Corrosion and Erosion Monitoring
Products and Services

PRESENTED to ICORR BY: DEREK MORTON
Why Corrosion / Erosion Monitoring?

• Health & Safety
• Environmental (loss of containment)
• Reduce inspection & maintenance
• Avoid Shutdowns
• Inhibitor control
Other Pipe Failure Mechanisms

- Microbiological Induced Corrosion (MIC)
- Corrosion Under Insulation (CUI)
- Erosion
- Stress Induced Corrosion Cracking (SICC)
Advantages of Effective Corrosion Monitoring Systems

• Management of chemical treatment programs
• Fast response to system upsets
• Adapting to changing process parameters/feed stock
• Corrosion database
• Materials performance evaluation
• Early warning of corrosion problems
• Effective reporting system
Corrosion/Erosion Monitoring Techniques

- Traditional ER Probe, Weight Loss Coupons and Bio Probes.
- High Resolution HSER Corrosion Monitor (Microcor)
- Instantaneous Corrosion Rate (LPR).
- Sand/Erosion – Intrusive
- Ultrasonic Wall Thickness - UT probe. (Ultracorr)
- Integrated Systems with Wireless Data Communication.
- Chemical Injection/ Sidestream.
- Corrosion Under Insulation (CUI) Detectors
- Downhole Corrosion/Erosion
Corrosion/Erosion Monitoring - Traditional Techniques

• **Intrusive Corrosion Monitoring**
  - 2” Access Fittings – Mechanical and Hydraulic
  - Coupons (WL, stress, bio, polymer, weld)
  - Probes (ER, HSER, LPR, ECN, galvanic)
  - Sand/Erosion probes
  - Chemical Injection/sampling fittings
  - Retrieval Tools & Services
  - Hot Tap Tools & Services

• **Instrumentation**
  - Portable Instrument –
  - Offline – Battery powered/portable instrument download.
  - On line sand/erosion and corrosion systems –
  - Integrated systems
  - Wireless
2” High Pressure Access Fittings

Cosasco Fitting

Hydraulic Fitting
The Cosasco Fitting

Protective Cover

Solid Plug

Hollow Plug

Access Fitting Assembly

Hollow Plug

Solid Plug
Weight Loss Coupons

**Type**
- Disc Coupon
- Strip Coupon
- Ladder Coupon

**Benefits**
- Low cost
- Absolute Metal Loss measurement
- Visual (corrosion mechanism eg. pitting)

**Disadvantage**
- Consumable, requires regular retrievals
- Long exposure time (typical 3 months)
- Can miss detecting a process upset
- Not practical for short term monitoring tasks
Corrosion Probes

- **Electrical Resistance (ER) probes** – low cost, gives relative metal loss trend (general corrosion). Good sensitivity to change in process corrosivity (dependant on element thickness), data easy to interpret. Consumable and prone to effects of conductive scale build up.

- **HSER (Microcor high sensitivity)** – based on same principles as ER probe as above but can give a higher response to change in process corrosivity. Good for inhibitor monitoring but more expensive probe design and requires higher spec instrumentation.

- **LPR probe** – provides instantaneous corrosion rate, but requires aqueous condition, prone to scale/iron sulphide interference. Consumable electrodes.

- **Galvanic probes** – simple and robust probe for giving an indication of desolved oxygen in water injection systems.

- **Bio-probe** – really a coupon used for checking bio film deposit on steel surface. Consumable and requires regular retrieval and ancillary analysis.
RBS & RSL High Pressure Retrievers

• **Standard Retriever (RBS)**
  - Field-proven as the best
  - Industry Standard

• **Non-Telescoping Retriever (RSL)**
  - Shorter Design
  - Non-telescoping design
  - Requires 20” less clearance

Double Block & Bleed Service Valve
Cosasco On Line Instruments & Probe Range

- Microcor®
- ER
- Erosion
- LPR
Metals Loss vs. Electrochemical Corrosion Rate Measurement

**Electrical Resistance (ER)**

*Physical Metal Loss (ER)* measured by change of resistance of probe element over time – operates in any environment

**Linear Polarisation (LPR)**

*Corrosion Rate (LPR)* measured through electrochemical interaction with corrosion of solid electrodes – operates only in water systems
Microcor - High Sensitivity ER Metal Loss Monitoring

Microcor High Pressure Line

Microcor Low Pressure Line
Standard ER vs. Microcor

Metal Loss

Electrical Resistance

Microcor

Noise Comparison

Apr 2000

Cosasco® Product Presentation
Corrosion rate changes are easily visible within 1 hour as shown by the graph (shows change from rate of 1 mpy to 10 mpy)
Microcor Online System (Cable)

1. Probe
2. Adapter
3. Microcor Transmitter
4. Communications
   • Cables
   • Ethernet
   • Fiber Optic
5. Intelligent Interface Unit (IIU)
   or
6. Corrosion Server
   • With ICMS3 Software
Microcor® Integrated Online System with IIU

**Diagram Description:**
- **RS 485 & 24 VDC** connections are shown.
- **uCorr TX** and **E-9020 TX** devices are connected to the system.
- **Modbus Serial or OPC Interface** is depicted.
- **Ethernet** connection is illustrated.
- A **Configuration laptop** with a local display is shown.
- A **Desktop remote display** is connected via **DCS SCADA or PLC**.
- **115/240 VAC Power** is indicated.
- Additional note: *Via Windows Remote Desktop or PC Anywhere*.
1. Microcor Probe
2. Probe Connecting Adapter
3. Microcor MDL Data Logger
4. Checkmate DL portable Instrument
5. Personal Computer
Cosasco Data Offline Software

- Windows Based Software for offline instrument data management
- To replace Corrdata II, Corrdata Plus and Microcor Tools used with data loggers.
- Enhanced features including trending, probe comparison, manual coupon data entry and reporting.
- Comprehensive Cosasco Probe / Instrument selection
- One operating licence per Installation (30 day free trial)
Cosasco Data Offline Software
Cosasco Data Offline Software – Coupon Report

**Coupon Data Entry Screen**

**Coupon Data Report**

**Sea Water Utilization South**

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<td>9.20</td>
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<tr>
<td>Initial Weight (g)</td>
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**Coupon Data Report**

**Coupon Data Entry Screen**

**Coupon Data Report**
Erosion?
• Immediate detection of sand being produced and erosion effect.
  - Gravel pack failure, sand carry over etc..
• Reduce risk for erosion damage
• Reduce maintenance and risk for clogging up system
• Optimize production based on the above
• Controlled startup of wells
Microcor® Probes configured for Sand Monitoring

Erosion/Corrosion Probes
Detecting Major Sand/Erosion Events

Erosion & Corrosion Probe Location

Active Trace: Metal Loss  TWA Downstream Pig Launcher Gas Lift to TWD

- Jul 2004
- Aug
- Sep
- Oct
- Nov
- Dec
- Jan 2005
- Feb
- Mar

mils

- 1.426 mils 2/21/2005 6:10:00 AM
Smart Wireless Mesh

IN THE EVENT TEMPORARY OBSTRUCTION BLOCKS A DIRECT CONNECTION

THE NETWORK AUTOMATICALLY REROUTES THE SIGNAL TO AN ADJACENT DEVICE ENSURING NETWORK RELIABILITY AND DATA INTEGRITY
MWT Smart Wireless Transmitter

Microcor or Erosion/Corrosion Probe

Battery Operated Transmitter
ER-310 Wireless ER Probe Transmitter

ER-310 Shown with an ER Probe
Wireless Interface Options
Wireless Network Gateway

- Plant Mounting Unit
- Hazardous Area Rating: Class 1 Div 2, or Zone 2
- Talks to 100 transmitters
- Ethernet, Modbus Serial, Modbus IP, and OPC Interfaces
- Web Server control and configuration

Gateway uses Wireless Hart7 Data Protocol with RS485 Output
**Key Benefits:**

- Highly Secure and Reliable Self Organizing Wireless Mesh and Star Network Configurations
- ISA100 Wireless Protocol Seamlessly Integrates With Yokogawa Wireless Networks
- Battery Life of 3 Years
- 1500 ft (450 m) Wireless Range
- Rated for Operation in Hazardous Locations
Cosasco ISA100 Wireless System

Compatible with Yokogawa, Honeywell etc.
Wireless Network Architecture

*The Micriscor Wireless Corrosion Monitoring System can directly read corrosion rate and metal loss data into any Process Automation System (Emerson, Honeywell, ABB, Siemens, GE). Tagged data via a modbus TCP/IP or OPC network.
Microcor Wireless System Benefits

- No sensor cable runs required
- Remote locations easily monitored
- Range can be increased with addition of Extender units (3 x 300m)
- Battery life (2-3yrs) and can be replaced on site.
- Integrated systems – Microcor (ER), LPR, Erosion, Temp/Pressure sensors etc
- Easily integrated into an existing Emerson Smart Wireless systems.
- Reduced cost (no cable runs, less labour and materials, automated data collection). Est least 20% less than a wired CM system.
ICMS3 Corrosion Management Distributed Data System

RCS On-Line Monitoring Hardware

RCS Data Logging Hardware

RCS Coupon Data

Ultrasonic Measurement Data

Process Control System (DCS)

ICMS3 Corrosion Management Server

RCS Software System Support

Customer’s Network System
Water Injection Monitoring

Treated seawater injected into Reservoir to raise well pressure and oil/gas recovery rate.

Oxygen needs to be removed to avoid corrosion issue downhole. Monitoring of dissolved Oxygen and corrosivity of injected water is essential.
Water Injection Monitoring

SEA WATER TREATMENT FOR WATER INJECTION

Water Injection Dissolved Oxygen/Corrosion Monitoring
Water Injection Monitoring - Instrumentation

**LPR/ Galvanic HP Probe**

**Wireless On Line Transmitter**

**On Line Cable System**
Output from LPR Probe gives water corrosivity in mm/yr.

Output from Galvanic Probe gives a relative dissolved oxygen level and used as an alarm for increase of oxygen levels.

Probes are located downstream of main pump on HP side.
Non-Intrusive – Corrosion/Erosion Monitoring

Ultracorr®- Ultrasonic (UT) Wall Thickness Measurement
Ultracorr® - Ultrasonic Wall Thickness Monitor

Fixed Sensor

Transducers permanently bonded to Pipeline before installation
Ultracorr Remote/ Buried Ultrasonic Pipeline Monitoring
Ultracorr Buried Pipeline Monitoring – Sensor Location

Buried Pipeline Low Spot

Buried Pipeline Erosion/Corrosion
Ultracorr2® - ATEX Certified Probe & Data Logger

- UST2 Sensor (A)
- TU-500 Portable Bluetooth Programmer/Data download Unit (E)
- Ultracorr2 Instrument (D)
Remote Monitoring/Inspection

Ultracorr Monitor:
5 minutes.
No scaffolding.

Manual:
1-2 hrs
Plus scaffolding
Ultracorr2® Offshore Erosion Monitor

Outlet Sensor

2x6” Reducer Sensor

Data Logger Units
Ultracorr2® Offshore Erosion Monitor
Ultracorr2® - Benefits

- **Non Intrusive** Wall Thickness measurement based on field proven technology.
- **ATEX Zone1** approved system (Up to 150 Deg C).
- **High sensitivity** and accuracy, resolves to 0.1 mil (0.0025mm)
- Pipe surface **Temperature** measurement
- Pipe wall range 0.1 to 2.0” (2.5 – 50mm)
- Pipe diameter >3”
- **Remote** sensor interrogation – Bluetooth wireless (20m) or cable up to 300’ (100m)
- Easy to install, rugged, permanent sensor fixture
• Provides an ongoing wall thickness loss monitor at critical locations on buried pipelines (eg bottom of line, low spot, C02 or TOL corrosion)
• Monitoring of pipe wall erosion at critical locations eg pipe bends, T sections, downstream of choke etc.
• Multiple sensor measurement with smart tag technology, interrogated using a low cost portable instrument.
• **Data Logger** Option
• Data transfer to PC software CORRDATA for wall loss distribution analysis and trending etc.
• Cost effective system – non intrusive, no consumable, **reduced scaffold access costs** etc.
Integrated Corrosion and Erosion Monitoring
Chemical Injection / Sampling

Chemical Injection - Nozzle
Chemical Injection Dosage Logger (RDC-CI)
Typical Chemical Injection Delivery Systems

Injection Rate Measurement Suitable for a wide variety of applications and chemicals.

- Corrosion Inhibitors
- Scale Inhibitors
- Biocides
- Demulsifiers
- Emulsifiers
- Chemical Additives
Chemical Injection Dosage Data Logger

Chemical Pump injection rate and accumulated flow.
Corrosion Under Insulation (CUI)

Corrosion Sensors
Corrosion Under Insulation
Severe CUI
Corrosion Under Insulation – The Problem.

• Insulation is normally required for heat retention and personnel protection.
• An insulated pipe will have an insulation layer between approx 50 to 150mm thick made typically from Rockwool, Syntactic Foam or Calcium Silicate etc and often with a thin outer cladding made from galvanised steel sheeting or waterproof coating.
• If outer cladding is damaged or not properly sealed then water can seep into the insulation and be retained.
• If conditions are right (oxygen, water, temperature, salts) then severe corrosion of the surface of the pipe may occur.
• Detection and inspection of CUI can be difficult and expensive with current practices.
• Corrosion may not occur even though there is water present in the insulation
• Location of corrosion is difficult to predict.
• Repairs can be expensive.
• Industry needs a low cost solution for detecting and monitoring active corrosion under the insulation.
COSASCO OFFERS THREE LOW COST SOLUTIONS

- CORROSION FUSE SENSOR ARRAY
- CONTINUOUS WIRE “CORROSION FUSE”
- CUI ELECTRICAL RESISTANCE PROBE
Type 1 Insulated Braid ‘Corrosion Fuse’ Wire/Type.

Steel Wire with Teflon Braid
Multiple probe array for insertion through insulation, gives ability to detect corrosion at known locations.

Typically 4 probes in two separate circuits with two ‘corrosion fuse’ sensors per probe. Parallel resistor value used to identify corroded element.

Sealed probe with two sensor elements
1.75”x1.25”x0.17”
(44x32x4.3mm)
Probes inserted through insulation at 4 clock positions around the pipe.
CUI Sensor Circuit Measurement

Circuit resistance checked with a Multimeter.

The design is such that the resistance measured on a corroded sensor will identify which probe and location the corrosion has occurred.
Type 3 - CUI ER Probe

Uses same element design as ‘corrosion fuse’ type probe but incorporates a reference circuit to provide a metal loss measurement.

Can be interrogated by standard ER corrosion probe instrumentation eg Checkmate.
Type 3 - CUI ER Probe

Corrosion Management Solutions
COSASCO® PRODUCT PRESENTATION

Remote CUI Sensor Installation

ALL PROBE TYPES CAPABLE OF REMOTE INTERROGATION VIA EXTENSION CABLE UP TO 150 FT (50M)
Flexible Riser – Polymer Coupon Monitor
COSASCO® PRODUCT PRESENTATION

Flexible Riser – Polymer Coupon Monitor

**Typical Flexible Pipe Composition**

- Carcass (304, 316, duplex,..)
- Polymer (PA11(nylon), PDVF, XLPE, PE)
  - Pressure Sheath
- Hoop strain armour (Z,T,C,..)
- Axial armour (2 or 4 layers)
- Outer polymer sheath (PA11, PE)
- Outer carcass/fire protection
Flexible Riser – Polymer Coupon Monitor

Polymer Coupon Installed in 2” access fitting rigid pipe.

Normally downstream of Flexible Riser End connection.

Polymer Coupon Types

- Disc Coupons
- Dog Bone Coupons
- Bar Coupons

Polymer Coupon Holder and Shroud
Data Management
SAFR – Surveyed Access Fitting Register

• Surveyed Access Fitting Register
• Instigated by Cosasco in response to HSE query on abandoned access fittings
• All fittings serviced by Cosasco are registered in a data base
• Each surveyed access fitting is fitted with a SAFR tag.
• Green SAFR tag for fittings “In Service”
• Red SAFR tag for fittings “Out of Service”
• Details of fittings recorded using SAFR Sheets
• Information logged in SAFR register
Access Fitting Re-Facer Tool

Reconditioning tool for damaged access fitting
Access Fitting Refacer Tool

- Restores Access Fitting sealing face to new condition in a matter of minutes
- No need to replace damaged access fittings.
- Feed system offers low clearance operation with precise feed for controlled cutting
- Can be conducted without shutdown
- Damaged Access Fitting can be reused after re-facing for normal servicing.
Surface Well Test – Solids Erosion Monitoring

The service comprises of:

- Rental of solids / erosion monitoring equipment
- Rental of Non Intrusive Wall Loss Measurement.
- Onsite engineering service / support
- Final well report detailing solids production erosion profiles, correlated to production event logs, verifying the solids cleanup sequence,
Integrated Surface Solids/Erosion Monitoring Systems
QuickSand Probe Well Test Data
Thank You !