Principle of Coupled Multielectrode Sensors and nanoCorr™ Analyzers for Localized and Most Types of General Corrosion

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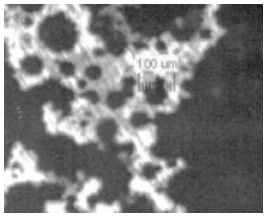
Cathodic sites: $O_2 + 4e^- + 2H_2O = 4OH^-$

Electrolyte (liquid, wet gas, bio-film…)

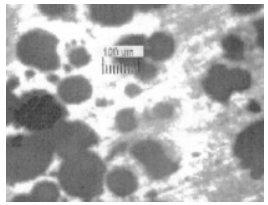
Electrolyte (liquid, wet gas, bio-film…)



Typical localized corrosion

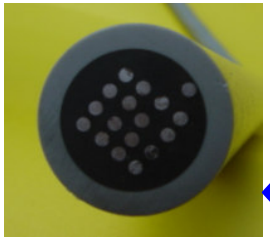
Anodic sites: $M - ne^- + nH_2O = M(OH)_n + nH^+$

(Electrons flow internally from anodic sites to cathodic sites)



Anodic & cathodic sites

Anodic and cathodic sites are separated but coupled externally. Electrons are forced to flow externally



Some electrodes more anodic, some more cathodic

Most corroded electrode simulates deepest pit

Insulators

Coupling Circuits

Instrument couples the electrodes via resistors and measures the electrons from and to individual electrodes

nanoCorr S-50 Multielectrode Probe Analyzer for Real-Time Monitoring of Corrosion Rates, pH, ORP, and Others

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With our CorrVisual™ software, S-50 nanoCorr™ Station measures real-time corrosion rates, corrosion potentials, temperature and other parameters simultaneously from:4 independent **Coupled Multielectrode** probes, 3 **pH** or 3 **ORP** probes, or 3 other transducers for parameters such as **conductivity**, **humidity**, **flow**, and **pressure.**

nanoCorr S-50 Has Exceptionally Wide Auto Range for Corrosion Rates:
20 nanometer/yr (0.0008 mil/yr) to 10 centimeter/yr (4000 mil/yr)

nanoCorr A-50 Multielectrode Probe Analyzer for Real-Time Monitoring of Localized and General Corrosion Rates

Corr Instruments, LLC, San Antonio, Texas , USA www.corrinstruments.com info@corrinstruments.com Phone: 210 748 4073

Powered by our CorrVisual™ software, A-50 nanoCorr™ Analyzer measures real-time corrosion rates and potentials from up to 6 independent **Coupled Multielectrode** probes with exceptionally wide auto range and high sensitivity:

20 nm/y (0.0008 mpy) to **10 cm/y** (4000 mpy) in or under:

Liquid, Gas, Biofilm, Oil, Coatings, Soil and Concretes

Some probes are designed for temperatures and pressures up to 230 atm (3400 psi) and 950 °C (1742 °F). nanoCorr communicates with computer through R-232 or RS-485. The nanoCorr and computer unit may also be accessed anywhere in the world though wireless means or telephone lines

Applications of nanoCorr Analyzers and Coupled Multielectrode Sensors in Concrete and Soil

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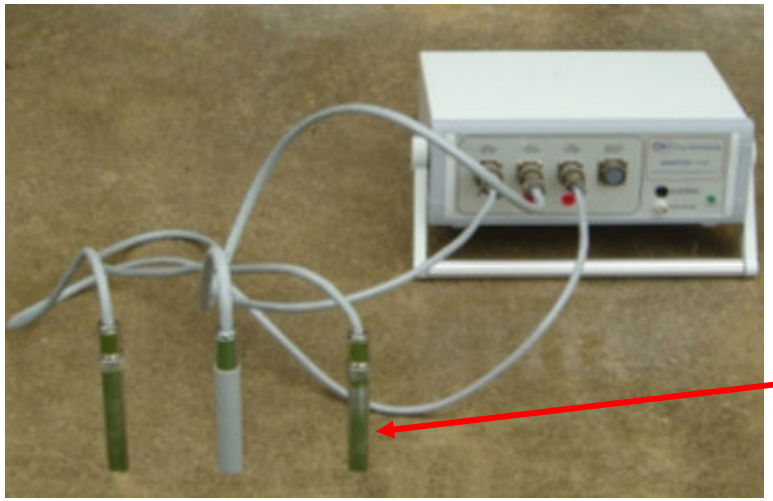
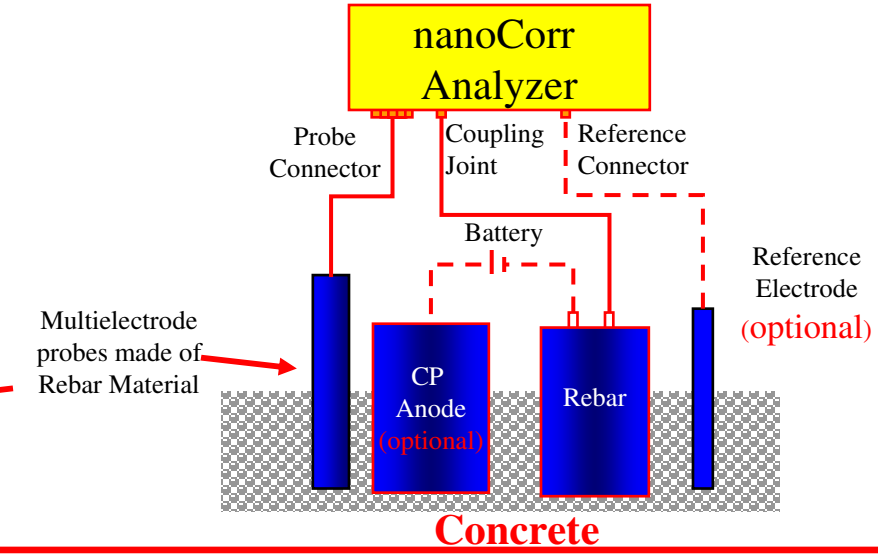
Real-time Measurements of Concrete Rebar Corrosion Rate with or without Cathodic Protection (CP)

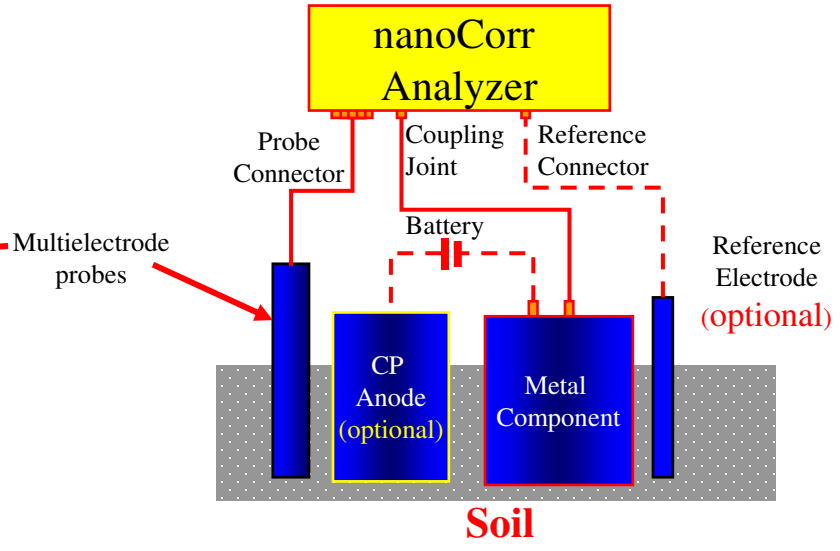


Data are transmitted to Control Station via wireless means



Real-time Measurements of Corrosion Rate in Soil with or without Cathodic Protection (CP)

Data are transmitted to Control Station via wireless means

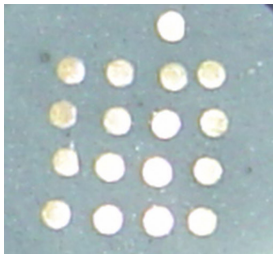


Real-Time Corrosion Monitoring in Drinking Water with Coupled Multielectrode Sensors and nanoCorr™ Station

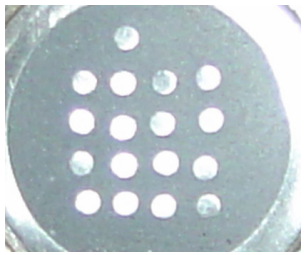
Corr Instruments, LLC, San Antonio, Texas , USA
www.corrinstruments.com info@corrinstruments.com Phone: 210 748 4073

S-50 Monitoring Station measures Corr Rates, Corr Potential, pH, ORP and Temp, and other signals from transducers such as Conductivity, Humidity, Pressure, and Flow Meters

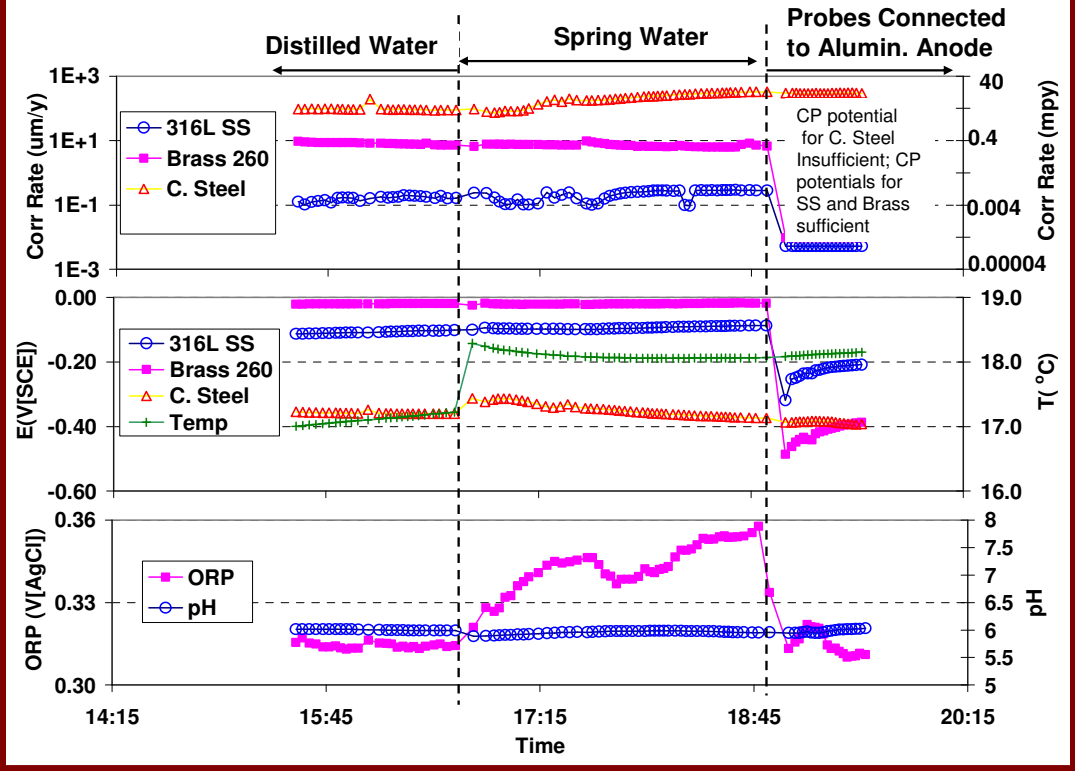
Coupled Multielectrode Probes

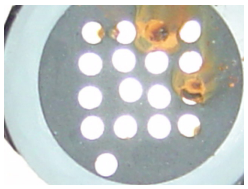


Brass 260 Probe after 8-Days in Spring Water. Discoloration observed on some electrodes



SS 316L Probe after 8 Days in Spring Water. No corrosion products observed





Top View

Side View

C. Steel Probe after 8 Days in Spring Water. Some electrodes were covered by corrosion products. Pitting corrosion was observed

REAL-TIME MONITORING OF CORROSION IN CONCRETE UTILIZING COUPLED MULTIELECTRODE ARRAY SENSORS

CORROSION/2005, Paper #05267 by X. S. Yang, Corr Instruments, LLC
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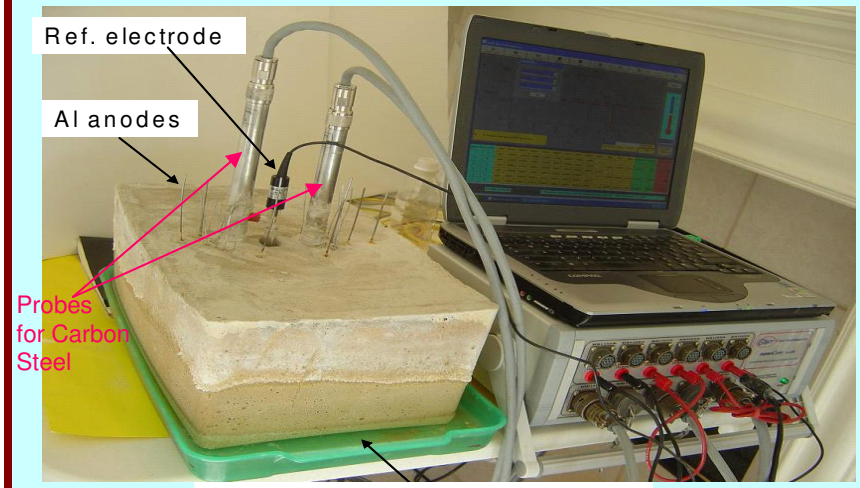
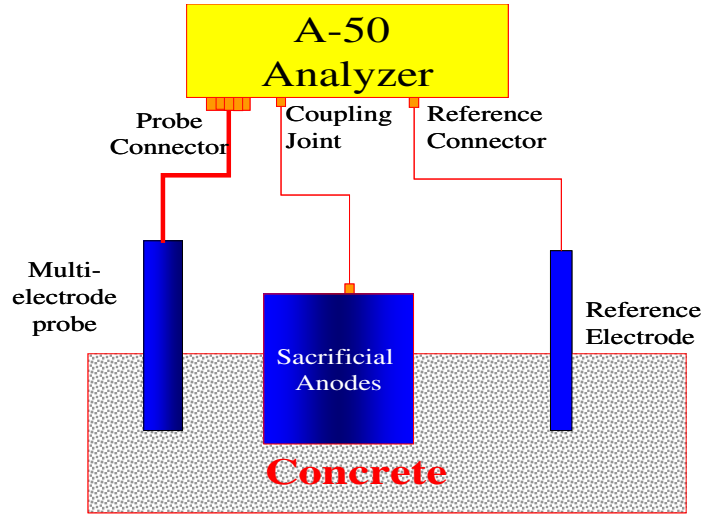
Experimental Setup--nanoCorr A-50 Was Used in the Test

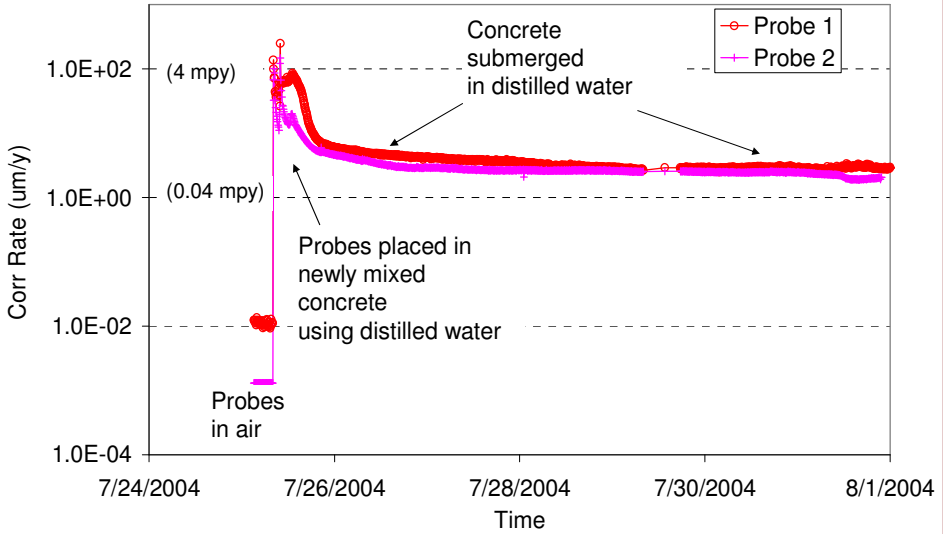


Filled with salt solution or distilled water

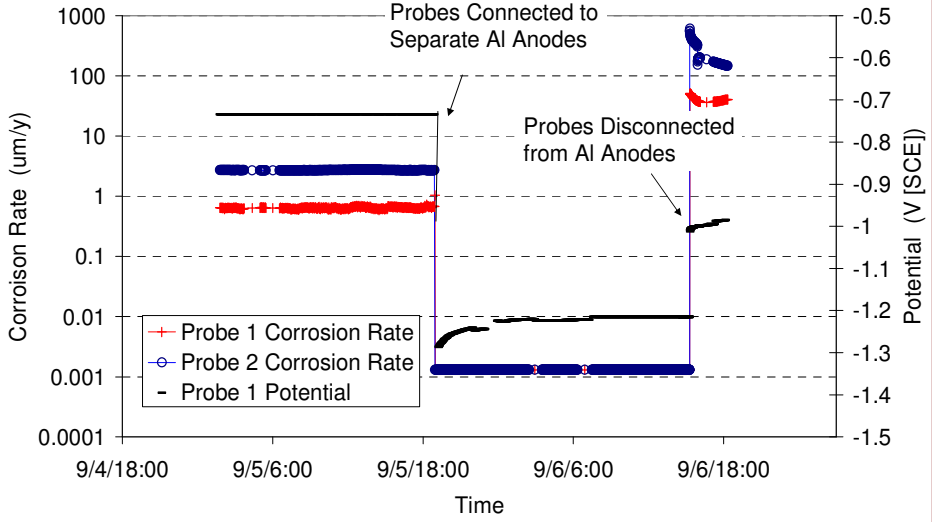
Measurement of Corrosion Rate of CS under Cathodic Protection



Localized Corr Rates of CS in Concrete Submerged in Distilled Water



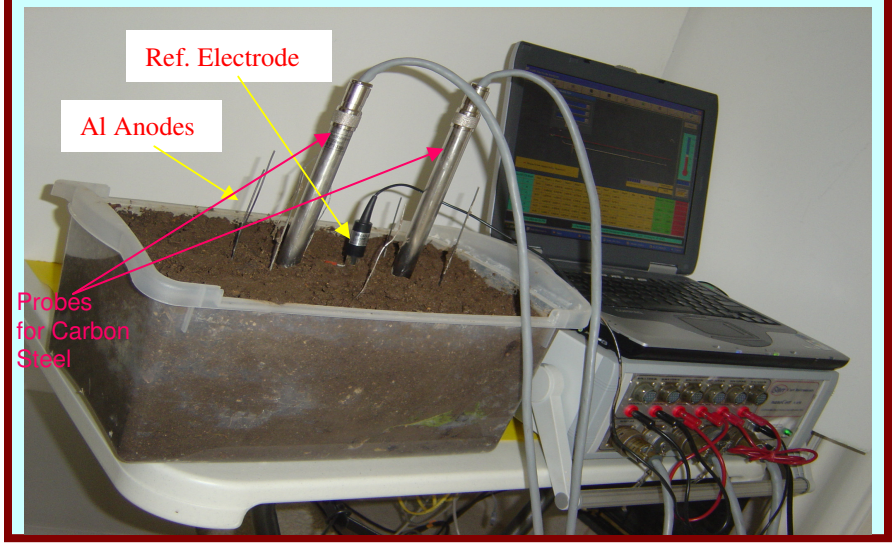
Effectiveness of Cathodic Protection for CS in Concrete



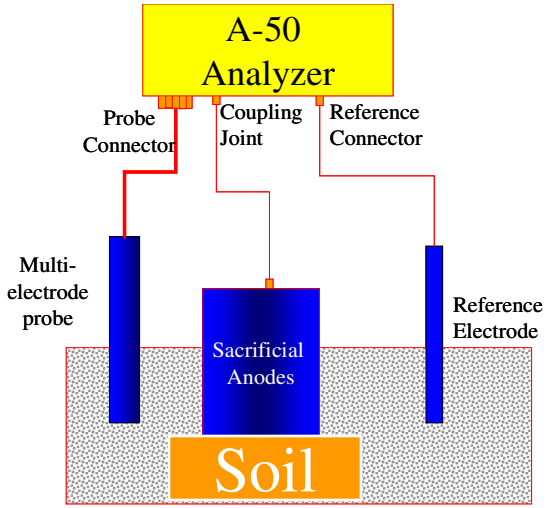
REAL-TIME MONITORING OF CORROSION IN SOIL UTILIZING COUPLED MULTIELECTRODE ARRAY SENSORS

CORROSION/2005, Paper #05381 by X. S. Yang, Corr Instruments, LLC
San Antonio, Texas www.corrinstruments.com info@corrinstruments.com Phone: 210 748 4073

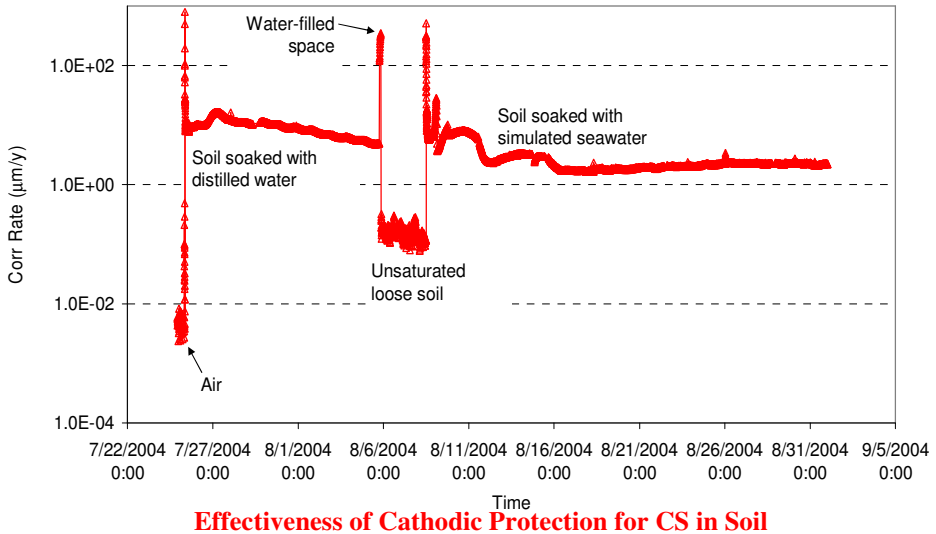
Experimental Setup --nanoCorr A-50 Was Used in the Test



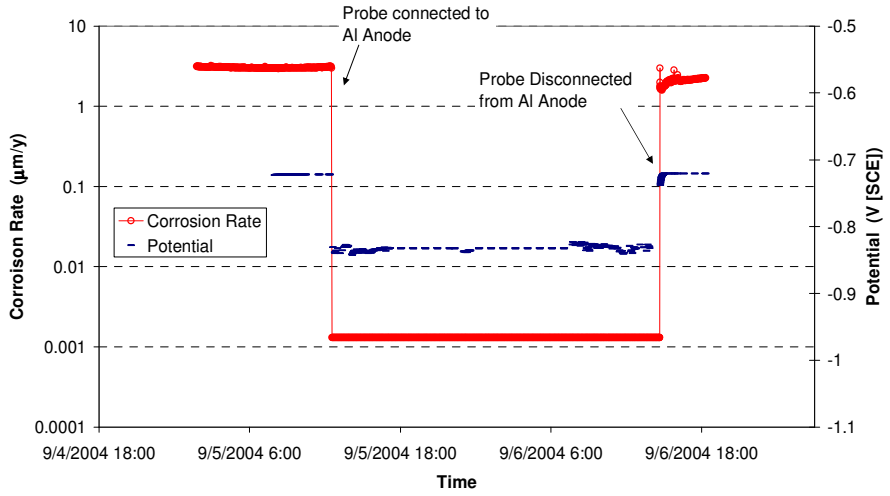
Measurement of Corrosion Rate of CS under Cathodic Protection



Localized Corr Rates of CS in Soil



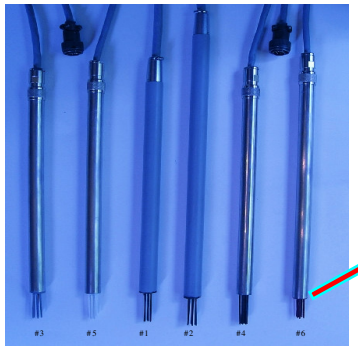
Effectiveness of Cathodic Protection for CS in Soil

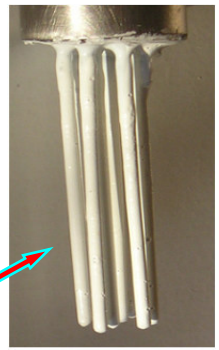


Online Monitoring of Undercoating Corrosions Utilizing Coupled Multielectrode Sensors

CORROSION/2004, Paper #04033 by X. S. Yang, Corr Instruments, LLC
San Antonio, Texas www.corrinstruments.com info@corrinstruments.com Phone: 210 748 4073

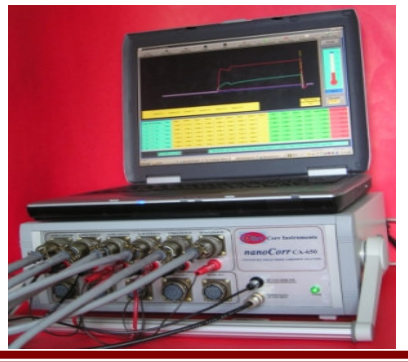
Coated Multielectrode Probes





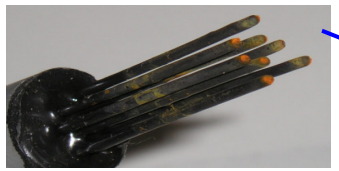
- Carbon steel electrodes of probes were painted with different coatings
- Coatings in some areas of selected probes were mechanically damaged to simulate initial defects
- Probes immersed in simulated seawater

nanoCorr™ A-50 Analyzer



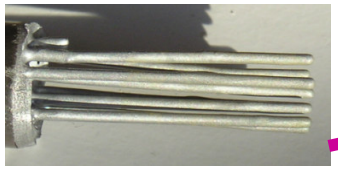
Corr Instruments nanoCorr Model A-50 Coupled Multielectrode Sensor Analyzer was used to simultaneously measure the signals from 6 coated probes

Test Results and Posttest Probe Appearances

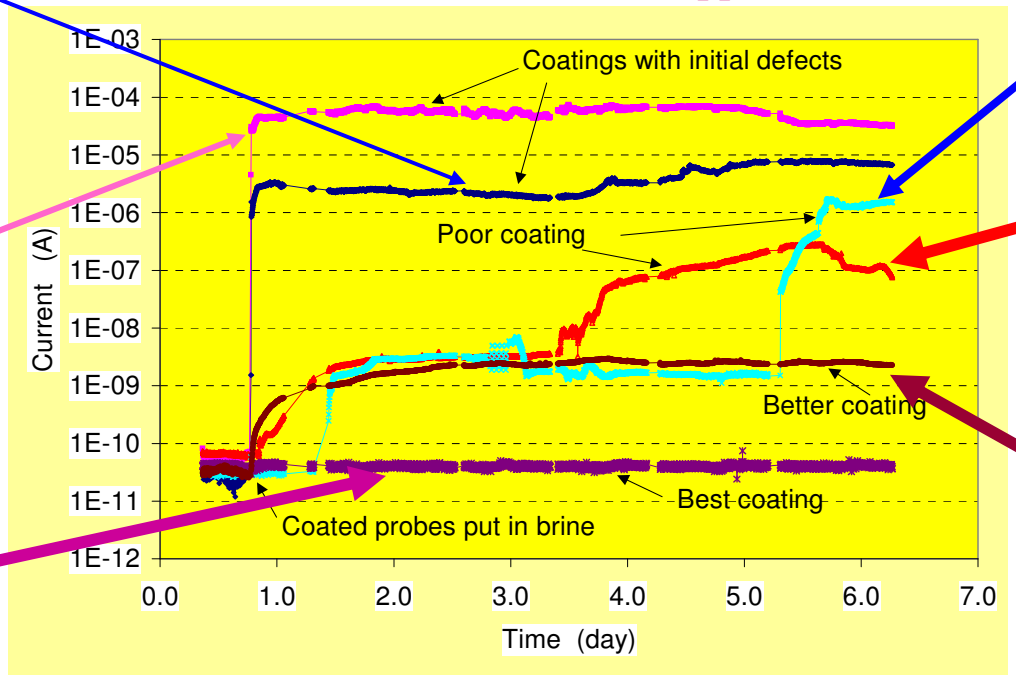


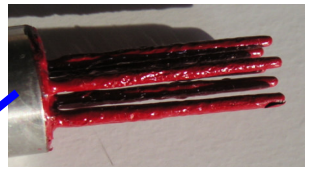
Rust observed on all defected areas after 7-day exposure

Rust observed on defected areas after 7-day exposure



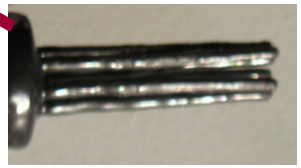
Coating appeared intact after 14-day exposure





A small area of coating peeled off after 7-day exposure

Signal was significant even though coating appeared intact after 14-day exposure



Coating appeared intact after 14-day exposure

Online Monitoring of Corrosion under Cathodic Protection Conditions Utilizing Coupled Multielectrode Sensors

CORROSION/2004, Paper #04094 by X. S. Yang, Corr Instruments, LLC

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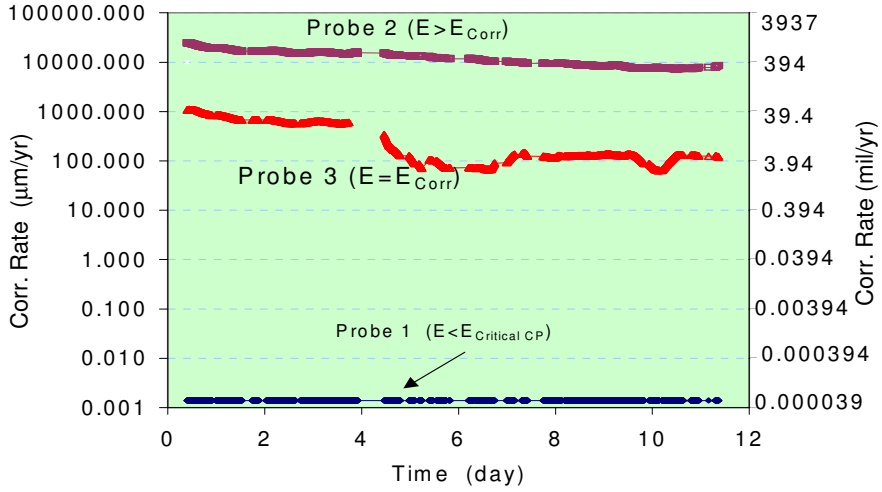
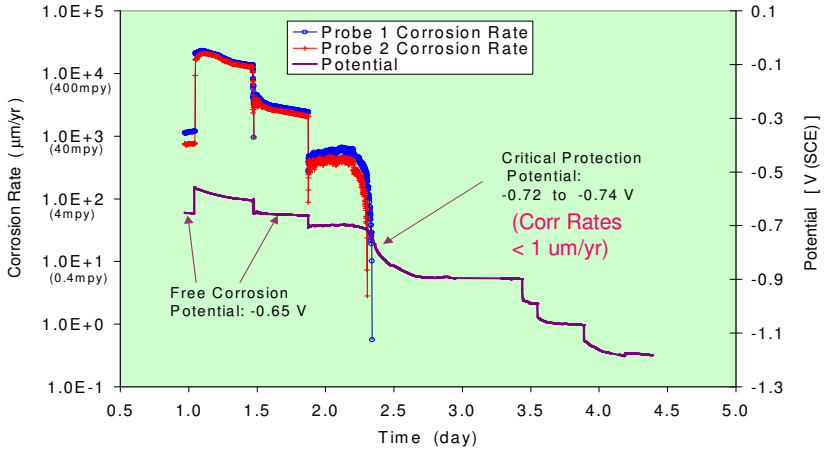
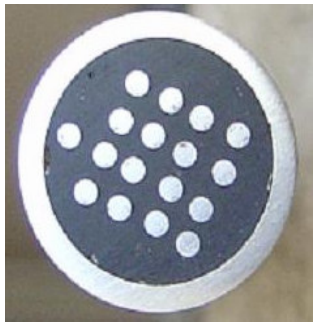
Corrosion Rates of Carbon Steel in Simulated Seawater at Three CP Potentials:
$E > E_{corr}$, $E=E_{corr}$, and $E<E_{Critical\ CP}$



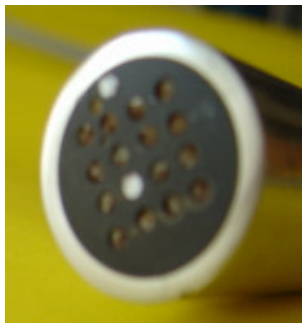
Measurement of Critical CP Potential for Carbon Steel in Simulated Seawater



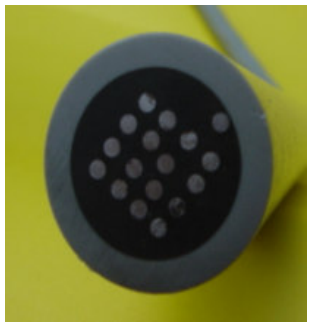
Posttest Probe Appearance



$E<E_{Critical\ CP}$ Probe 1



$E>E_{Corr}$ Probe 2



$E=E_{Corr}$ Probe 3

Mounting Options of Depth-Adjustable Multielectrode Sensor Probes for High-Temperature and High-Pressure Applications

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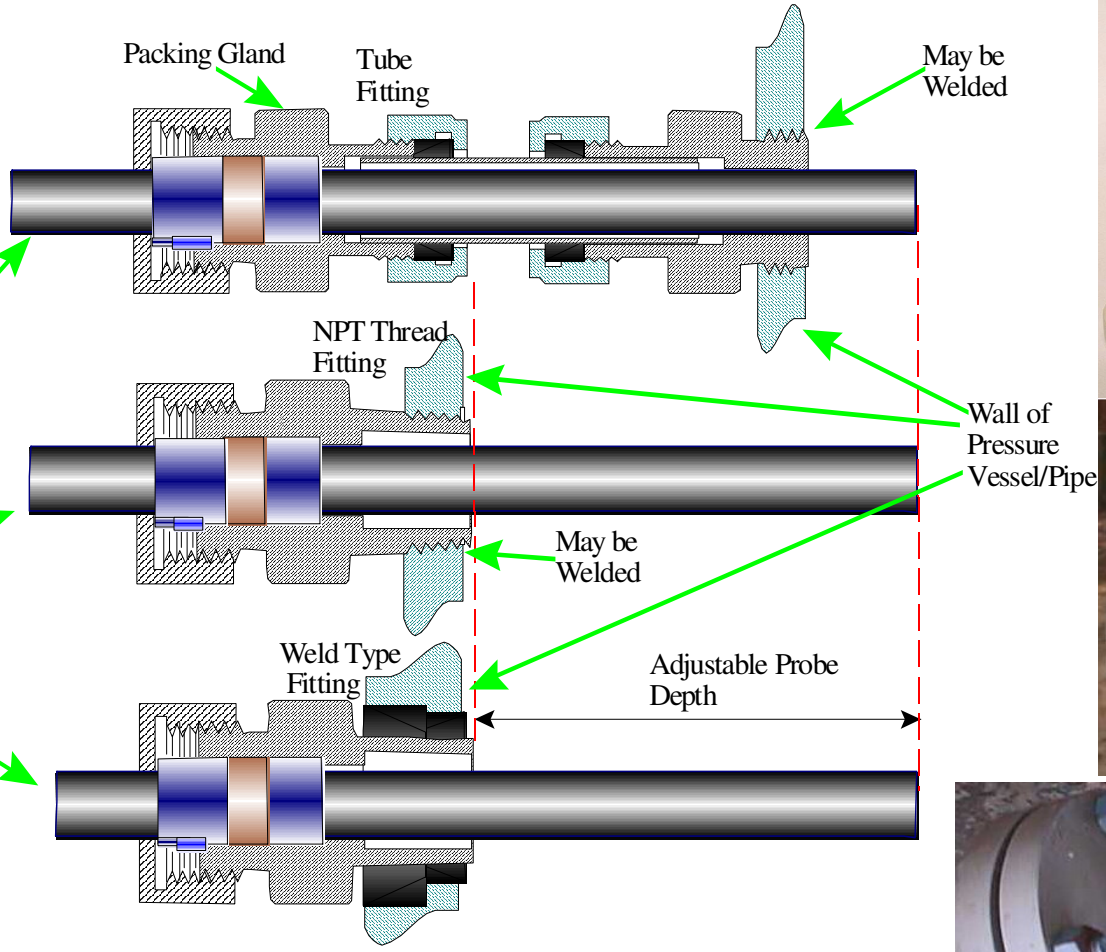
High-Temperature and High-Pressure Probe Fitting



High-Temperature and High-Pressure Probe Insertion Tube

Applications of nanoCorr Analyzers and Coupled Multielectrode Sensor Probes in Liquids, Gases, Soil, Concrete or under Deposits

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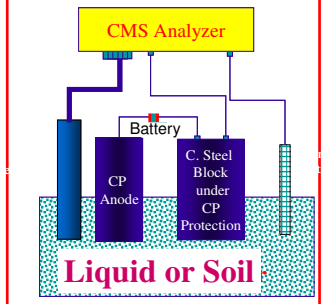
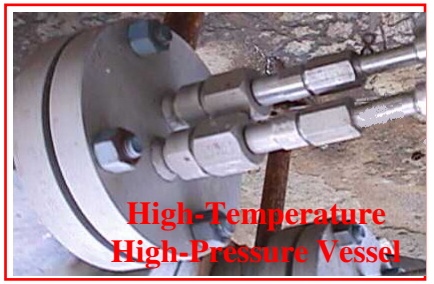
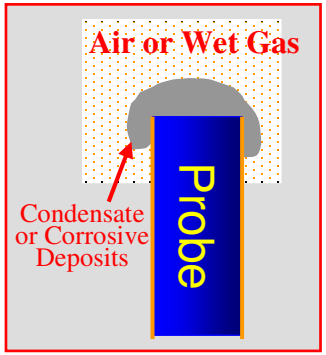
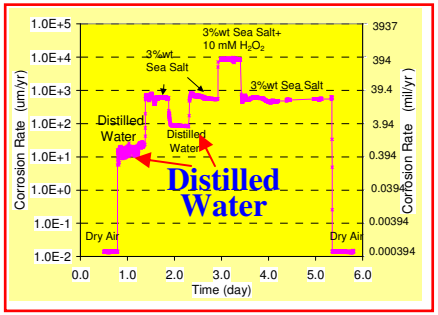
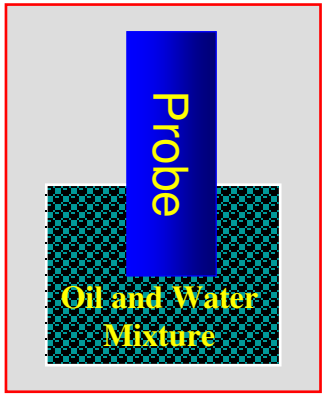


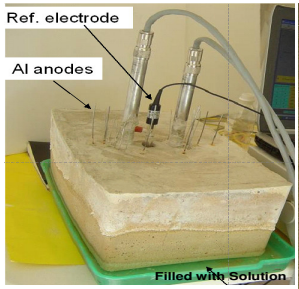
Cathodic Protection

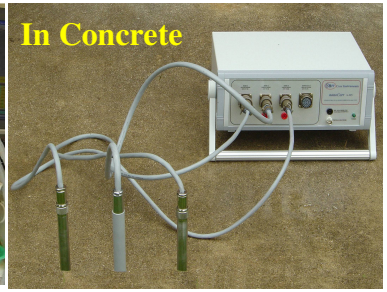












Typical nanoCorr Analyzers for Real-Time Monitoring Localized and Most Types of General Corrosion and for Electrochemical Studies

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 **Model S-50 Station**	Model S-50 measures real-time corrosion rates, corrosion potentials, temperature and other parameters simultaneously from four independent Coupled Multielectrode probes, three pH or three ORP probes, or three other transducers for parameters such as conductivity, humidity and flow.
 **Model A-18 Model S-18**	Model A-18 measures corrosion rate from one or two independent probes, and has one channel for temperature, and two channels for the corrosion potentials of probes. Model S-18 also measures up to three pH or three ORP probes, or three other transducers for parameters such as conductivity, humidity, flow, and pressure.
 **Model A-36 Model S-36**	Model A-36 measures corrosion rate from one to four independent probes, and has one channel for temperature and four channels for the corrosion potentials of probes. Model S-36 also measures up to three pH or three ORP probes, or three other transducers for parameters such as conductivity, humidity, flow, and pressure.
 **Model A-50**	Model A-50 measures corrosion rates from one to six independent probes, and has one channel for temperature, and six channels for the corrosion potentials of probes.