Appendix 1

List of participants and excused persons

Participants NACE-EFC WP15 meeting 26th April 2007 in Paris La Défense

NAME		COMPANY	COUNTRY
Authier	Sylvain	Exxon Mobil	FRANCE
Beucler	Valerie	Nalco	FRANCE
Boucher	Christian	Institut de Soudure	FRANCE
Claesen	Chris J	Nalco	BELGIUM
Comerman	Claude	Heurtey Petrochem SA	FRANCE
Cornali	Stephane	Heurtey Petrochem SA	FRANCE
de Bruyn	Hennie	Borealis AS	NORWAY
Dupoiron	François	Total Petrochemical	FRANCE
Floquet	Jean Pierre	Honeywell	BELGIUM
Jean Kittel	Jean	IFP	FRANCE
Koschel	Diana	UGITECH	FRANCE
Lanfant	Mathieu	SOFRAP	FRANCE
Lorenz	Maarten	Shell Global Solutions International B.V.	NETHERLANDS
Mehdawe	Ayman	Honeywell ME	UAE
MeLampy	Michael	Hi-Temp Coatings Technology	USA
Munier	Michel	IFP Technology Group - AXENS	FRANCE
Peultier	Jerome	Industeel	FRANCE
Richez	Martin	Total	FRANCE
Ropital	François	IFP	FRANCE
Surbled	Antoine	Couronnaise de Raffinage	FRANCE
Themiot	Jean Luc	INEOS	FRANCE
Trasatti	Stefano	University of Milan	ITALY
Van Wortel	J.	TNO	NETHERLANDS

Excuses received for NACE-EFC WP15 meeting 26th April 2007 in Paris La Défense

Name	Company	Country
Joanna Hucinska	Gdansk Technical University	POLAND
Anni Visgaard Nielsen	Statoil Refinery, Kalundborg,	DENMARK
Istvan Lukovits	Chemical Research Center	HUNGARY
Curt Christensen	Force Institutes	DENMARK
Stefan Winnik	Exxon Mobil Chemical	UK
Roberto Riva	Eni R&M	ITALY
Martin Hofmeister	Bayernoil Raffineriegesellschaft mbH	GERMANY
György Isaak	Env. & Corr. Manager	HUNGARY
Yahya T. Al-Janabi	Saudi Aramco	SAUDI ARABIA
Michael Davies	CARIAD Consultants	GREECE
Gerit Siegmund	ExxonMobil Germany GfKorr	GERMANY
Patrice Houlle	Haynes International	FRANCE
Günter Schmitt	Lab for Corrosion Protection	GERMANY
Cesar Vitorio Franco	UFSC	BRASIL
Maarten Langbroek	ABB Lummus Global	NETHERLANDS
Iris Rommerskirchen	Butting Edelstahlwerke GmbH&Co KG	GERMANY
Hildegunn Urke	Statoil ASA	NORWAY
Tiina Hakonen	FORTUM Oil & Gas Oy	FINLAND
Carmelo Aiello	Eni	ITALY
Joerg Maffert	Dillinger Huttenwerke	GERMANY
Frank Dean	Ion Science Ltd	UK
Lars Volden	Statoil ASA	NORWAY
Andrew Kettle	Exxon Mobil	UK
Jack Tulp	Fluor BV	NETHERLANDS

Appendix 2

EFC WP15 Activities and

Eurocorr 2007 Refinery sessions program

Presentation of the activities of WP15

European Federation of Corrosion (EFC)

- Federation of 32 National Associations
- 19 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
- for more information http://www.efcweb.org

EFC Working Parties

- 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
- WP 16: Cathodic protection
- WP 17: Automotive
- WP 18: Tribocorrosion
- WP 19: Corrosion of polymer materials
- Task Force 2: Corrosion and Protection of steel structures

WP 15 was created in sept. 96 with J. Harston as first chairman

EFC WP15 Spring Meeting 26 April 2007 Paris La Défense

EFC Working Party 15 « Corrosion in Refinery » Activities

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

http://www.efcweb.org/WP_on_Corrosion_in_the_Refinery_Industry.html

Publications

- 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 on Corrosion Under insulation
- Future publications
  - Typical refinery failure cases atlas ?
    Send your contribution to Francois Ropital
  - other suggestions ?

EFC WP15 Spring Meeting 26 April 2007 Paris La Défense

EFC Working Party 15 plan work 2006-2008

· Task force an Corrosion Under Insulation

· Failure cases atlas : creation of a task force

· Cooling water treatment:
Creation of a task group of WP15 members to cooperate with EFC WP1 and NACE on publication of update or new documents

. Session with NACE at Eurocorr 2008 in Edinburgh "Detailed study case study on RBI" contact with De Yuan Fan STG34

. Session with WP1 (inhibitors) at Eurocorr 2008 in Edinburgh "Naphthenic acid corrosion" (proposal of WP1 group)

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
a NACE proposal is on cooling water systems in relation with WP1
joint Eurocorr sessions with NACE

EFC WP15 Spring Meeting 26 April 2007 Paris La Défense

Draft Eurocorr 2007 program

Program of lectures of session N "Corrosion in refinery"
Wednesay 12 September 2007

9h50-10h15	N.S. Meck,	The effects of aging on the corrosion performance of a new age-hardenable Ni-Cr-Mo alloy
10h-15-10h40	J. Huciñska,	Metal dusting in CCR platforming unit
11h10-11h35	A. Groysman,	Naphthenic acid corrosion study
11h35-12h00	K. Briegel	Utilizing the chemical plant control system for real-time, online corrosion monitoring & process optimization
12h00-12h25	J. Mason	Automatic classification of defects in a corrosion environment
14h00-14h25	S. Srinivasan	Prediction system for sour water corrosion quantification and management in refineries
14h25-14h50	L. Candido	Potentiometric evaluation of intermediary sulfur compounds used as corrosion inhibitors in waste waters in refineries
14h50-15h15	H. Jambo	Electrochemical method for conversion of sulphur compounds in residual water of refineries
15h15-15h40	M. Askari	EIS and polarization studies on corrosion behavior of carbon steel in alkanolamine and sour water mixtures
16h10-16h35	P. Eaton	Impact of Fouling on Refinery Overhead Corrosion

Joint session A+N

16h35-17h00	C. Claesen,	Chemical inhibition of high temperature sulphidic corrosion in lab evaluations and petroleum refinery applications
17h00-17h25	E. Bobillon	Correlation of electrochemical corrosion measurement and short time weight loss tests for efficiency testing of film forming corrosion inhibitors

Draft Eurocorr 2007 program

Workshop High Temperature Corrosion in the chemical and petrochemica industries
Monday 10 September 2007

11h00-11h25	John	
11h25-11h50	Ostergard	Metal dusting, sulphidation and creep: three degradation challenges in the process industry
11h50-12h15	Kirchheiner	Analysis and Identification of Catalytical Surface Reactions on Al-bearing Ni-base Alloys
14h00-14h25	Cabet	Carburization of nickel base alloys under diluted impure helium containing methane
14h25-14h50	Al-Rabie	
14h50-15h15	Trindale	Characterizing the Carburization of Ethylene Pyrolysis Tubes by Means of Non-Destructive Magnetic Measurements and Thermodynamics Calculations
15h15-15h40	Avram	Corrosive action of natural gases upon the check rot and ducts' equipment
16h10-16h35	Pajonk	Chemical inhibition of high temperature sulphidic corrosion in lab evaluations and petroleum refinery applications
16h55-17h00	Jepson	Analysis and Identification of Catalytical Surface Reactions on Al-bearing Ni-base Alloys

Workshop High Temperature Corrosion in the chemical and petrochemica industries
Tuesday 11 September 2007

9h50-10h15	Kleingries	
10h-15-10h40	Huczkowski	Effect of gas composition on the oxidation behaviour of metallic materials in high temperature heat exchangers
11h10-11h35	Ani	The Effect of Water Vapor on High Temperature Oxidation of Fe-Cr Alloys at 1073 K
11h35-12h00	Durham	Development of a High Temperature NiCrAl Alloy Cyclic Oxidation Behaviour of Alloy Variants with Different Yttrium Contents
12h00-12h25	Overbeck	Development of High Performance Cast Alloys Alloy 31 and Alloy 59 for the Chemical Process Industry
14h00-14h25	Maffert	Development of cladded plates for pressure vessels
14h25-14h50	Ravi	
14h50-15h15	Latreche	High temperature corrosion behaviour of NiAlMo APS-coatings in chlorine-based atmospheres
15h15-15h40	Zurek	New methdo of receiving porous iron electrodes on ickel base
16h10-16h35	Boukis	Corrosion behavior of Ni-base alloy 625 in supercritical water containing alcohols and potassium hydrogen carbonate.
16h35-17h00	Mabbuttt	

Appendix 3

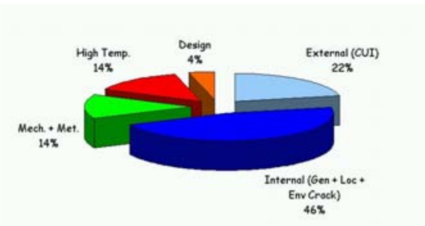
CUI, PCO T/A 2007 feedback, Inspection prioritization program for the future

A. Surbled

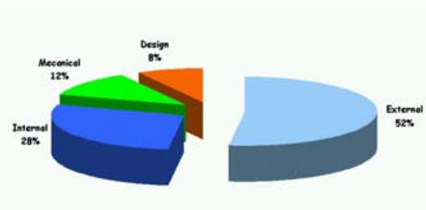
(Couronnaise de Raffinage)

CORROSION UNDER INSULATION ASSESSMENT

SITE SITUATION vs. CUI



- Likelihood of CUI occurrences
  - About 22% of potential degradation mechanisms identified in CCD.



- Actual occurrences for external damages (mainly CUI)
  - Near 52 % of leaks (28 % of leaks saved)

2

CUI Examples

- Steam Separator (VBU), larges crevices
  - Bottom only insulated
  - Location: Shell, near manhole
  - Corrosion Deepness: 3 mm
  - Skin temperature: ~ 60°C
  - Painted (maintenance)
  - Service Life: 14 years
  - Root cause: Cladding Condition, Rain hat damaged

CUI Examples

- Naphtha Splitter, 2004
  - Inspection follow RBI study (2003)
  - Corrosion above stiffener
  - Corrosion deepness: 4-5 mm
  - Skin Temperature: ~70°C
  - No Paint
  - Service life: 30 years
  - Root cause: Water ingress, stiffeners, clad condition

CUI Examples

- Cor. Under Ignifuge Deisopentaniser
  - Under insulating bricks
  - Oxide thickness: 38 mm
  - Loss of thickness: > 6 mm, small hole in skirt
  - Skin Temperature: Ambient
  - No Paint
  - Service life: 33 years
  - Root Cause: Rain Hat Missing

Shell

CUI PROGRAM - BACKGROUND

- 2002: RBI Studies existing, does meet to actual SHELL RBI methodology
  - Inspection Results meet to CUI Assessment
- 2004: S-RBI Methodology experienced in CRR Refinery
  - Inspection Results during 2004 T/A meet to CUI Assessment
- 2007 + : Review & Revision of all existing CUI RBI Studies + Exhaustive screening of units for CUI

Shell

S-RBI CUI PROGRAM

- PROGRAM: 2007 – 2012
  - 2007 – 2008: RBI Studies, Ranking
  - 2009 +: On Site inspection S-RBI Based
- SOURCES OF DATA
  - LIKELIHOOD
    - Operating Temperature: Process Data through PI
    - Coating Status: Inspection Records
    - Cladding & Insulating Material Condition: Inspection Record/On Stream Inspection
    - Insulation Type: Maintenance Records
    - Heat Tracing: Records/On Stream Inspection

S-RBI CUI PROGRAM

- CONSEQUENCE
  - Existing RBI Studies/Consequence Hypothesis
- EQUIPMENT SUB-TAG For CUI (technical characteristics)
  - Protrusion
    - Nozzle / Diameter
    - Reinforcing Ring
    - Collar
    - Skin fire proofing rain hat
    - Brackets / Lifting Lugs
    - Pipe hangers / Support / Shoes
  - Other
    - Terminations
    - Inspection holes
    - Damaged part of jacket/Fire proofing…

CUI ASSESSMENT – MAIN STEPS

- Prioritization of the units
  - Type of HC \ Temperature
- Complete list of Equipment including Piping
  - Analysis, Is insulation needed?
- Performing External Visual Inspection
  - \+ Inspection background
- Probability of Occurrence
- Potential Consequences
  - Existing RBI Studies
- Inspection Strategy

INSPECTION STRATEGY

Probability	D	IS-4	IS-3	IS-2	IS-1	IS-1
	C	IS-4	IS-4	IS-3	IS-2	IS-1
	B	IS-4	IS-4	IS-4	IS-3	IS-2
	A	IS-4	IS-4	IS-4	IS-4	IS-3
Priority		1	2	3	4	5
CoF	Business Loss	Slight	Minor	Moderate	Major	Massive
	Harm to People	Slight	Minor	Moderate	Major	Massive
	Environ.	Slight	Minor	Moderate	Major	Massive

Consequence of Failure

MITIGATION PLANNING

- 2008 +
- Detailed Schedule to Mitigate Risk identified / ALARP, Cost estimate
- Base of Mitigation
  - IS-1: Delag 100% of susceptible areas
  - IS-2 & IS-3: Delag 50% of susceptible areas
  - IS-4: No further inspection, reassessment

Appendix 4

Thermal High Temp Technology on new insulative and personal protective coating

M. MeLampy

(High-Temps Coatings Technology Company)

EUROPÄISCHE FÖDERATION KORROSION
EUROPEAN FEDERATION OF CORROSION
FEDERATION EUROPEENNE DE LA CORROSION

Hi-Temp PPC-703

PERSONNEL PROTECTIVE COATING INSULATIVE SYSTEM

Presentation to:

European Federation of Corrosion
Working Party 15
Corrosion in the Refinery Industry

By
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HI-TEMP COATINGS TECHNOLOGY

WHAT IS A PERSONNEL PROTECTIVE COATING?

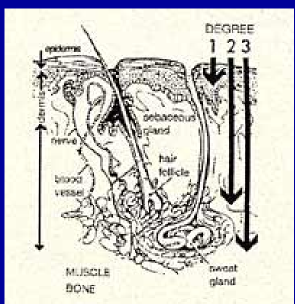
"Five second rule"

ASTM-C1055

"Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries"

- 1.4 "..... contact time for industrial situations has been established at 5 seconds".
- 5.3 "…..exposure to which as average individual might be subjected".
- 5.7 "….metallic surfaces above 158°F, damage occurs almost instantaneously upon contact".

FIG.1 Approximately 58°- 60°C is the temperature at which an average person can have skin contact time for 5 seconds without cell death.



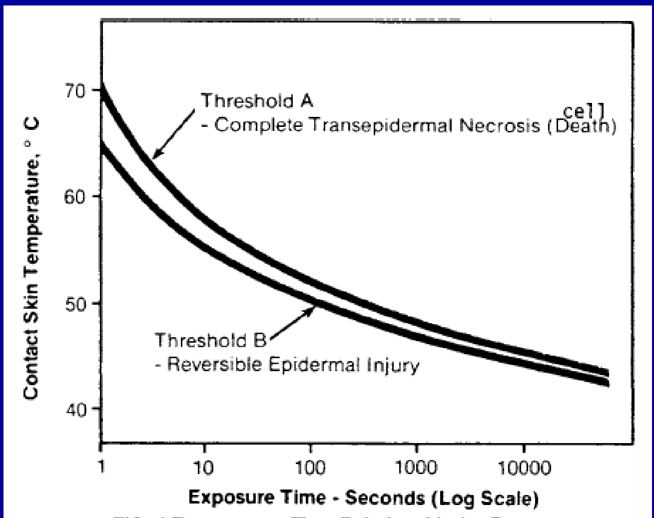


FIG. 1 Temperature-Time Relationship for Burns

Heat Transfer

- Conduction
  - Transfer of heat through a solid
- Convection
  - Transfer of heat through a liquid or gas
- Radiation
  - Transfer of heat through electromagnetic radiation

Terminology

- Reflection
  - Energy is reflected when it contacts a surface
- Emissivity
  - The amount of heat radiated in comparison to a black body (constant)
    - High emissivity - radiates more heat
- Absorbtivity
  - The portion of the heat radiation absorbed by the surface
- Transmittance
  - The amount of heat transferred to a material
    - A low transmittance is desired for a thermal insulator

Hi-Temp PPC-703
PERSONNEL PROTECTION CHART

TEMPERATURE RANGE	COATING THICKNESS	# OF COATS
49° - 115°C	625 microns	1
116° -137°C	1250 microns	2
138° - 160°C	2000 microns	3
161° - 177°C	3000 microns	4

Basic Data

Water based
Single Component
Can be top-coated
Volume solids: 77%
VOC is less than 121g./l.
Weight per gallon: 2.4 kg
Can be applied directly to hot steel
Requires Primer (HTC 1027)

SIMPLICITY

4 systems; 625, 1250, 2000, & 3000 microns

Only 2 Questions!

Temperature of substrate?

Ambient or hot applied?

Per Coat - DFT

- Based on temperature of application
- Based on personnel protective level required (overall thickness)

Hot Applied

Up to 177ºC

DFT range 500-750 microns per coat

Hi-Temp PPC-703 PERSONNEL PROTECTION CHART

TEMPERATURE RANGE	COATING THICKNESS	# OF COATS
49° - 115°C	625 microns	1
116° -137°C	1250 microns	2
138° - 160°C	2000 microns	3
161° - 177°C	3000 microns	4

The Primer

HTC 1027

One component system
One coat 100-150 microns primer application

Other Properties of 1027

Can be applied
- Direct to metal
- To hot surfaces up to 260ºC
  - Three coats 375-450 microns
- Ambient application
  - 2 coats 250-300 microns

- Used as Primer
- Dry Temperature Resistance
  - Continuous 649°C
  - Peak 753°C
- Dry/Wet/Dry Cycling to 538°C
- Used to provide protection of insulated austenitic stainless steel against chloride induced external stress corrosion cracking

Approved for use by:

- Shell
- Exxon Mobile
- Saudi Aramco
- Valero
- BP Amoco
- Chevron
- And many others

Approved CUI Coating

1 Rated in North America for a wide range of CUI Issues

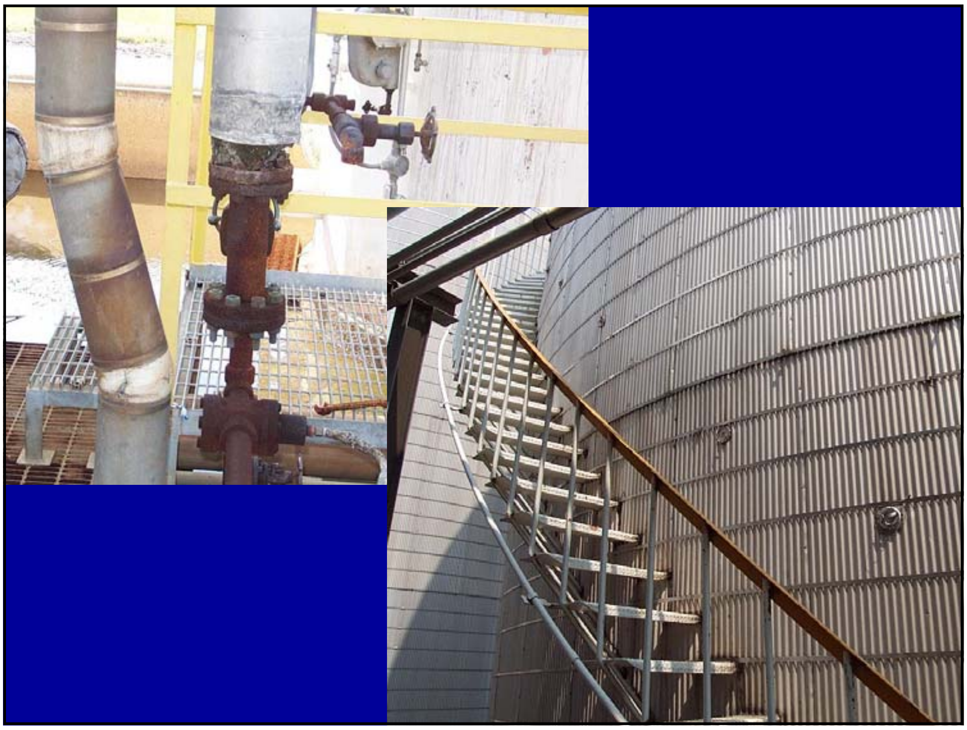
Ranked best during independent testing by Major Multinational

Hi-Temp PPC-703

One component system

Thinning: Not recommended

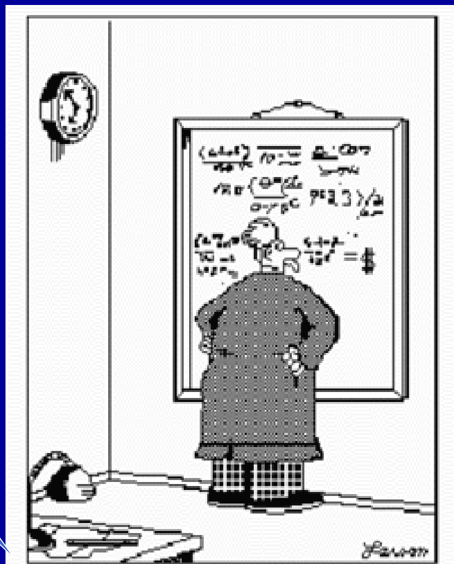
Clean up: Water



Opportunities

- Can be applied efficiently on an operating unit
- Insulative properties may reduce operation costs

Einstein discovers that time is money



Einstein discovers that time is actually money.

Opportunities

Much faster to create a personnel protective surface than -

- insulate and jacket or
- provide mechanical screen protection

Labor savings

New construction savings are big

Opportunities

Can be applied in the shop and then erected.

Traditional Insulation:

Can not see corrosion

Takes up more space and weighs more.

Difficult while unit is hot.

CONCLUSION

HTC PPC has
- insulative properties
- primer technology
- application properties
- dry time
- hardness properties
- cost savings
  - First cost
  - Maintenance costs

PPC 703

- 3/16" Carbon Steel
  - 125-175 microns 1027
  - 2500-3000 microns PPC 307
- 20ºC ambient temperature
- Hot Plate 195ºC
- Substrate 162ºC
- Two typical ice cubes

HTC 1027

- Ice Water
- 400 microns dft coating applied hot
- Test sample temperature

344ºC (650ºF)

Questions ???


USER FRIENDLY by Illiad
Tech support, Greg speaking.
Hello. Do I have to buy stamps to send e-mail?
Copyright (c) 1998 Illiad
No...no, m'am. You do not need to buy stamps to send e-mail.
Okay. Bye.
Another stupid question?
There's no such thing as a stupid question, only stupid people.

Appendix 5

Experiences with relaxation cracking of 304H, 347 and alloy 800H in a ethylene cracker furnace

H. de Bruyn (Borealis Group)

Experiences with cracking of high temperature materials

Hennie de Bruyn

Chief Engineer Material Technology

BOREALIS

SHAPING the FUTURE with PLASTICS

Experiences with cracking of high temperature materials

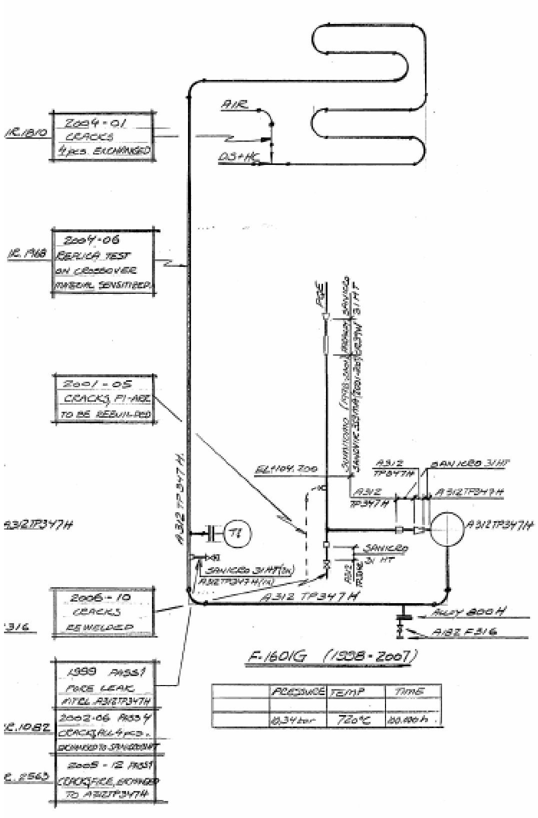
- Steam cracking
  - Stenungsund, Sweden
  - Porvoo, Finland
  - Noretyl, Norway (JV with HydroPolymers)
  - Borouge, Abu Dhabi (JV with ADNOC)
- Propane dehydrogenation
  - Kallo, Belgium
- Stenungsund
  - Several furnace designs
  - 1 Millisecond furnace
  - Cracking of 304H & 800HT

SHAPING *the* FUTURE *with* PLASTICS

Review of cracking problems (Millisecond furnace)

- Background
  - Furnace commissioned in 1990
  - Furnace revamp in 1998

- Problems
  - Cracking of different materials in jump-over system
    - 304H
    - 800HT (Sanicro 31HT)
  - Temperature
    - 720ºC – design
    - 600 - 650 ºC - operating



SHAPING *the* FUTURE *with* PLASTICS

Experiences with cracking of 304H

De-coke air line

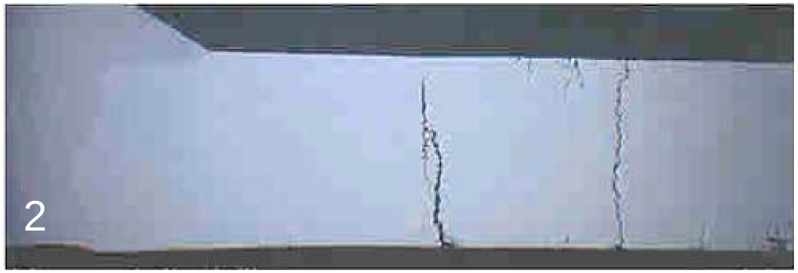
- January 2004
  - Cracking detected in 3 inch de-coke air lines
  - Material: austenitic stainless steel type 304H
  - Cracking transverse to tube axis
  - Close to welds, but not in HAZ

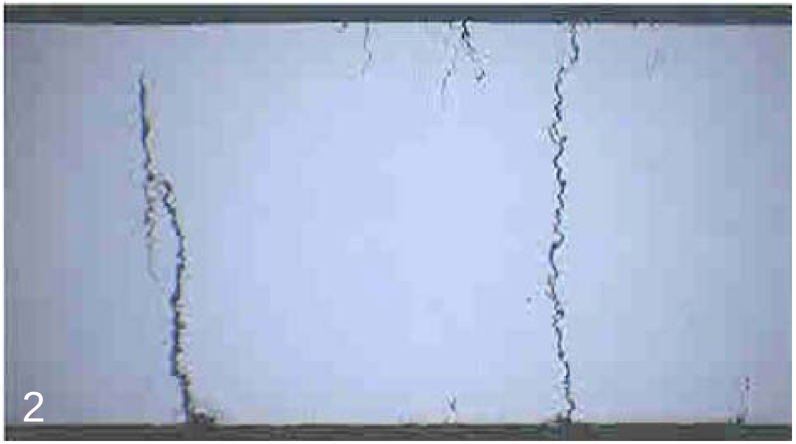
Experiences with cracking of 304H

De-coke air line

<u>Macro</u>

- Cracking initiated from the inside surface
- Some minor defects/cracks initiated from the outside



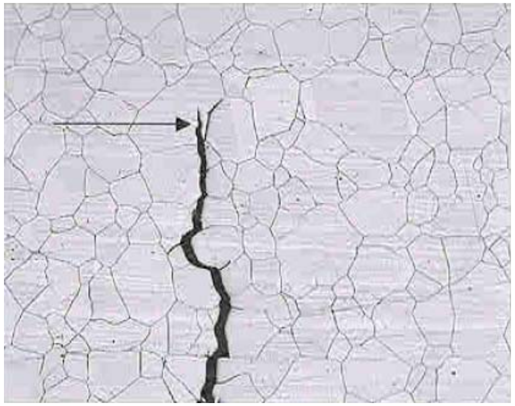


Experiences with cracking of 304H

De-coke air line

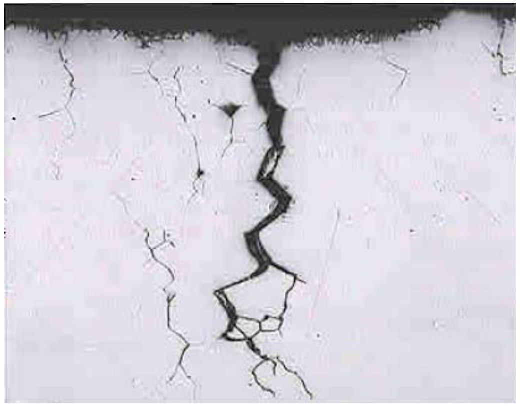
Inside

- Mixed mode
- Trans-crystalline & inter-crystalline
- Blunt tip



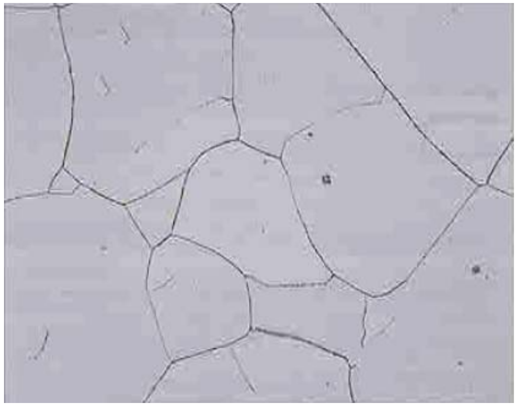
Outside

- Inter-crystalline
- Branching



Experiences with cracking of 304H

De-coke air line



- Further observations
  - High level of sensitization (carbide precipitation at grain boundaries)
- Failure mechanisms considered
  - Thermal fatigue
  - Stress relaxation cracking
  - SCC during shutdown (polythionic acid)
- Conclusion
  - Most probably thermal fatigue due to cyclic de-coking operations
  - No evidence of Ni-filament (relaxation cracking), or evidence of voids ahead of the crack tip

Experiences with cracking of 800HT

PI-connection

- 1999
  - Leak detected
  - Assumed to be weld defect & repaired
- 2002
  - Leak detected on pass 4
  - Replacement of weldolet & ¾" pipe on all 4 passes
  - 347H not available; substituted with Sanicro 31HT (alloy 800HT)
- 2005
  - Leak & fire on pass 1
  - Replace in 347H; other 3 OK

Experiences with cracking of 347H & 800HT

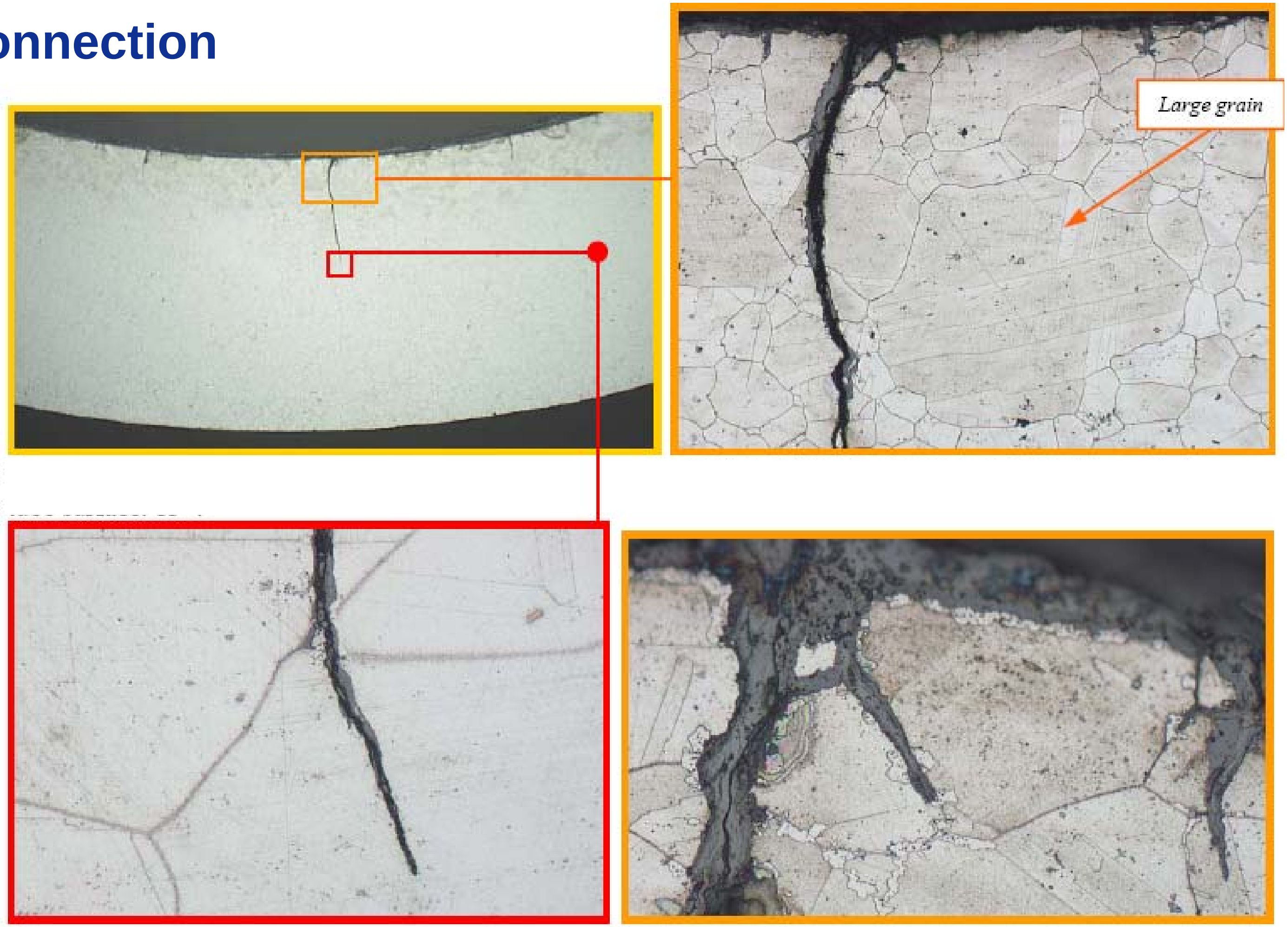
PI-connection

Visual

- Cracking in transverse & longitudinal directions
- Close to weld

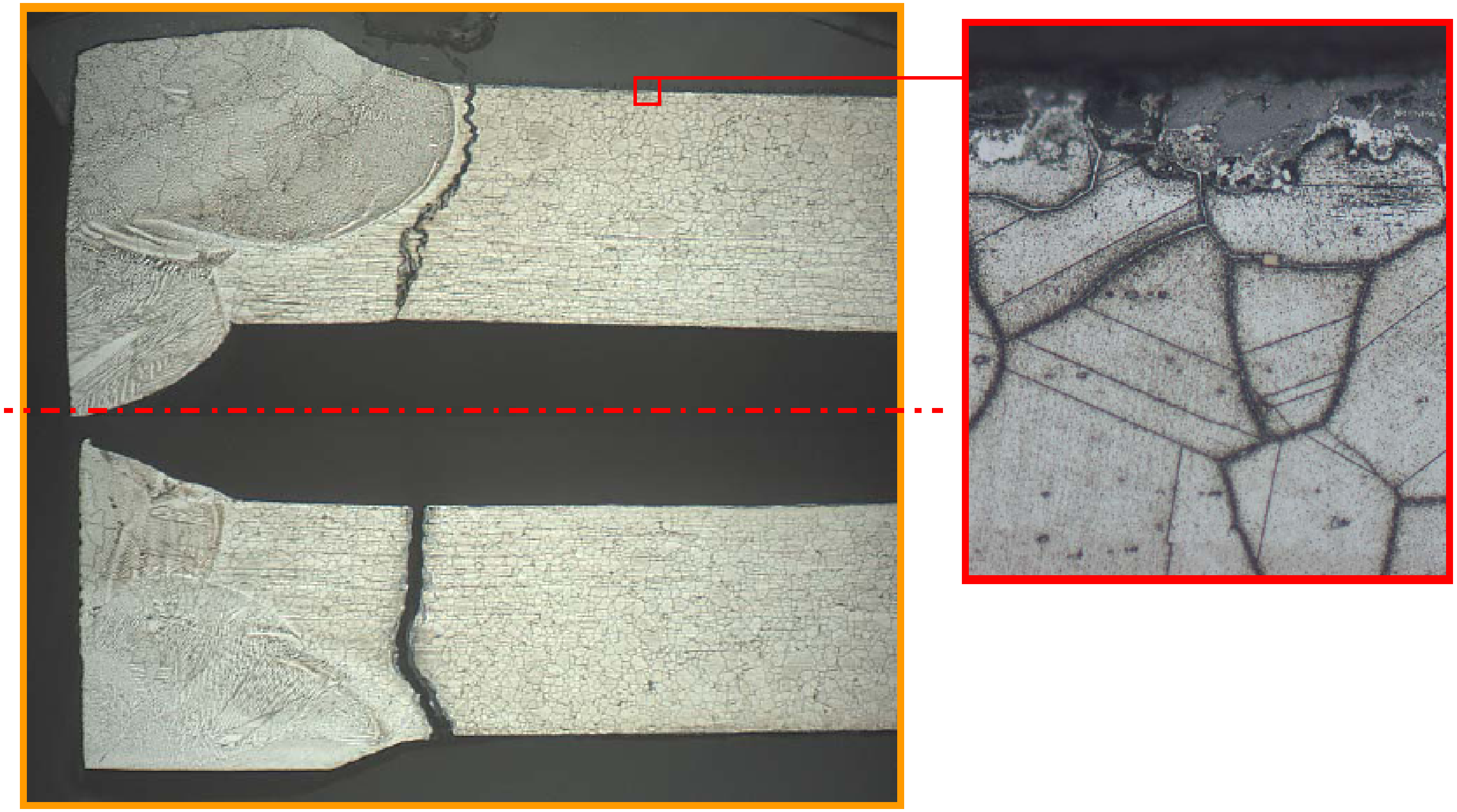
Experiences with cracking of 347H & 800HT

PI-connection



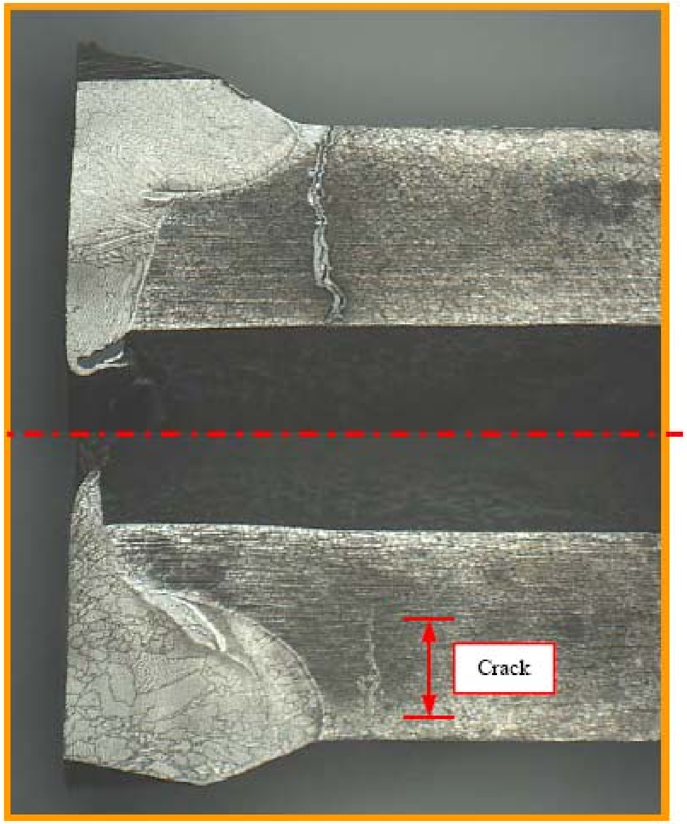
Experiences with cracking of 347H & 800HT

PI-connection



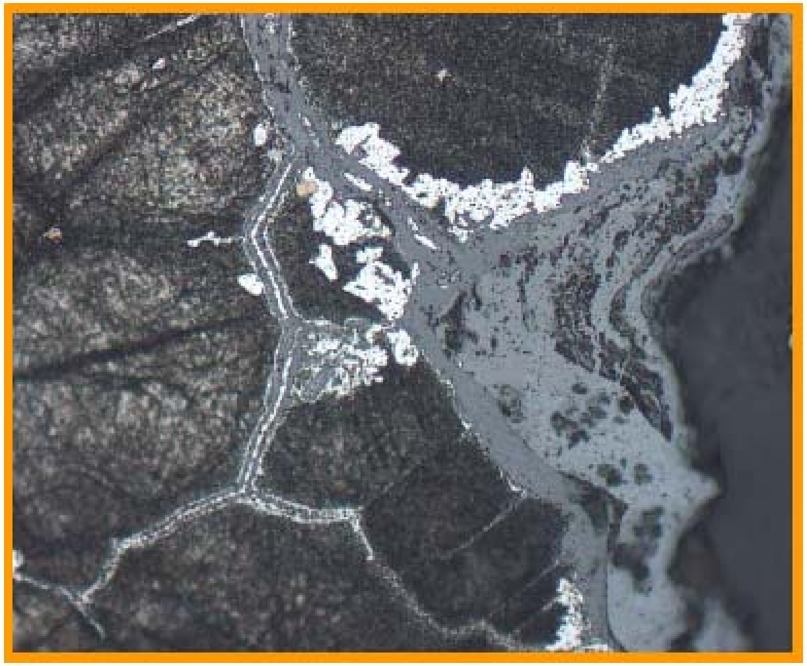
Experiences with cracking of 347H & 800HT

PI-connection



Experiences with cracking of 347H & 800HT

PI-connection



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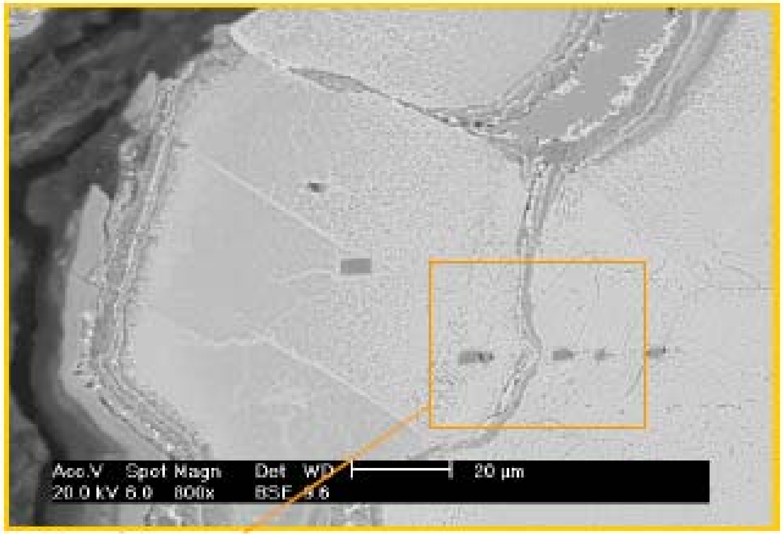

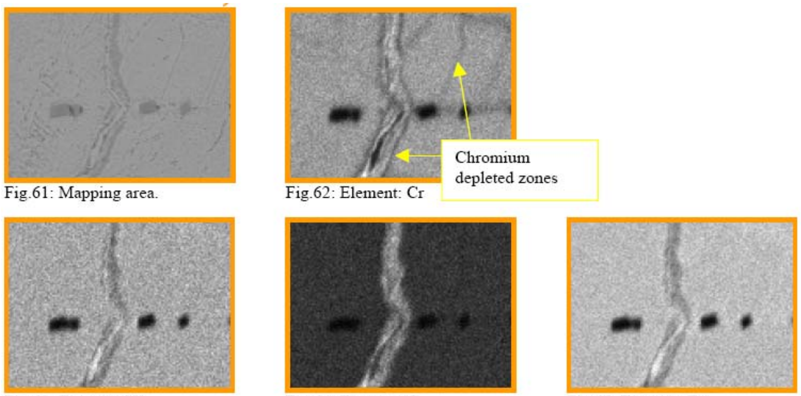

Fig.61: Mapping area.
Fig.62: Element: Cr
Fig.63: Element: Ni
Fig.64: Element: O
Fig.65: Element: Fe

Conclusions

- Evidence of stress relaxation cracking in Sanicro 31HT
- Unknown if the initial 347H suffered from the same mechanism

Experiences with cracking of high temperature materials

- Lessons learnt
  - Do not assume that you know the cause of failure, i.e assume that it is a weld defect!
  - Investigate all failures properly
  - Ensure that the person/company doing the investigation has the necessary competence
  - Thermal fatigue: consider redesign,
  - Relaxation cracking:
    - Materials selection (alloys > 25%Cr)
    - PWHT

- Investigating cracking of high temperature alloys
  - Hardness measurements
    - Above 220HV associated with stress relaxation cracking
  - Preparation and etching of specimens
    - Ref. Hans van Wortel (NACE CORROSION/2007) – NO DETAILS PROVIDED
  - Electron microscopy
    - Analyses of oxides and filaments in cracks
    - Detect voids ahead of the crack tip