Appendix 7

Prevention of atmospheric corrosion on carbon steel by means of Sofeisation

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Working Party 15
Corrosion Refinery Industry Meeting
Paris La Défense (France)
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Hosted by Total - Michelet Tower

Prevention of atmospheric corrosion on carbon steel by means of Sofeisation

By Mathieu Lanfant

Prevention of atmospheric corrosion on carbon steel by means of Sofeisation

Introduction:

One way to prevent atmospheric corrosion: Paint

Surface preparation: difficult and costly, done by shot-blasting.
This does not eliminate corrosive agents like oxygen found in the air and humidity.

Causes of future corrosion appear:
- when paint is applied (air and humidity trapped between the metal and the coating);
- in case of **damage caused by an impact.**

Solution: Treating a metal surface with Soféisation achieves the following:

1- Prevents oxygen from being in contact with the metal.
2- Prepares the surface to receive the protective paint directly on top of rust (no need for shot-blasting).
3- Prevents corrosion from spreading underneath the coating in case of impact to the metal/protection.

Description – Composition – Information on Ingredients:

Chemical name	Classification	Content %
Solvent Naphtha (petroleum), Medium Aliph.; Straight Run Kerosene	Xn;R65. N;R51/53. R10,R66.	35-50 %
Butanol-norm	R10 Xn;R22 Xi;R37/38, R41 R67	5 – 10 %
Cobalt octoate	Xn;R22. R43.	< 1

Physical and Chemical Properties:

Appearance:	Viscous liquid / light yellow-honey coloration
Water solubility:	Immiscible
Odour:	Perceptible, solvent
Boiling point/range:	150 – 195°C
Relative density:	0.86
%VOC:	Max 499 g/l

PRODUCT REFERENCE	PRACTICAL COVERAGE	THICKNESS
R101 COLOURLESS	approx. 14 m² / litre	approx.15microns
R101 PIGMENTED	approx. 13 m² / litre	approx.20microns

TECHNICAL DATA - SOFEISATION

TECHNICAL DATA	R 101 VF COLOURLESS	R 101 VF RED-BROWN, ALUMINIUM, or BLACK
Specific use	**applied directly to rusted surfaces (St2 type)**	**as 2nd coat on top of R 101 colourless or directly to rusted surfaces (St2 type)**
Binder	45 %	45 %
Dry content	45 %	45 %
Solvents	55 %	55 %
Viscosity	21.6 sec. Ford Cup n°4	21.6 sec. Ford Cup n°4
Density	0.86	0.86
Flash point (Abel-Pensky)	35º C (95º F)	35º C (95º F)
P.H. (60 % aqueous solution at 25º C / 77º F)	6.5	6.5
Thinner	**ready for use - never add any thinner**	**ready for use - never add any thinner**
Homogeneity	stir before use	light sedimentation to be thoroughly stirred before use
Application	brush, roller, conventional or airless spray gun, dipping	brush, roller, conventional or airless spray gun, dipping
Pressure for spray application	2 to 2,5 bars at the spray tip	2 to 2,5 bars at the spray tip
Drying time - dry to touch (20º C / 68º F) - ready for use (20º C / 68º F) - between coats (20º C / 68º F)	 approx. 1 hour approx. 3 hours approx. 2 hours between coatings of the same product, otherwise no time limit	 approx. 1 hour approx. 3 hours approx. 2 hours between coatings of the same product, otherwise no time limit
Polymerization time Before paint coating	 2 days (varies w/ hygrometry)	 2 days (varies w/ hygrometry)
Effective coverage	approx. 14 m² / litre	approx. 13 m² / litre
Thickness	approx. 15 microns	approx. 20 microns
Contact angle (wetting and spreading)	5 measured by the Lorentz and Wettres methods	5 measured by the Lorentz and Wettres methods
Gloss	semi-glossy	semi-glossy
Colour	colourless lacquer	aluminium, black, red-brown
Heat resistance - continuously - momentarily	 - 55º C to + 180º C - 67º F to + 356º F up to + 200º C up to + 392º F	 - 55º C to + 180º C - 67º F to + 356º F up to + 200º C up to + 392º F
Application temperatures	+5º C (37º F) to 55º C (131º F)	+5º C (37º F) to 55º C (131º F)
Salt water resistance Acid resistance Alkali resistance Flexibility	excellent high high excellent	excellent high high excellent
Noxiousness	not dangerous	not dangerous
Physiological reactions to welding	no emission of poisonous gas no modification of welding parameters	no emission of poisonous gas no modification of welding parameters
% VOC	Max. 499g/l	Max. 499g/l
Storage time	2 years under shelter sealed drum	2 years under shelter sealed drum
Packing	20 litres metal drum	20 litres metal drum

Prevention of atmospheric corrosion on carbon steel by means of Sofeisation

Description of Application:

Soféisation is directly applied on rust and adherent mill scales - St2 grade, according to the Swedish Standards.

With its exceptional **saturating power**, Soféisation **infiltrates by capillary action** into the metal's porous oxide layer and into cracks. It **penetrates by adsorption** down to the sound metal, preventing air and moisture from being trapped and thereby preventing oxidation.

Because Soféisation is **hydrophobic**, it repels moisture, stopping all risks of inner corrosion.

After **polymerization**, Soféisation completely **isolates** the protected surfaces.

Soféisation becomes hard and will not peel off.

Soféisation does not generate any chemical reaction: its action is only physical and mechanical. **There is no formation of toxic compounds**.

Performance:

Soféisation can be applied to an entire metallic surface, including parts where welding is necessary. **The process does not modify welding parameters**. When welding, fumes released by cracking are very light and non-toxic; special precautions are not necessary.

Once a surface has been treated with Soféisation, coatings can be applied without risk of deterioration from air and humidity that may have been inside the metal prior to treatment. **Soféisation is compatible with all types of paints and over coatings** including, but not limited to, synthetic, oil, bituminous, epoxy, rubber, polyurethane, thermal insulation products, etc.

Soféisation is very flexible: when a piece of treated metal is folded at a 90º angle, Soféisation will not break. This allows treated metal surfaces to be manipulated without impeding the protective properties of Soféisation.

In addition, the full protection of all metallic parts is preserved in case of drastic and rapid temperature changes (expansion and contraction of metals). All metal works protected with Soféisation can **resist temperatures ranging from - 55º C to + 180º C** (- 67º F to + 356º F).

At temperatures higher than 180º C (356º F), Soféisation will gradually turn into a very fine powder without interfering with the operation of the protected equipment (such as in the case of heat insulated pipes or ovens with refractory cement for instance). This does not **generate gas or fumes, or cause flaking.**

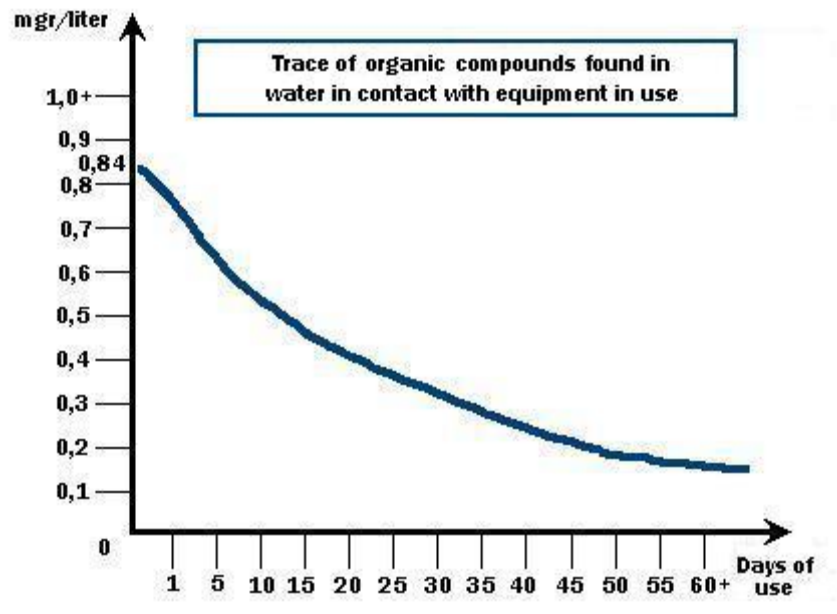
Soféisation products are single-compounds and therefore ready-to-use, which is very convenient for application out in the field. In case of impact received during handling, transport or assembly, deterioration to metals treated with Soféisation will be limited and remain localized, hence rust will not spread. The damaged area requires only a light brushing and local reapplication of R101 to re-establish the protection.

Because Soféisation is hydrophobic, **the application can be done in very humid environments** with a high hygrometric level that can exceed 95%.

Soféisation layers are very thin:
1 coat of R 101 = approx. 15 microns – 1 coat of R 102 = approx. 20 microns
The process can be used for the protection of finely machined or threaded parts. In addition, because the process has excellent thermal conductivity, the **thermal exchange coefficients are preserved**.
R101, the base product of Soféisation, is **colourless**. Therefore, all original markings on metal works are preserved and protected.

Soféisation is conforming to the new European directive 2004/42/EC for 2007 and 2010 regarding the VOC limits.

<u>Regarding questions you may have about the toxicity of Soféisation:</u>



Tests made by the Laboratoire Central de l'Alimentation on Water Tanks.

Amount found on the first day: 0.84mgr/l

As for comparison, potable water is allowed to contain 1-2 mgr/l

Note: As equipment is used, the trace amounts of organic compounds dissipate.

Conclusion:

Our sector is very competitive and astonished by the price increases of steel and/or its maintenance. Also, environmental issues are playing an important economic part in maintenance.

Our main goal was to find a solution to prevent atmospheric corrosion and therefore reducing costs of maintenance. Soféisation is a process that has been around for more than 35 years, however, it remains technologically advanced.

In fact, it is in 2007 a rational and very effective solution to not only prevent, but also resolve the problems caused by atmospheric corrosion on carbon steel by means of Soféisation.

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For more information regarding Sofeisation, please contact:

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Appendix 8

Information on the Nace TG347 Survey

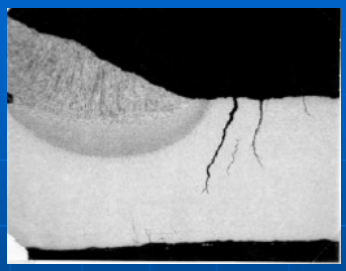
Alkaline Stress Corrosion Cracking of Carbon Steel in FCC

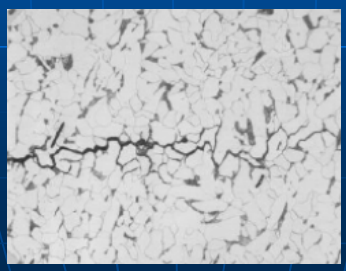
Carbonate stress corrosion cracking in the FCCU main fractionator overhead systems and FCCU gas plants (since the early 1980s).
Increase since 2000s attributed to operating change due the production of low sulfur products directly from the FCCU.

NACE TG347 proposed technical committee report 2007-01-05
"Review and Survey of Alkaline Carbonate Stress Corrosion Cracking in Refinery Sour Waters"

Responses from 42 units (36 refineries)
84% without cracking experience
16% with
- time to failure: 6 months to 50 years
- affected by residual + applied stress
- from which 69% concern piping
- overhead of fractionator, sour water tank stripper (second tower with NH3 ↗)
- standard PWHT has not always been successful

Alkaline Stress Corrosion Cracking of Carbon Steel in FCC





Alkaline Stress Corrosion Cracking of Carbon Steel in FCC

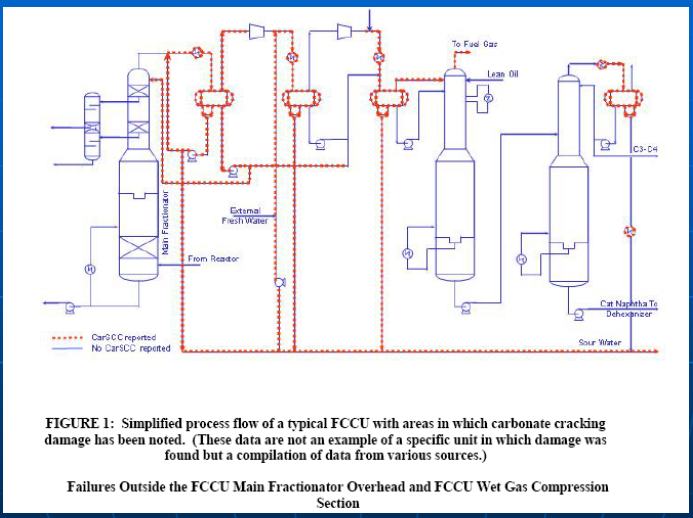


FIGURE 1: Simplified process flow of a typical FCCU with areas in which carbonate cracking damage has been noted. (These data are not an example of a specific unit in which damage was found but a compilation of data from various sources.)

Failures Outside the FCCU Main Fractionator Overhead and FCCU Wet Gas Compression Section

from NACE TG347 proposed technical committee report

Alkaline Stress Corrosion Cracking of Carbon Steel in FCC

Water environment factors

according API 581

>50 ppm H2S in the liquid water phase or pH of 7.6 or greater

- Nonstress-relieved carbon steel
- pH >9.0 and CO_3^{2-} >100 ppm or
- 8.0< pH <9.0 and CO_3^{2-} >400 ppm

Nace papers (Truax, Kmetz, Rivera)

Factors of API 581 +

- Electrochemical potential between -500 mV and -600 mV vs. a saturated calomel electrode (SCE)

NACE TG347 survey

Polysulfide injection : no evidence of increase or decrease ASCC

Cyanide : API 581 ASCC ↗ but no correlation according the litterature

Carbonate conc. 3 times higher in units with ASCC

pH higher of 0.3 in units with ASCC (no ASSC in the range 9.5 to 10.5)

Alkaline Stress Corrosion Cracking of Carbon Steel in FCC

Feed factors - NACE TG347 survey

Total Nitrogen is 3 times higher in units with ASCC
Average NH_3 is 2 times higher in units with ASCC (4600 v 2100 ppm)
H_2S average amount is 20% of the one of uncracked units (2700 vs 3100 ppm)
93% of the cracked feed were hydrotreated (54% for the uncracked deed)

S/N=0.7 for units with ASCC
S/N=6 for units without ASCC

Cyanide is lower for units with ASCC (that all have APS treatment)

Fluid solid operation factors - NACE TG347 survey

Catalyst circulation rate in units with ASCC is 70% of the one in units without
CO is 2% in units with ASCC (6% without) : partial combustion
O_2 is 0.8% in units with ASCC (1.6% without) : O_2 may stabilize the sulfide protective layer

Alkaline Stress Corrosion Cracking of Carbon Steel in FCC

Mitigation of ASCC- NACE TG347 survey

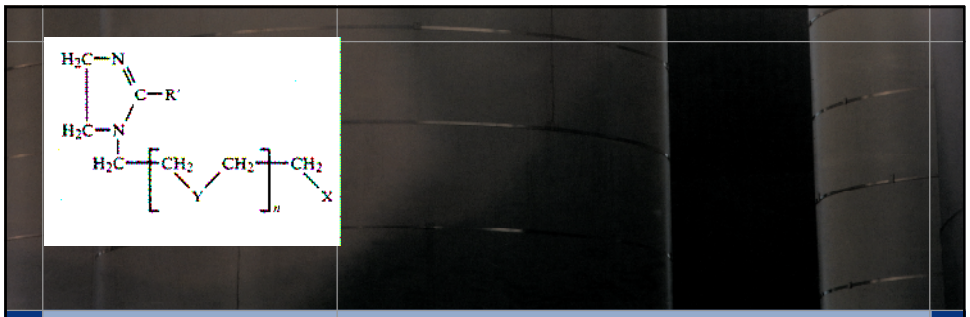
- Stress relief
- Barrier sytems (cladding with SS 316 or N 625)
- Alloy upgrade (SS 316 or N 625)
- Water washing
- Inhibitors (water soluble > oil soluble ones ?)

Any other contribution from WP15 members
to the NACE TG347 is welcomed

Appendix 9

Inhibition of carbonate SCC in FCC's

C. Claesen (Nalco Energy Services)



C. Claesen
Nalco Energy Services

Inhibition of Carbonate Stress Crack Corrosion

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Topics

- Definition of CSCC
- Conditions Causing CSCC
- Chemical Inhibition
- Field Example

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CSCC Definition

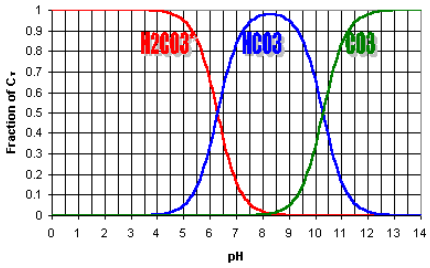
- Cracking of carbon steel under the combined effects of a static stress and an alkaline carbonate containing environment
- Cracks are intergranular and filled with iron oxides.
- Usually located near a weld

Conditions Causing CSCC

- API 581 High Risk Conditions:
  - Un-stress-relieved carbon steel
  - pH > 9.0 and carbonate concentration > 100 ppm
  - pH between 8.0 and 9.0 and carbonate concentration > 400 ppm
- Some refiners believe water composition is not sufficient to evaluate risk, further investigations by NACE TG347
- Sampling issues
- Analysis issues

Conditions Causing CSCC

- The Carbonate system is an equilibrium between
  - Carbonic Acid (H2CO3)
  - Bicarbonate (HCO3-)
  - Carbonate (CO3--)
- If total carbonic species and pH are known the Carbonate concentration can be derived
- Carbonate only starts to become significant above pH 8,5



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Chemical Inhibition - Lab Evaluation

- Inhibitor evaluation work was done using a slow strain rate test under Carbonate Cracking Conditions
- Different inhibitors compared with untreated situation
- Clear inhibition effect of Imidazoline type filmer
- Inhibition believed to be caused by interaction of the imidazoline with the iron oxide (magnetite) layers at the metal surface or inside the cracks

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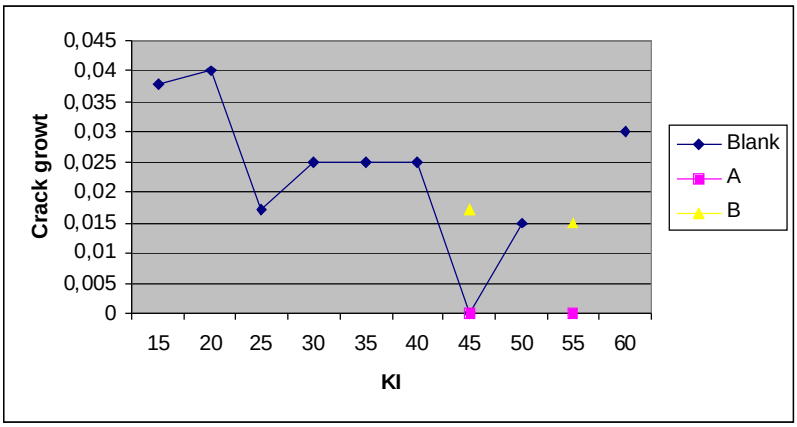
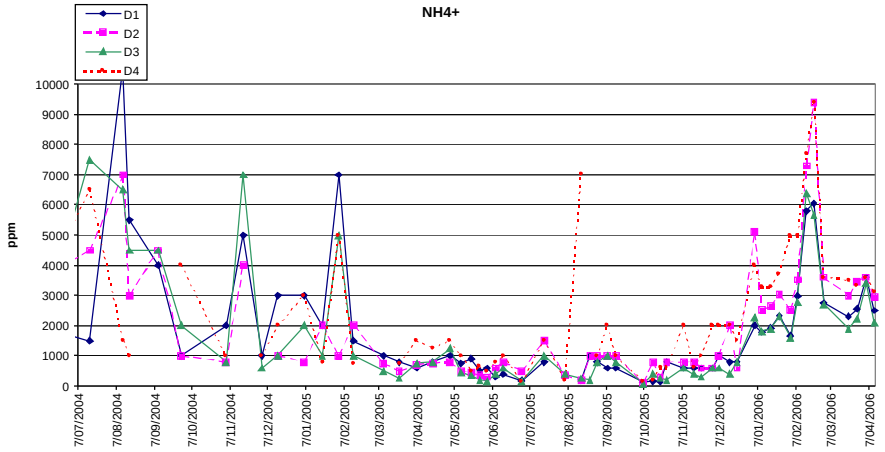
Chemical Inhibition - Lab Evaluation



Field example

- Unit was already treated with a filmer
- Conditions changed due to feed hydrotreating
- No cracking in filmer wetted parts
- Cracking in downstream equipment that did not receive filmer. (Sulphur plant feeddrum)

Field example



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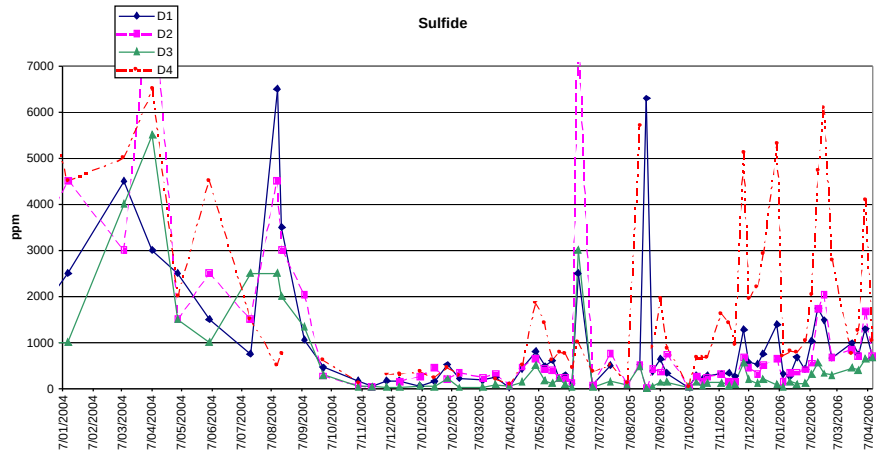
Field example



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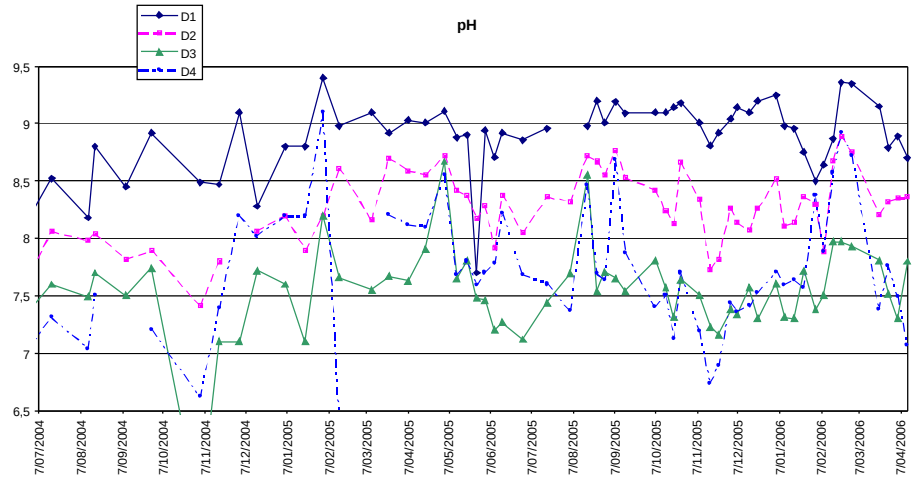
Field example



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Field example

Risk assesment using API 581

Drum	min pH	max pH	avg pH	Carbonate ppm	Carbonate Cracking risk
RX	8.3	9.4	8.9	1100	High
1st comp	7.4	8.7	8.2	2600	Medium
2nd comp	7	8.2	7.5	3700	Medium
De-eth	6.6	9.1	8.3	1300	Medium-High

NALCO

Conclusions

- Avoid conditions that can cause CSCC
- Use proper sampling and analysis techniques
- Proper PWHT
- Use of an Inhibitor can help but is not recommended as a sole prevention strategy

Appendix 10

State of the art with case studies on online corrosion monitoring

Ayman Mehdawe (Honeywell)

Corrosion
The New Process Variable

Ayman Mehdawe
Corrosion Specialist

Honeywell

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Corrosion – The New Process Variable

Program Topics:

- Corrosion cost Facts & Figures.
- Corrosion Vs **Operational Integrity boundaries.**
- The Current Situation.
- Honeywell Corrosion Solutions.
- **SmartCET** Corrosion Transmitter.
- System Communication.
- Case Studies.
- Corrosion Management Strategies.

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Corrosion – An Expensive Issue for Industry

Annual Est. Corrosion Costs (US$)

Oil & Gas Production

Refining

Pulp & Paper

Chemical Processes

Utilities

Operators need better information…..sooner

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Corrosion vs. Operational Integrity Boundaries

Operations Integrity Boundary:

- **A set of physical or operational limits that a unit can run without compromising asset integrity.**
- **Without a source of on-line, real-time corrosion data, there is no basis to properly assess unit integrity limits.**
- **Wherever the corrosion rate is high or fluctuates significantly with process conditions, corrosion is a significant part of the OIB.**

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Corrosion vs. Operational Integrity Boundaries

Online Corrosion monitoring

- **Provide "real-time risk assessment" specific to unit operations …**
- **Provides a basis for setting & maintaining better integrity limits.**

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The Current Situation

Online PVs but Offline Corrosion Monitoring.

- **Plants run with online, real-time measurement of key performance variables.**

But

- **Corrosion measurements are commonly *OFF-LINE* and NOT easily viewed with process variables.**
- **In this approach, corrosion is usually NOT OBSERVED until substantial damage has been realized.**
- **Outcome – High cost of corrosion**

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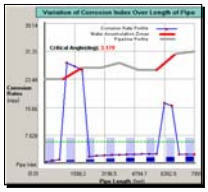
Honeywell's Corrosion Solutions

- Corrosion control in industrial processes requires integration and analysis of corrosion data with process data.
- Honeywell offers:
  1. **Unique Corrosion Measurement Technology** (**SmartCET**®) that offers benefits over conventional techniques for Online, Real-Time measurements
  2. **Corrosion Modeling Tools**
  3. **Corrosion Prediction & Modeling Software's**
  4. **Expert Corrosion Services**
     Consulting, Laboratory Testing, Failure Analysis



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New Corrosion Monitoring Strategy

"The New Paradigm"

- **Honeywell technology offers the means to interface real-time corrosion measurement with process information on a real-time basis.**
- **This provide new insights on the true economic impact of corrosion and new methods to achieve:**
  - **Improved process control and efficiency**
  - **Better maintenance planning**
  - **Asset management.**

Make decisions based on where you *are*, not where you've been

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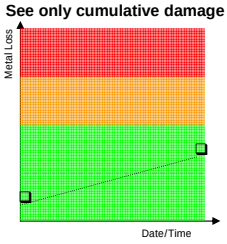
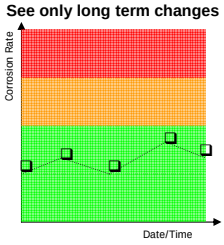
Taking Corrosion from Off-line to Online, Real-Time

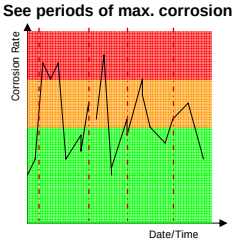
See only cumulative damage



See only long term changes



See periods of max. corrosion



Off-line	**Online**	**Online, Real-Time**
Weight Loss Coupon Off-line ER Visual Inspection UT inspection	Periodic UT On-line ER	Super ER Conv. LPR	**SmartCET® – SuperLPR** **• LPR** **• HDA** **• ECN** **New C.R. & Pitting data every 7 minutes**
Time Frame - months ***Time frame too long for process correlation***	**Time Frame – days/weeks** ***Time frame too long for process correlation***	**Time Frame - minutes** ***Time frame consistent with process correlation***

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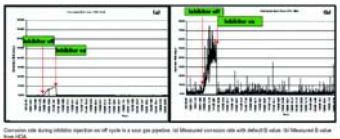
New Monitoring Strategy – Corrosion as a Process Control Variable



Online measurement of corrosive activity by monitoring electrical properties of the corrosion process.

⬇

Integrate into DCS

⬇

Value

Enabling
- Corrosion root cause analysis
- Process optimization
- Maintenance planning
- Asset management

Transforms Data into High Value Information

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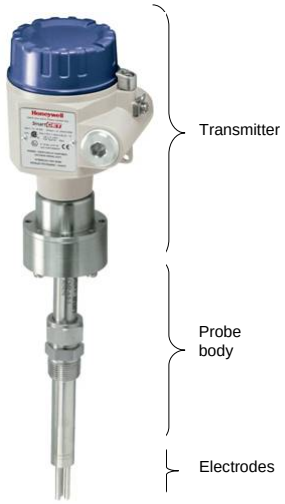
SmartCET Corrosion Transmitter

- **Multivariable**
  - General Corrosion Rate
  - Pitting Factor
  - B-Value (Stern-Geary)
  - Corrosion Mechanism Indicator
- **Measurement cycle consists of**:
  - ECN – 300 seconds
  - LPR / HDA – 100 seconds
  - Solution Resistance – 30 seconds
- **4-20mA output with HART**
- **Interfaces to a variety of probes**



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Online, Real-Time Monitoring Technology

"SuperLPR" Technology

Multiple techniques applied simultaneously

Harmonic Distortion Analysis (HDA)

Linear Polarization Resistance (LPR)

Electrochemical Noise (ECN)

Accurate general corrosion rate

Identification of localized corrosion

Pitting corrosion detection… unique capability

- ❑ **Automated data cycle (every 7 minutes), consistent with process control/automation applications**
- ❑ **Hazardous areas (IS) rated**
- ❑ **Simple interface to process control systems (via HART & 4-20 mA)**
- ❑ **4 PV outputs**
  - ❑ **2 for operator/control level: Corrosion Rate, Pitting Factor**
  - ❑ **2 for diagnostics: B value, CMI**

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Probe – the sensing element

- The application will dictate the type of probe used

FACT! The best probe design gives the best data.

Honeywell can match probe designs to the

specific process applications

Flush mount or intrusion probe	For dew point or near dew point applications	Flange Insert electrodes	Interleaved Thin film probe	Heat Transfer/ Corrosion sensor
Liquid environments	Air cooled / controlled temperature	Flow through applications. 360º sensing	Atmospheric corrosion, condensing or vapor environments	Flow through corrosion monitoring and heat transfer monitoring

Unique probe designs can be accommodated

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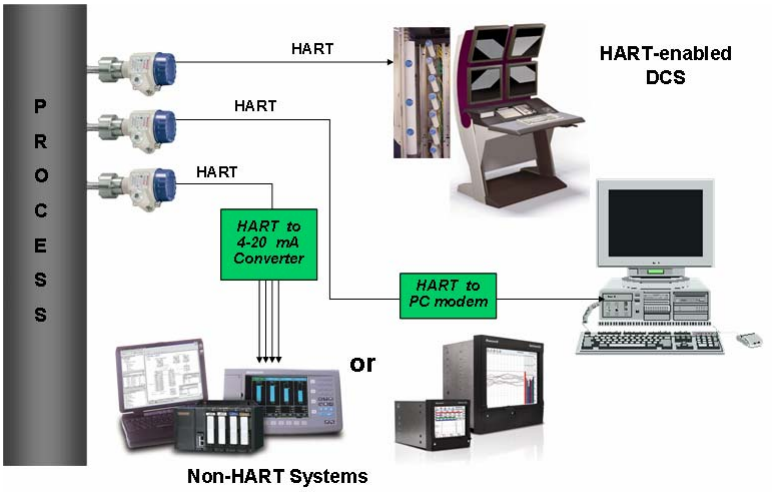
System Communications



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Case Study 1

The Problem:

- High mild steel corrosion rates in Towers serving condensers with admiralty brass tubes.
  - corrosion product plugged Condenser tubes.
  - galvanic corrosion suspected.
- Economic impact was:
  - increased backpressure in condensers
  - subsequent higher heat rate to overcome problem
- Corrosion study was conducted in two phases:
  - **Phase I** – Establish baseline corrosion rates
  - **Phase 2** – Develop a treatment solution

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Case Study 1

River Water Analysis

Ca (as $CaCO_3$) – 226 mg/l	Cl - 76 mg/l
Mg (as Mg CO_3) - 146 mg/l	SO_4 – 110 mg/l
Na (as Na) - 25 mg/l	M alkalinity (as $CaCO_3$) – 220 mg/l
Fe (as Fe) - 0.4 mg/l	P alkalinity (as $CaCO_3$) – 0 mg/l
pH - 7.8	Si (as SiO_2) – 9.4 mg/l

Chemical Treatment Program

COMPONENT	TREATMENT LEVEL (mg/l)
Phosphonate	3.0
Copolymer	3.0
NaOCl/NaBr	0.20 mg/l residual for 40 minutes

Cycled Water Analysis

Ca – 725 mg/l	Cl – 251 mg/l
Mg – 468 mg/l	SO4 – 390 mg/l
Na – 94	M alkalinity – 540 mg/l
Fe – 0.6 mg/l	P alkalinity – 120 mg/l
pH – 8.3	Si – 24 mg/l

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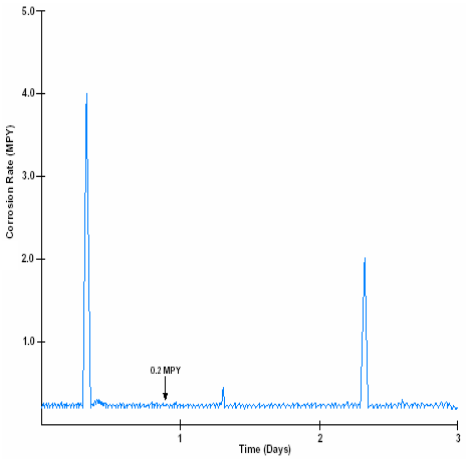
Case Study 1



The baseline corrosion rate measurement for the admiralty brass indicated "spiking" events that were coincident with the halogenations

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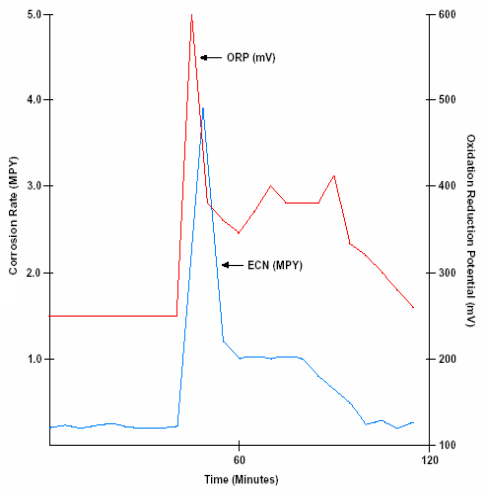
Case Study 1



The graph shows correlation between the ORP readings and the measured corrosion rate.

The investigation proved that the halogenation operation was responsible for the introduction of 30 ppb of copper into the recirculating water twice per day.

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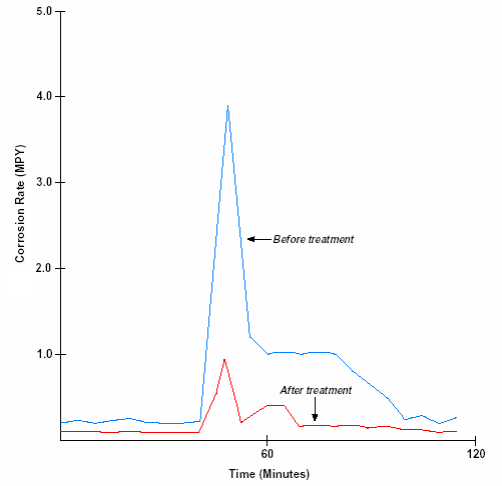
Case Study 1



Reduced corrosion rate after Azole treatment:

This was achieved through 85% reduction in copper dissolution. The mild steel corrosion rate was controlled at less than 5mpy, which exceeded the plant's requirements. Most importantly, the corrosion control was implemented without changing the established halogenation practices.

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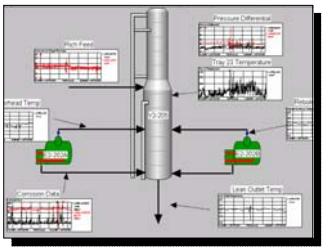
Case Study 2: Amine unit monitoring OIB & solution

- An amine treating system operated for eight years without corrosion started to experience equipment integrity failures and severe corrosion.

Selected Honeywell's online, real-time SmartCET corrosion monitoring system.

- **Corrosion data was obtained real-time**
- **Data was coupled with process**
- **KPIs in data historian.**
- **Process correlation**



- Outcome showed that corrosion was not a continuous process, but was related to periods of reboiler process instability.
- Instability was initiated by high residue levels that, once correlated to corrosion activity, were successfully decreased by reclamation.

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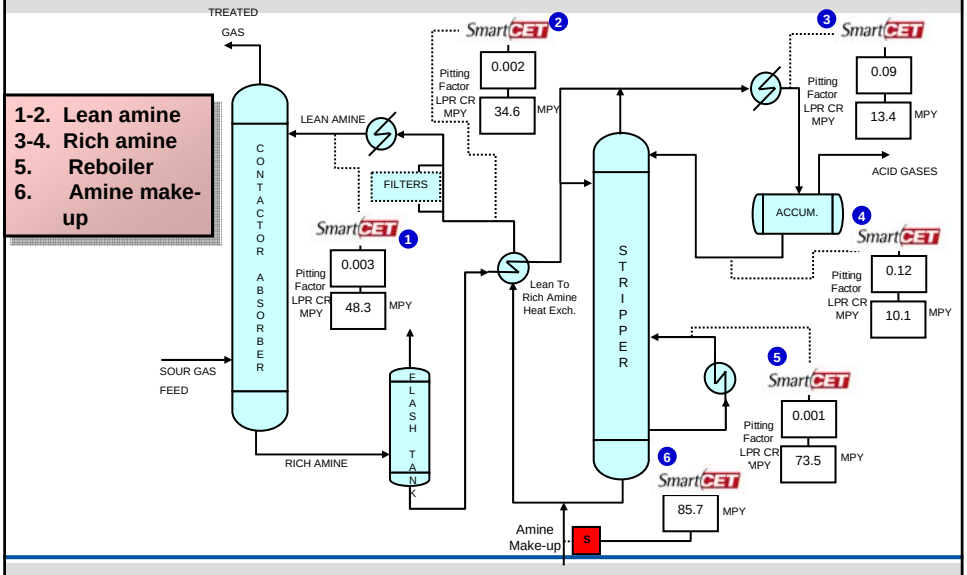
Monitoring in the Amine Unit



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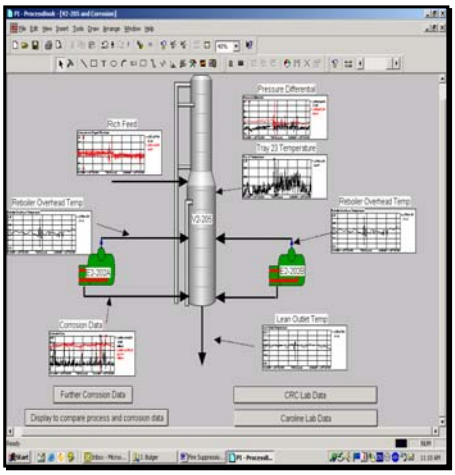
Integration with Process Control

Corrosion is a process parameter:



Corrosion rate and process data trends can be viewed simultaneously.

Operators, Process Eng& Corrosion specialists all have access to the same data – online, real-time.

Simplified Data means operator level personnel can see the corrosion "red line".

Real-time data integration eases Root Cause diagnostics and analysis.

Confirming the success of remedial measures on-line.

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Corrosion Management Strategy

Inspection Plan and corrosion control strategy development : TECHNICAL SERVICES

- -Chemical Treatment (Corrosion inhibitors, Amines, neutralizers, etc).
- - Water wash
- - Control of corrosive sources : water, CO2, H2S, Acid, Ammonia levels, Sulfur, etc
- - Material Selection
- - Corrosion Resistant Alloys
- -Coatings, linings, cladding
- - Welding procedures
- -Cathodic protection, external coatings
- - H2S scavenger injection
- -Dehydration
- -Inspection plan (UT, radiography)

Operating Environment
Temperature, pressure
CO_2, H_2S, water cut
water condition
Material, Pipe ID
Previous Failures
Repair History
Inspection Schedule

Corrosion Characterization (Diagnosis)-PREDICTION

Corrosion prediction –by Modeling : PREDICT, RISK-IT, SOCRATES.
underground and surface facilities
-Upstream and downstream equipment) –
-Characterization of corrosive conditions
-Remaining life of materials after corrosion evaluation
- Fitness for Service Assessment

Corrosion Monitoring and follow-up process conditions
-Inspection techniques: UT,
- Laser inspection
- Chemical analysis : Fe, pH
- Probes, Coupons
- ONLINE MONITORING : SmartCET

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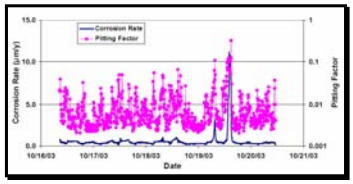
Corrosion Services Offerings

Consultation

- **Plant Corrosion Survey**
  - Review corrosion data, failure, maintenance record, asset replacements
  - Monitoring points / probe configurations
  - Process correlated analysis
  - Plant diagnostics
- **Expert Consultation**
  - Materials selection
  - Inhibitor usage
  - Failure analysis
- **Corrosion Prediction**
  - Corrosion modeling
  - Analysis of operating conditions
  - Sensitivity studies
  - Process projections
  - Simulation of service environments

Customer Testing

- **Laboratory Testing and Research**
  - NACE, ASTM & ISO testing techniques
  - Custom testing/evaluation
- **Joint Industry Programs**
  - Customer sponsored corrosion research



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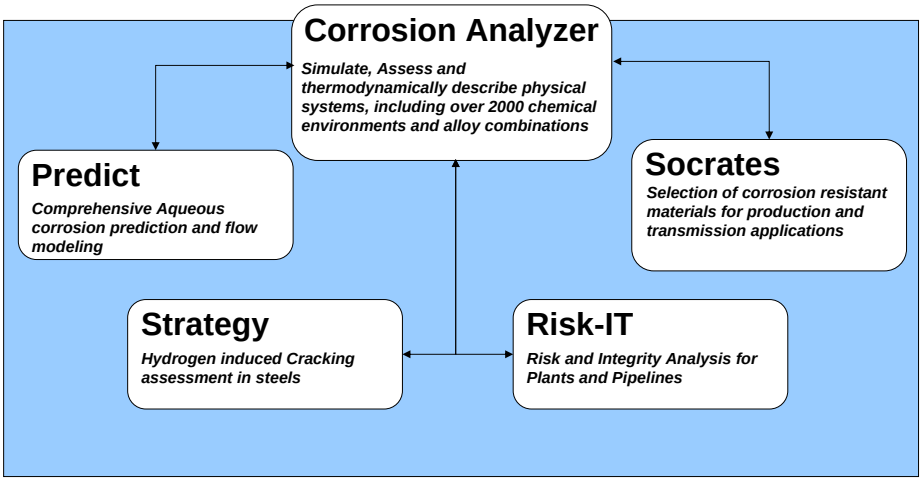
The Desktop Corrosion Laboratory TM (DCL)

A Comprehensive Suite of Tools to Simulate and model any corroding system



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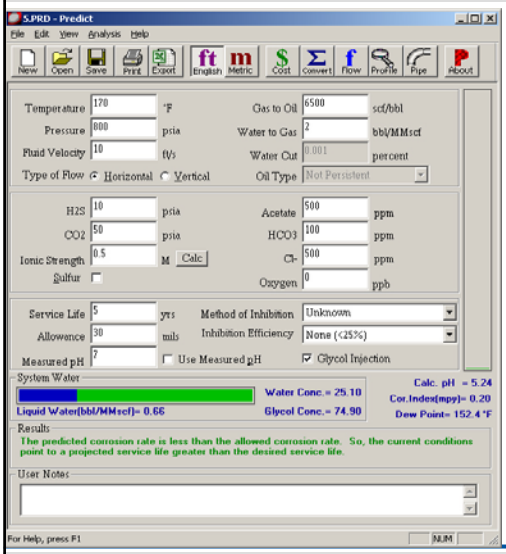
Predict® Pipe - 3.0

Quantitative ICDA for Pipelines –
A Novel Approach to Pipeline Failure Prevention



Comprehensive, in-depth ICDA for pipelines, with a number of functional modules:

- pH computation
- Water phase behavior
- Glycol Injection
- Rigorous flow modeling
- Corrosion distribution profile
- Integrate analysis, data with other software systems

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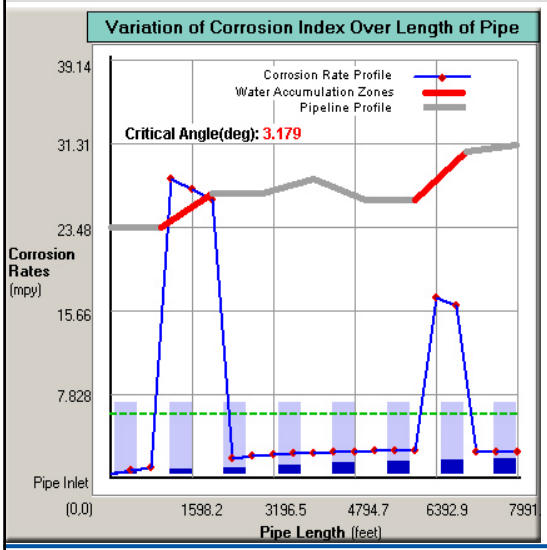
Corrosion Distribution Profile in Predict® Pipe



- Easily obtain a bird's-eye view of Internal Corrosion
- Identify hot spots
- Determine a number of system behavior factors that assist in planning and scheduling maintenance
- Develop a rigorous, technical basis for monitoring and inspection prioritization
- Tremendous reduction in time spent in determining health of pipelines
- Substantial cost savings
- Regulatory compliance

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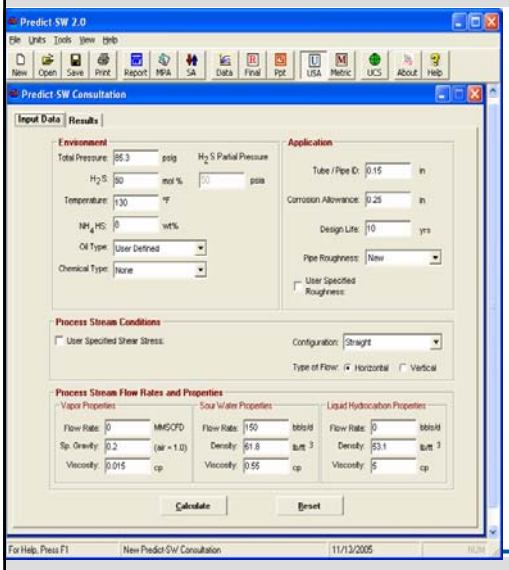
Predict®-SW 2.0

Prediction and Assessment of Ammonium Bi-sulfide Corrosion Under Refinery Sour Water Service Conditions.



•Quantify Corrosion as a function of NH4HS concentration, velocity (shear stress), H2S partial pressure, Temperature…etc.

•Extensive data for 14 materials ranging from CS – Alloy C276.

•Enhanced Flow Modeling Module- Flow induced corrosion.

•Multipoint and Sensitivity Analyses capabilities.

Program currently used by about 20 sponsor companies.

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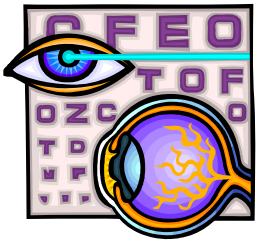
Three Steps to Success - Eyes

Step One

- **Bring corrosion signals into the DCS along with other process data.**
  - Plant operators have “eyes” to “see” corrosion in its real context with other real-time process information.
  - Initiates the use of online, real-time corrosion measurement by plant operators.

- **They are the first-line of defense against corrosion.**



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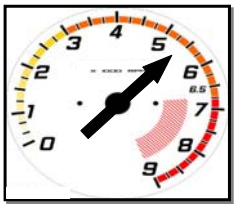
Three Steps to Success – “The Tachometer”



Step Two

- **Correlate operational or process variables with corrosion “events”.**

- Operators learn quickly and start optimizing the unit to maximize productivity while minimizing corrosion.
- The corrosion measurement is the “*tachometer*” for the plant.
- Corrosion measurement provides the “red line” to achieve optimum performance while keeping corrosion within acceptable limits.

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Three Steps to Success – "Automated Solutions"

Step Three

- **Implement automated closed-loop control solutions:**
  - Integration of corrosion data into Process Knowledge platforms enables users to make more informed decisions.
  - Make adjustments to the process to maximize productivity and minimize corrosion damage.

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Summary – Key Messages

- On-line, real time corrosion data offers significant advantages over off-line strategies.
- Integration of corrosion data into Process Knowledge platforms enables users to make more informed decisions.
- Knowing actual corrosion rates – all the time – permits better understanding of asset conditions.
- Analyzing corrosion data along with other process data allows for easier correlation of pre-damage to conditions.
- Adjusting processes to operate at the most profitable point must include an impact analysis for corrosion damage.
- Honeywell Corrosion Solutions offer customers significant opportunity to minimize costs and maximize productivity.

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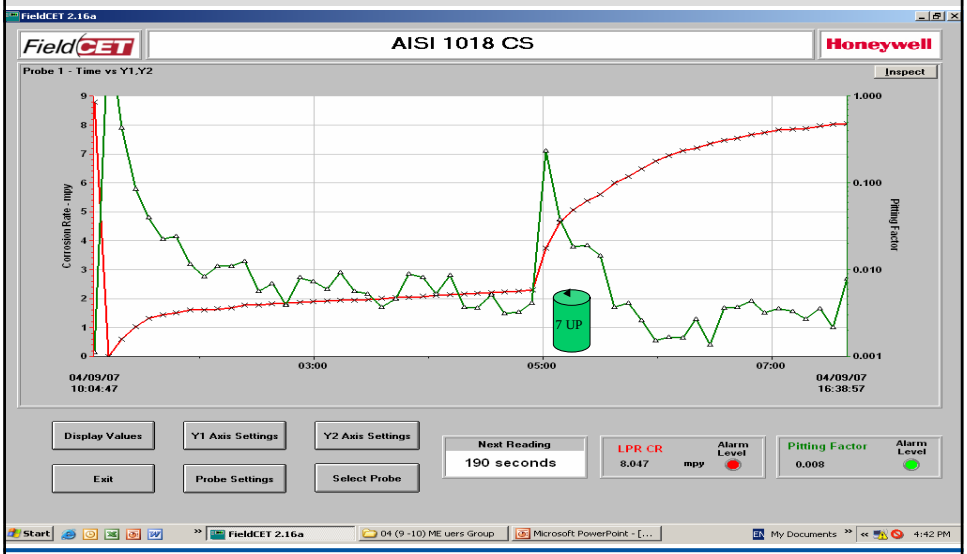
SmartCET Corrosion Transmitter Demo unit



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Thank You

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