WATER INJECTION SYSTEMS - CORROSION MONITORING
Overview

Water, used for well injection is normally treated seawater and thus it is critical to control the corrosivity of the fluid, prior to injection downhole. The normal practice is to remove the dissolved oxygen and kill the marine bacteria. The oxygen entrapped in the seawater can dramatically increase the corrosivity of the fluid both in the topside pipework and downhole tubulars.

Bacteria and marine organisms are easily removed using biocide or chlorination treatment. Dissolved Oxygen can be reduced by an aeration process and final control by Oxygen scavenger, chemical dosing.

The seawater is pumped downhole above the reservoir pressure and often there will be a two stage pump system used.

The oxygen content will normally be measured in ppb with an ‘on line’ analyser instrument, but these tend to be expensive, delicate and have limited pressure capacity.

The dissolved Oxygen level can often be affected by air being drawn in through leaking pump seals, poor valve maintenance or incorrect oxygen scavenger dosage. It is therefore recommended to monitor the corrosivity of the seawater and for detecting increases in the dissolved oxygen due to these effects.

Material selection is one means of reducing loss of containment due to internal corrosion and Duplex CRA pipe material is often chosen but expensive compared to carbon steel. There are two very reliable and robust, probe monitoring techniques that can assist in measuring and controlling the fluid corrosivity. Eg LPR and Galvanic intrusive probes. An LPR probe will provide an instantaneous corrosion rate of the seawater and a galvanic probe will rapidly detect an increase in the dissolved oxygen level.

It will be important to react to increases in the treated seawater corrosivity and thus it is recommended that any probe monitoring system is installed as an ‘on line’ communication system, tied back to the plant DCS, where alarm settings can be maintained. The corrosion effects on water injection downhole tubulars and consequent effects on reservoir produced fluids can be damaging, if not controlled topside.

The combination of the LPR and the Galvanic probe techniques is a powerful tool as the LPR probe will give an actual measurement of the fluid corrosivity while the Galvanic probe gives a rapid response to an increase in dissolved oxygen content. These probes would normally be installed via 2” access fittings in the topside WI pipework just prior to the water injection riser connection.

Hardware Description

1. LPR-Corrosion Rate Probe

The Cosasco Linear Polarisation Resistance (LPR) probe will provide an instantaneous corrosion rate reading (um/yr). Corrosion rates are determined electrochemically (by Stern-Geary’s equations) from the measured polarisation resistance and with patented Solution Resistance Compensation (SRC) technology to provide an instantaneous
corrosion rate and field proven ‘Pitting Tendency’ results. The probe electrodes must be fully immersed in the electrolyte where fluid corrosivity is measured.

Use of LPR-probes requires a conductive electrolyte and are therefore mainly recommended for water systems, oil systems with high water contents, and for detection of corrosion due to accumulated water condensation.

In the case of a Water Injection system, this technique is often applied in tandem with Galvanic probes for confirming the corrosivity of the treated water injection fluids before being injected downhole.

The LPR Probe electrodes are replaceable and normally made of Carbon Steel, although other electrode materials CRA, copper etc. can be provided to suit the pipe material.

The LPR Online, Intrusive Corrosion Monitoring System can be based on the Corrater LPR hard wired or Wireless comprising:

- **Cosasco® Two-Inch Flanged Access Fitting Assembly**, or 2” Hydraulic in material selected to suit piping, complete with Hollow Plug, 3 Hole Pressure Retaining Cover c/w Pressure Gauge and Bleed Valve. Meets NACE MR0175 and MR0103.

- **Cosasco E-9020 digital or LPR 310 (CWT-3905)** - Wireless transmitter, mounted directly on the probe, using the appropriate probe adapter or alternatively via a probe/tx cable (option for locations with limited access). Connection to the monitoring system is made via Emerson Smart Wireless Mesh or ISA 100 wireless network.

- **Cosasco Model 6080 (LPR) High Pressure Probe**, with two carbon steel elements. Probe Length will be chosen to suit; pipe wall thickness and access fitting type for monitoring at pipe wall with protruding electrodes positioned in the flow. The probe can have flush or intrusive elements selected in carbon steel or CRA material.

*High Pressure, up to 6,000 psi*
2. Galvanic Probe - Dissolved Oxygen Monitor

The Galvanic Dissolved Oxygen probe is based on the LPR probe with brass/steel electrodes.

Galvanic probes are used for detecting dissolved oxygen in water injection systems and based on an intrusive probe which incorporated two elements, one brass and the other steel, which are exposed to the injected water. A galvanic current is measured between the elements which will be proportional to the electro-potential difference and conductivity of the electrolyte (water). The probe can be supplied with flush or protruding electrode elements. The flush element is selected for high flow rates and long life for position at 6 o'clock on the pipe, while the protruding electrode probe provides a higher response.

The Cosasco Model 6080, Galvanic-probe is designed for two, electrode brass and steel, galvanic current readings. The probe electrodes must be in contact with the electrolyte where fluid conductivity is measured.

In many cases, this technique will be applied in tandem with the LPR probe technique for confirming the conductivity due to increased dissolved oxygen in the treated water injection fluids, before being injected downhole. The Galvanic technique is sensitive to these changes and would normally be used as an early warning of possible oxygen intake from a leaking valve or loss of de-aeration and oxygen scavenger.

The same instrumentation as used with the LPR probe (ref 3) is used with the Galvanic probe application.

Galvanic Intrusive Corrosion Monitoring System, can be Hard Wired or Wireless Online, comprising:

- **Cosasco® Two-Inch Flanged Access Fitting Assembly, or 2” Hydraulic in material selected to suit piping, complete with Hollow Plug, 3 Hole Pressure Retaining Cover c/w Pressure Gauge and Bleed Valve. Meets NACE MR0175 and MR0103.**

- **Cosasco E-9020 digital or LPR 310 (CWT-3905) Wireless Transmitter, mounted directly on the probe, using the appropriate probe adapter or alternatively via a probe/ tx cable (option for locations with limited access). Connection to the monitoring system is made via Emerson Smart Wireless Mesh or ISA 100 network.**

- **Model 6080 LPR Probe, with steel and brass elements. Lengths chosen to suit monitoring at pipe wall with protruding electrodes positioned in the flow.**
3  LPR / Galvanic Instrumentation.

The Cosasco E-9020 hard wire or LPR 310 (CWT-3905) Wireless Transmitter instrument is mounted directly on the probe, using the appropriate probe adapter or alternatively via a probe/tx cable (option for locations with limited access). Connection to the monitoring system is made via the Emerson Smart Wireless Mesh incorporating the HART7 protocol or ISA 100 network system. Note same communication system as used with Quicksand, ER, LPR and Galvanic probes.
The instrument unit measures the polarisation current and computes the instantaneous corrosion rate (um/yr) and pitting tendency before digitising the readings for subsequent transfer via cable or wirelessly, to the DCS or ICMS3 via the wireless network Gateway (see diagram below). The transmitter electronics are fitted inside IP66 SS housing and complete system is certified to Zone 1, ATEX Ex d (ib) IIC T4 code for intrinsic safety operation in Zone 1, with a temperature rating of -40 to +70°C.

Power requirement: internal 7.2 v lithium power module with battery life of 2 to 3 yrs depending on measurement interval. Note battery can be changed without hot work permit restrictions.

Summary

A dramatic increase in the corrosivity of the fluid both in topside pipework and downhole tubulars is often caused by oxygen entrapped in the seawater. An online corrosion monitoring system using a combination of LPR and galvanic probes provides a powerful tool to monitor the corrosion rate in seawater and an increase in the dissolved oxygen level.

For more product details follow the links below.

E-9020 Digital LPR Transmitter
LPR-310 Wireless LPR Transmitter
6080 LPR Probe