection or when leaks occur. CUI is a common problem shared by the refining, petrochemical, power, industrial, onshore and offshore industries.

The European Federation of Corrosion (EFC) Working Parties WP13 and WP15 have worked to provide guidelines on managing CUI together with a number of major European refining, petrochemical and offshore companies including BP, Chevron-Texaco, Conoco-Phillips, ENI, Exxon-Mobil, IFP, MOL, Scanraff, Statoil, Shell, Total and Borealis. The guidelines within this document are intended for use on all plants and installations that contain insulated vessels, piping and equipment. The guidelines cover a risk-based inspection methodology for CUI, inspection techniques (including non-destructive evaluation methods) and recommended best practice for mitigating CUI, including design of plant and equipment, coatings and the use of thermal spray techniques, types of insulation, cladding/jacketing materials and protection guards. The guidelines also include case studies.

ISBN 1 84569 423 6
[ISBN-13: 978 1 84569 423 4]
March 2008
176 pages 234 x 156mm hardback
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Usually dispatched within 24 hours

EFC Working Party 15: Future objectives of the group

How to manage our working party meetings / Eurocorr sessions

· Eurocorr Sessions
✓Implements of Eurocorr sessions or workshops with other WP and NACE (a workshop can be on a topic without formal presentation)

✓Implication of young corrosion students, PhD at Eurocorr session with a dedicated poster session

. Working Party Meetings
✓Future topics of task forces
✓Facilitating student trainings outside their countries in our companies
✓Presentation of UE funding projects in our area (if they are)
✓Collaboration on Standard

Increase the collaboration with NACE
exchange of information on our activities - joint Eurocorr sessions

EFC Working Party 15 plan work 2008-2010

· Cooling water treatment: achieved
Publication of a common document

• Failure cases atlas : creation of a task force and a web page

. Proposal of Nace to co-organize a conference on "Corrosion in refineries – practical applications" around June 2010 that will take place in Europe (Amsterdam ?)
Task group of WP15 with Nace STG34 (Carol Laughlin)

. Sessions with other EFC WP at Eurocorr (2010 in Moscow, 2011 in Stockholm) on which topics?

• Publications

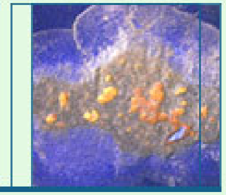
• Education – qualification - certification

Appendix 3

Eurocorr 2009 sessions

EUROCORR





DECHEMA I SITEMAP I CONTACT I OUR WEBSITES I

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- Imprint
- **EUROCORR 2009**
  - Committee
  - Aims and Scope
  - Location
  - Scientific Programme

EUROCORR 2009

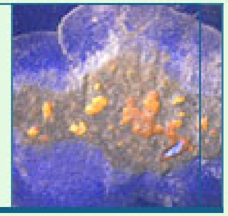
The European Corrosion Congress

6 - 10 September 2009, Nice, France

EUROCORR is the annual European Corrosion Conference of the EuropeanFederation of Corrosion, which will be hosted in 2009 by CEFRACOR, ENSCPand FFC/SCI.

EUROCORR 2009 will be a forum for international exchange of informationabout all aspects of corrosion and corrosion protection, with emphasison **"Corrosion from the Nanoscale to the Plant"** .The scientific and technical program will consist of plenary and keynote lectures,oral presentations in parallel sessions and poster contributions. A large technical exhibition will be held simultaneously with the Conference.

EUROCORR



DECHEMA I SITEMAP I CONTACT I OUR WEBSITES I

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  - Aims and Scope
  - Location
  - **Scientific Programme**
  - *Neu*

Scientific Programme

Planned Sessions:

Session 1:
Corrosion and Scale Inhibition (WP 1)
organised by G. Schmitt

Session 2:
Corrosion by Hot Gases and Combustion Products (WP 3)
organised by M. Schütze, D. Monceau

Session 3:
Corrosion Mechanisms & Methods (WP 6 & 8)
organised by P. Marcus, J.M.C. Mol

Session 4:
Microbial Corrosion (WP 10)
organised by R. Gubner

Session 5:
Coatings (WP 14)
organised by L. Fedrizzi

Session 6:
Cathodic Protection (WP 16)
organised by M. Roche

Session 7:
Environment Sensitive Fracture (WP 5)
organised by J.-M. Olive

Session 10:
Corrosion Education (WP 7)
organised by R.A. Cottis

Session 11:
Nuclear Corrosion (WP 4)
organised by D. Féron

Session 12:
Corrosion in Oil & Gas Production (WP 13)
organised by S. Olsen

Session 13:
Corrosion in Refinery Industry (WP 15)
organised by F. Ropital

Session 14:
Marine Corrosion (WP 9)
organised by U. Kivisäkk

Session 15:
Corrosion of Steel in Concrete (WP 11)
organised by M. Raupach

Session 16:
Automotive Corrosion (WP 17)
organised by F. Hannour, B. Normand

Appendix 4

Corrosion of an ejector in a FCC

Alec Groysman (Oil Refineries Ldt)

Failure of Venturi Scrubber (Ejector) at the CCR Unit

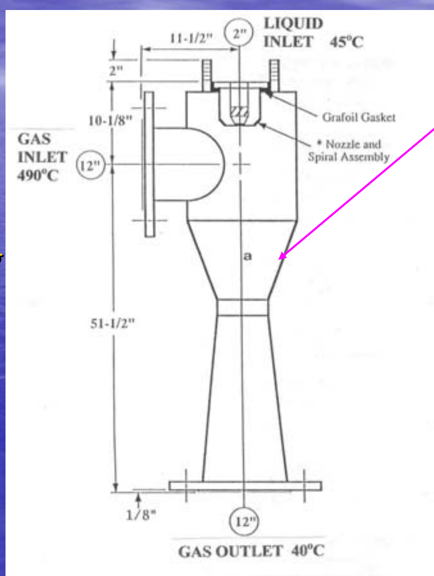
Dr. Alec Groysman

Oil Refineries Ltd.,
Haifa, Israel

EUROCORR 2008

Venturi Scrubber (Ejector)

The scrubber was designed for neutralizing of CO_2, HCl and Cl_2



Upper cone

Material:

Hastelloy B-2

3 mm

70% Ni

28% Mo

1.6% Fe

0.4% Cr

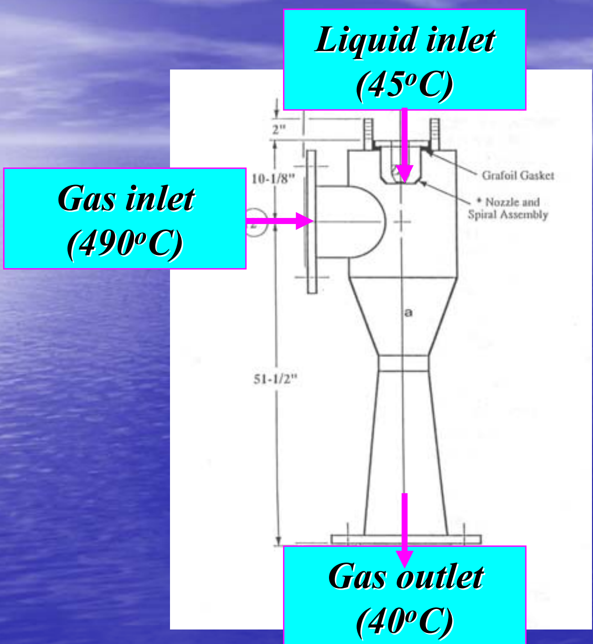
Process gas, composition (mol.%):

Nitrogen	78
Oxygen	10.7
Carbon dioxide	8.6
Water vapors	2.6
Hydrochloric acid	0.2
Chlorine	0.02

Inlet pressure: 3.4 Bar

Scrubbing liquid: diluted caustic solution (pH=8-9)

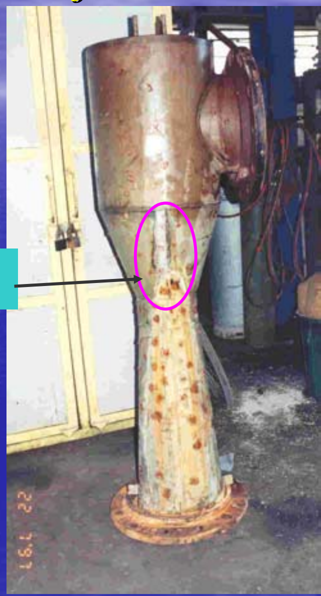
Venturi Scrubber (Ejector)



General view of the Venturi Scrubber failure

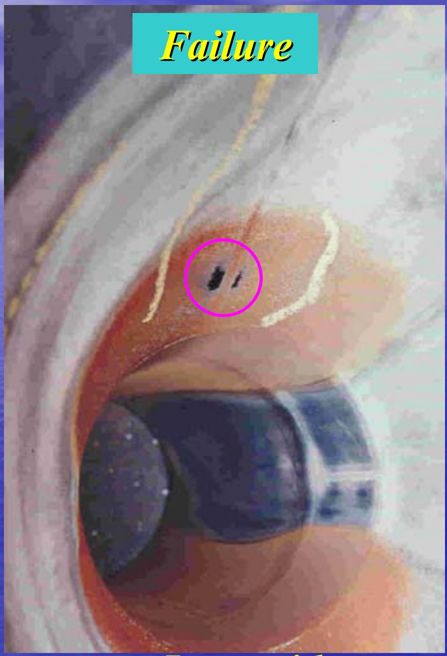
Following 9 months of service

Failure



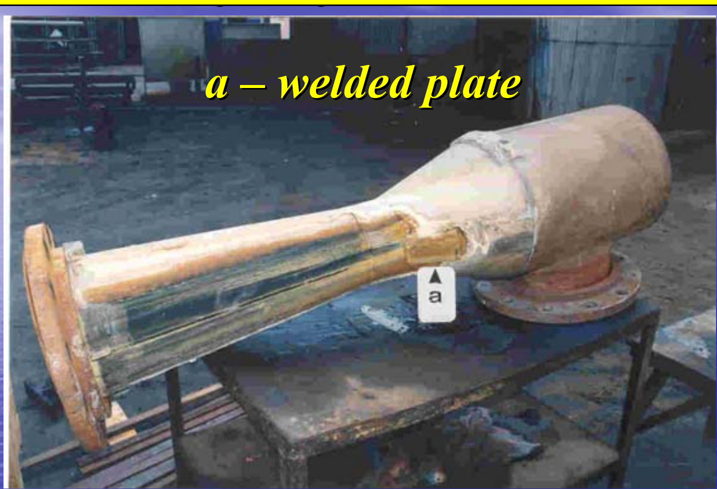
Failure

Outer side



Inner side

General view of the failed Venturi Scrubber



Chemical Analysis of the Deposits:

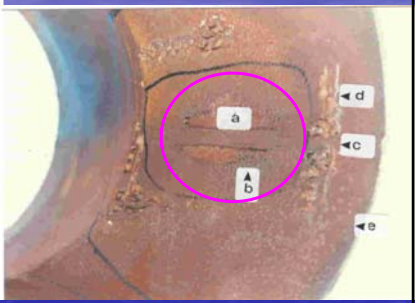
Inside: NaCl, corrosion products of Ni and Mo.

Outside: NaCl, NaOH, corrosion products of Ni, Mo, Fe.

Upper cone

Outer surface

Inner surface



a – welded plate

b – locations of leakage

a – large tears

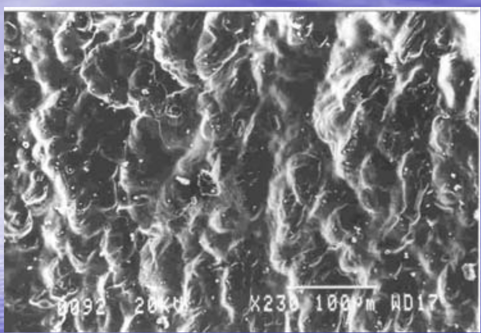
b – small pores

c – weld seam

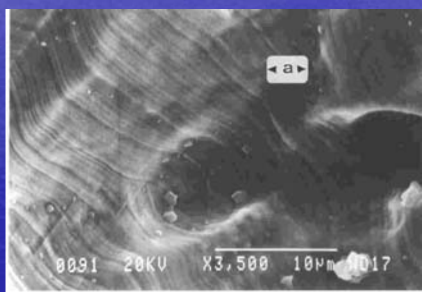
d –seam of the plate

e –pits

Scanning Electron Microscopy examination

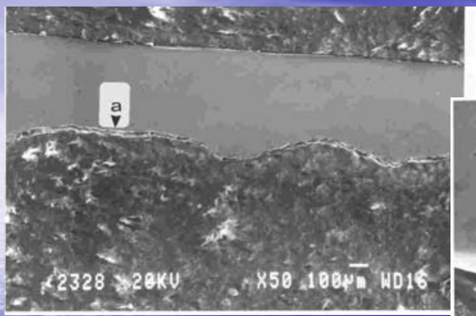


Upper cone, Pitted inner surface, x 230 (SEM)

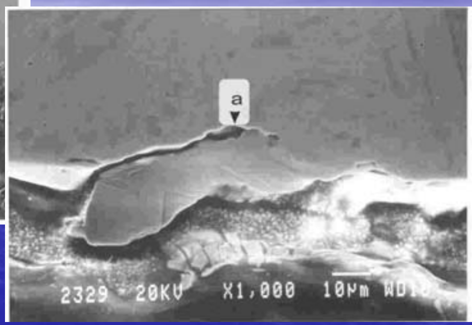


a – Fatigue striations, x 3,500 (SEM)

Macroscopic cross-section through the weld seam



x 50

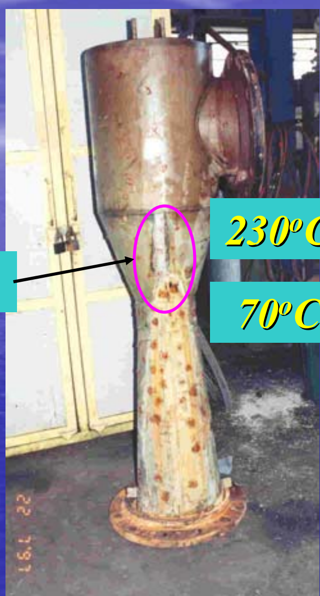


x 1,000

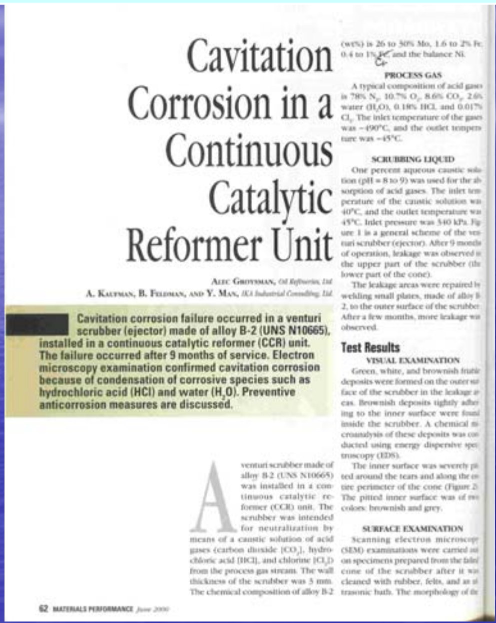
a - crack

Conclusion: cavitation !

Temperature measurement



Material Performance, June, 2000, p. 62



Cavitation Corrosion in a Continuous Catalytic Reformer Unit

ALEC GROYSMAN, Oil Refineries, Ltd
A. KAUFMAN, B. FELDMAN, AND Y. MAN, IKA Industrial Consulting, Ltd

Cavitation corrosion failure occurred in a venturi scrubber (ejector) made of alloy B-2 (UNS N10665), installed in a continuous catalytic reformer (CCR) unit. The failure occurred after 9 months of service. Electron microscopy examination confirmed cavitation corrosion because of condensation of corrosive species such as hydrochloric acid (HCl) and water (H_2O). Preventive anticorrosion measures are discussed.

A venturi scrubber made of alloy B-2 (UNS N10665) was installed in a continuous catalytic reformer (CCR) unit. The scrubber was intended for neutralization by means of a caustic solution of acid gases (carbon dioxide [CO_2], hydrochloric acid [HCl], and chlorine [Cl_2]) from the process gas stream. The wall thickness of the scrubber was 3 mm. The chemical composition of alloy B-2 (wt%) is 26 to 30% Mo, 1.6 to 2% Fe, 0.4 to 1% Fe, and the balance Ni.

PROCESS GAS

A typical composition of acid gases is 78% N_2, 10.7% O_2, 8.6% CO_2, 2.6% water (H_2O), 0.18% HCl, and 0.017% Cl_2. The inlet temperature of the gases was ~490°C, and the outlet temperature was ~45°C.

SCRUBBING LIQUID

One percent aqueous caustic solution (pH = 8 to 9) was used for the absorption of acid gases. The inlet temperature of the caustic solution was 40°C, and the outlet temperature was 45°C. Inlet pressure was 340 kPa. Figure 1 is a general scheme of the venturi scrubber (ejector). After 9 months of operation, leakage was observed in the upper part of the scrubber (the lower part of the cone).

The leakage areas were repaired by welding small plates, made of alloy B-2, to the outer surface of the scrubber. After a few months, more leakage was observed.

Test Results

VISUAL EXAMINATION

Green, white, and brownish friable deposits were formed on the outer surface of the scrubber in the leakage areas. Brownish deposits tightly adhering to the inner surface were found inside the scrubber. A chemical microanalysis of these deposits was conducted using energy dispersive spectroscopy (EDS).

The inner surface was severely pitted around the tears and along the entire perimeter of the cone (Figure 2). The pitted inner surface was of two colors: brownish and grey.

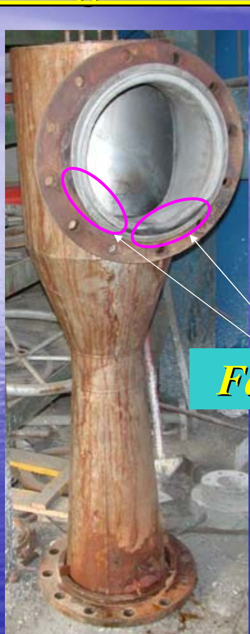
SURFACE EXAMINATION

Scanning electron microscopy (SEM) examinations were carried out on specimens prepared from the failed cone of the scrubber after it was cleaned with rubber, felts, and an ultrasonic bath. The morphology of the

62 MATERIALS PERFORMANCE June 2000

Change to Hastelloy C-276

New problem ?



Failure

Failure

Holes and Pits

Cause: Dew point acid corrosion.

Remedies:

1. *Keep the temperature above the dew point (≥ 130^{o}C).*
2. *Change of geometry.*
3. *Apply inner ceramic flexible protective coatings ?*
4. *Utilize high temperature inhibitors ?*

Appendix 5

Poor service of Monel type alloys as distillation tower internals in refineries

Miroslav Michvocik (MOL, Slovnaft)

Poor service of Monel type alloys as distillation tower internals in refineries.

Miroslav Michvocík, György Isaák

EUROCORR 2008, September 2008

Slovnaft

MEMBER OF THE MOL GROUP

Case study description

LC Finer (Hydrocrack) Unit Fractionator

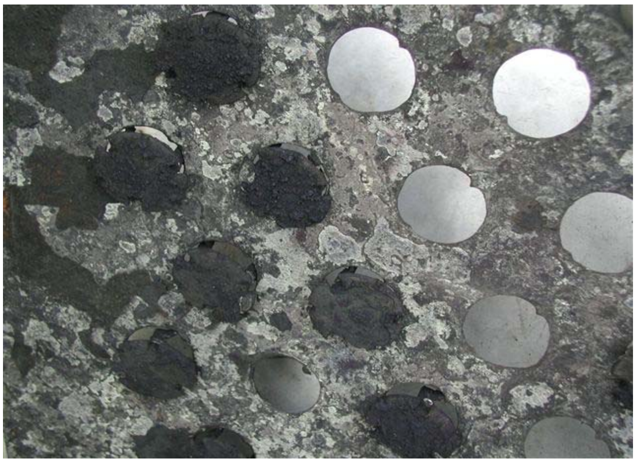
- Turnaround in October 2006 – detailed check up - no corrosion problem was detected
- Turnaround in June 2007 – visual inspection – no corrosion problem
- At the beginning of year 2008 operation of fractionating section of LC Finer unit was very unstable.
- Turnaround in March 2008 - sever deterioration of internals of atmospheric column C201 was observed.
- Monel valve trays were damaged in 1–18 tray section – upper part
- No explosion, fire, injuries have occurred

Slovnaft 2

View of the completely corroded tray section

View of a less heavily damaged tray

Corroded valve tray



Media and Operating condition

- LC Finer unit processes mainly vacuum residue from distillation units and LCO and MCB cuts from FCC unit
- Corrosive agents in the feed:
  - Sulphur: 2,8 wt. %
  - Nitrogen: 0,5 wt. %
  - Chlorides: 18 ppm
  - Cyanides: 0,5 ppm
- Pressure in overhead of C201 tower: 270 kPa
- Temperature:
  - 175 °C in overhead of C201
  - 338 °C in 22nd tray
  - 370 °C in 42nd tray

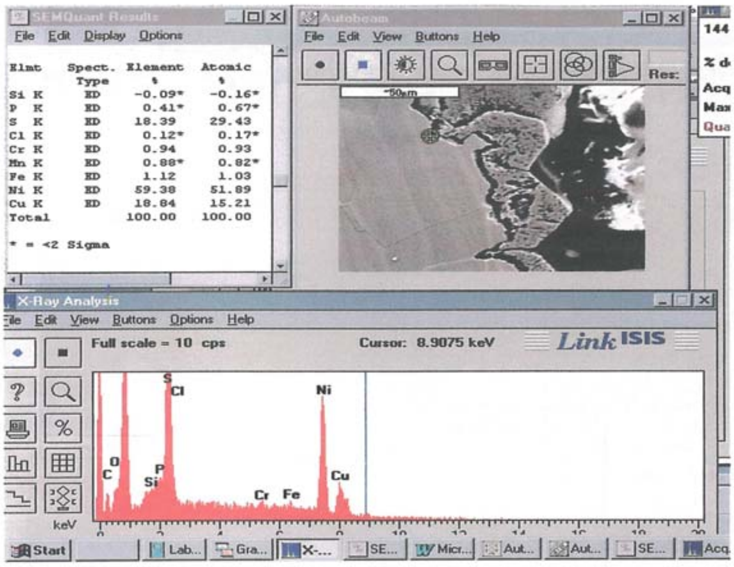
Material composition and corrosion protection treatment

- 1-18 trays – Monel 400
- 19-42 trays – Stainless Steel ASTM A240   410 S
- Tower shell
  - Tower body: Carbon steel
  - Cladding: Monel 400 (1-18 tray)
    410S Stainless steel (19-42 tray)
- Corrosion protection treatment:
  - Until 2005 year – filming inhibitor + neutralizer
  - Since 2005 year – filming inhibitor only

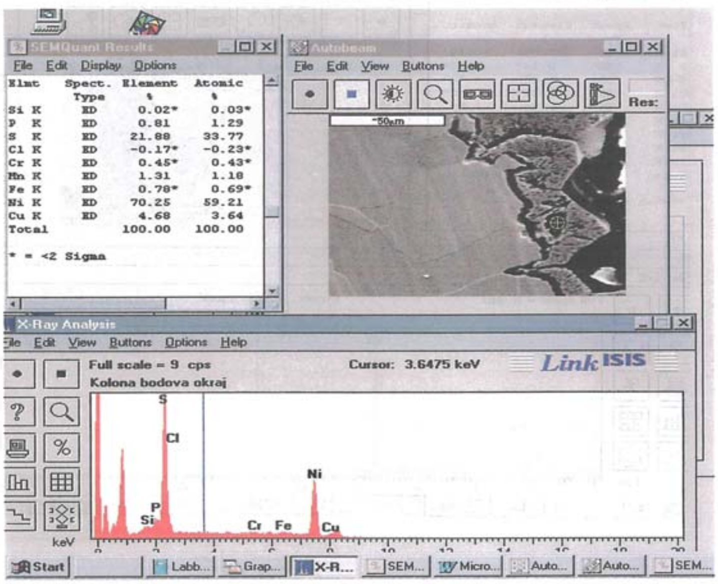
Type and cause of corrosion

- Selective leaching of copper from Ni:Cu matrix of Monel 400 alloy – De-alloying
- Proved by X-Ray microanalyses of metal surface and
- X-Ray diffractometric analysis of corrosion products
- Cause of corrosion:
  - Attack of complex forming species (ammonia and cyanide ions) under heavy ammonium bisulfide/chloride deposits

Type and cause of corrosion



Type and cause of corrosion



Specimen of tray material after removal of deposits

Remedy

- Accomplished: Temporary replacement damaged trays to new ones made of 410S Stainless steel
- Recommended:
  - Using corrosion coupons of several materials for selection of proper material
  - Application of neutralizer ???

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Appendix 6

CO_2 corrosion measurement by electrochemical methods

Alessandro Cafissi (University of Milan)

CO_2 Corrosion Measurements by Electrochemical methods

Alessandro Cafissi, S.P.Trasatti, S.Sgorlon*

Dept of Physical Chemistry and Electrochemistry
via C. Golgi 19, 20133 Milan
University of Milan, Italy

*VeneziaTecnologie,
via delle Industrie 39
Porto Marghera (VE)

EUROCORR

Working Party Business Meetings

Why doing corrosion monitoring?

- Predictive maintenance
- Minimize operational and capital expenses
- Reduce amount of inhibitors required
- Safety requirements
- Diagnostic information about the health of your assets

Electrochemical monitoring methods

For
General corrosion:
- **ER** **E**lectrical **R**esistance
- **LPR** **L**inear **P**olarization **R**esistance
- **HDA** **H**armonic **D**istortion **A**nalysis

Localized Corrosion:
- **ECN** **E**lectro**c**hemical **N**oise

Corrosion Monitoring: Linear Polarization Resistance (LPR)

Detects electrochemical corrosion

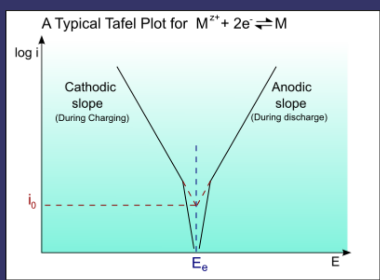
Established and used for more than 30 years

Fast results (within minutes)

Longer electrode duration

Tafel slopes (b_a, b_c) need to be provided

Results pretty accurate



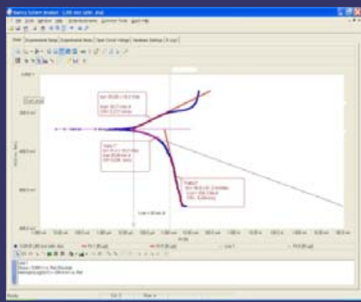
PRINCIPLE OF THE MEASUREMENT

When a metal/alloy electrode is immersed in an electrolytically conducting liquid, it will corrode by an electrochemical mechanism. This process involves two simultaneous complementary reactions.

$$\Delta E/\Delta I = \frac{ba\ bc}{2.3\ I_{CORR}\ (ba + bc)}$$

$$I_{CORR} = \Delta I/\Delta E\ x\ constant$$

At anodic sites, metal will pass from the solid surface into the solution, thus leaving a surplus of electrons at the metal surface.



Small, externally-imposed, potential shifts (ΔE) will produce measurable current flow (ΔI) at the corroding electrode. The behavior of the externally imposed current is governed, as is that of ICORR, by the degree of difficulty with which the anodic and cathodic corrosion processes take place.

The greater the difficulty, the smaller the value of ICORR, and the smaller the value of ΔI for a given potential shift.

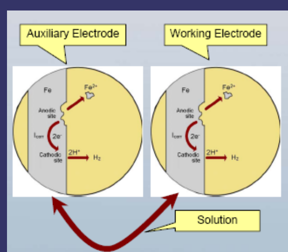
The numbers ba and bc are empirical rate constants, the Tafel constants, so the relationship can be more simply expressed as:

The value ΔE/ ΔI is known as the Polarization Resistance.

Corrosion Monitoring: Electro Chemical Noise (ECN)

Theory

Electrochemical Noise are potential and current fluctuations that occur naturally between nominally identical electrodes during corrosion processes



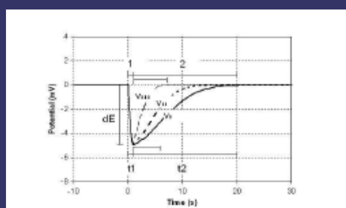
The technique is non-intrusive in that no external voltage or current is applied to the corrosion cell and as such the data obtained is claimed to more accurately represent the corrosion kinetics at the time of measurement.

The system requires three electrodes, a reference and two working electrodes.

In aqueous systems a standard reference electrode is used, however at high temperatures and pressure a pseudo reference electrode of more noble material as the working electrodes is employed.

Advantages

Primarily used to measure localized corrosion and pitting attacks



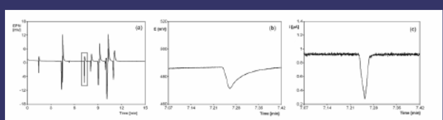
Results are based on continuous sampling of probe current and/or voltage and a sub sequential statistical evaluation

Fasts results (within minutes)

Longer electrode life duration

No Tafel slopes (b_a, b_c) needed

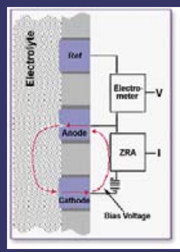
Results pretty accurate

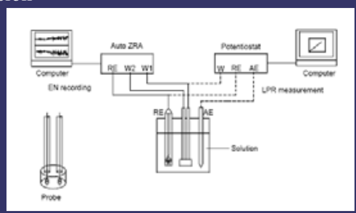


PRINCIPLE OF THE MEASUREMENT

- **Localized Corrosion detection (ECN):**
- **• measure of the coupling current between two electrodes, and do a statistical evaluation on these current samples**
- **• calculate of the standard deviation and the rms of the measured current samples**
- **• The result is a dimensionless index:**
- **Std Dev / RMS => 0 < PF < 1** $\mathrm{PF} = \frac{\sigma_{i_{corr}}}{i_{corr}}$

PF = 1 → localized corrosion
PF = 0 → general corrosion





Experimental arrangement for EN and LPR measurements.

3 litre Hastelloy Autoclave testing

Pressure test: 150 - 170 bar
Temperature test: 50°- 60° C
Gas mixture: CO_2 - $CO_2 + H_2S$ (100ppm)
Brine Solution: 110 g/l (salt mixture)

Weight loss coupons

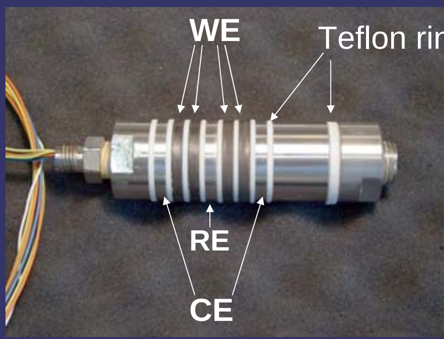
High Pressure Probe

Benefits

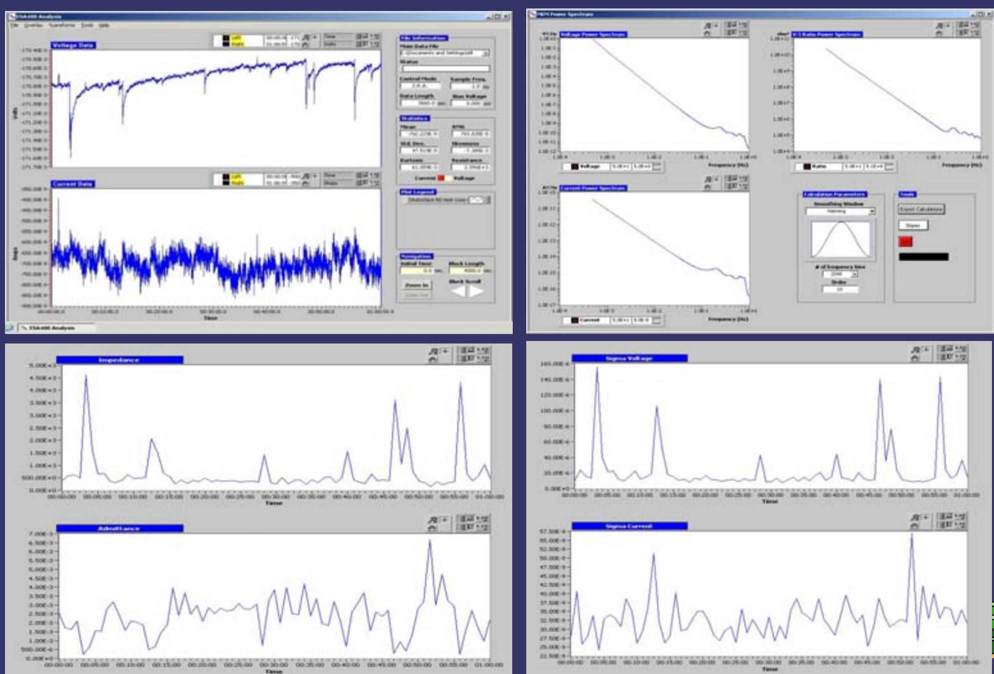
Safe and Easy to Install, Operate and Maintain
Permits the Insertion without disturbing the system
Can Be Used in High and Low Pressure Systems
Can Be Used in Sour Systems
Easily Modified for Different Applications

Applications

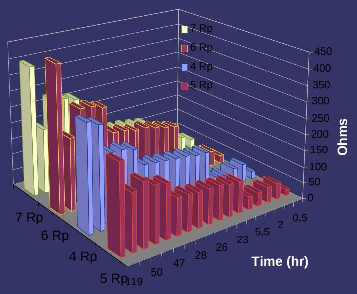
Gas Gathering and Transmission Systems
Pipelines
Oil and Gas Production Systems
Refinery Operations
Petrochemical Plants
Municipal Systems

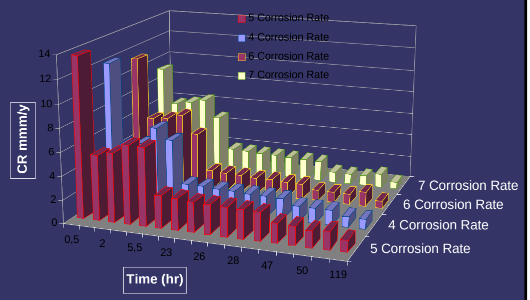


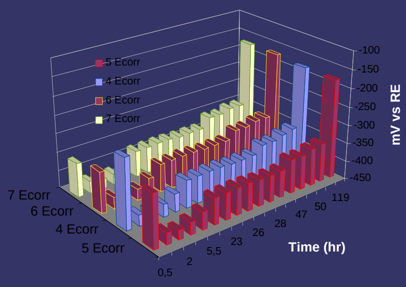
Electrochemical Noise results

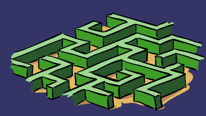


LPR Results


7 Rp
6 Rp
4 Rp
5 Rp
450
400
350
300
250
200
150
100
50
0
Ohms
119
50
47
28
26
23
5,5
2
0,5
Time (hr)


5 Corrosion Rate
4 Corrosion Rate
6 Corrosion Rate
7 Corrosion Rate
CR mmm/y
14
12
10
8
6
4
2
0
0,5
2
5,5
23
26
28
47
50
119
Time (hr)


5 Ecorr
4 Ecorr
6 Ecorr
7 Ecorr
-100
-150
-200
-250
-300
-350
-400
-450
mV vs RE
0,5
2
5,5
23
26
28
47
50
119
Time (hr)



Appendix 7

Discussion on "Optimal choice of materials, for see water cooled refinery heat exchanger tubes"

György Isaak   (MOL)

Corrosion of sea water cooled heat exchangers

	Number of sea water exchangers	**Number of Al-Brass tube exchangers**	**Number of Cu-Ni tube exchangers**	**Number of Ti tube exchangers**
Total	94	50	29	15
Failed	35	35	0	0
Replaced		11(Cu-Ni)*		

*Note: Remaining 39 exchangers will be replaced to Cu-Ni ones within one year

Tube cracking at expanding end area by over-stress

Tube cracking at middle area by ammonia SCC

Debris from thre sea water

Debris from thre sea water

Tube end erosion by high velocity sea water

Tube end erosion by high velocity sea water

Appendix 8

Stress relaxation cracking of stainless steels

Advancement of the Cefracor survey

CEFRACOR
French corrosion Society

Corrosion in Oil and Gas Industries
High temperature working group

Members :

CETIM , EPA, Haynes Intl , IFP , Industeel , Ugitech, Technip, Total

Oil and gas High temperature group :

specific commission in the CEFRACOR

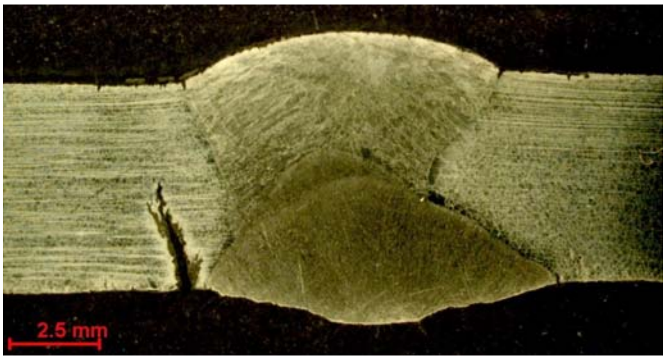
Main goals :

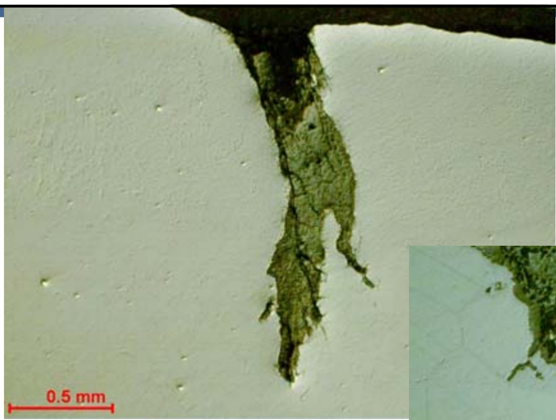
- return of experience exchanges
- « forum « between users (O&g company) , research center , producers , fabricatior, engineering .
- Works on specific topics : Stress relaxation cracking

Stress Relaxation Cracking :

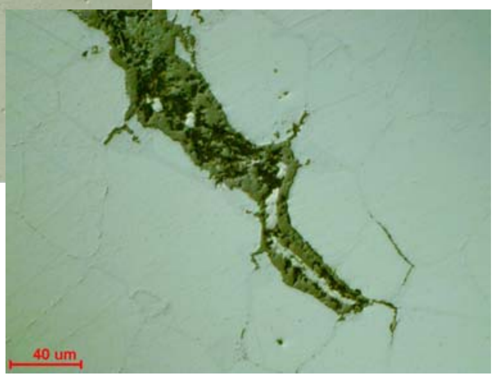
Cracking phenomenon of the austenitic grades working at high temperatures 450 à 800°C and particularly in case of high stress and strain.

Location : primarily in heat affected zone but not only !





Intergranular



nickel filament

Stress Relaxation Cracking (From C.Shargay Fluor) :

- 450-800°C
- Thicker walls (>1") more susceptible for cracking during fabrication; all thicknesses can crack in-service
- Location – primarily HAZ
- Intergranular; Ni filament
- ASME Sect. VIII, UNF-56 (e) recently added a requirement to PWHT Alloy 800,H,HT at 885 min. for services >530°C
- No similar requirement in B31.3 or CODAP or other codes yet

Stress Relaxation Cracking :

- **Many works and publications** : see particularly H.Van Wortel , ENSMP publications

- **Sometime mentionned by steels and alloys producer**

- **Often experimented by users : 347 , 321 , 304 , 800H, 617, 803 ....**

Working group actions program (1) :

- **Return of experience in France**
  - Grades
  - fabrications conditions
  - Service conditions

- **Propose a best pratice guide in order to limit the risk :**
  - Grades sensitivity versus temperatur e;
  - Design recommandation
  - Fabrication recommended method (geometry , welding practices , filler material)

Working group actions program (2) :

- **Caracterisation test proposal** (based on the TNO methodology

- Discussion with producers
  - to include the temperature range sensitvity in the grades brochures and documentations

- Discussion with Codes authorities
  - to add the recommandations

- **Open for international cooperation**