Application Note
Water Injection Systems Corrosion Monitoring

PROCESS DESCRIPTION

In many oil production fields, the method of choice for a secondary recovery operation is water injection. In coastal or offshore locations, sea water is used as the injection fluid. For land-based production, the available waters include produced water (which is separated from the produced oil), well water, or ground water from nearby lakes. Prior to injection into the formation, each of these various types of waters must pass through a water preparation plant whose purpose is to purify, filter, and deoxygenate the water. A diagram of a typical water injection plant is shown in Figure 1.

PROBLEM IDENTIFICATION

Ground water is purified to remove silt and organic impurities. A very thorough filtration is performed to reduce the amount of small particles in the water, which if allowed to remain in the water, would plug the geological formation and cause injectivity problems. The filters used for this purpose are prone to harbor bacteria, whose rapid growth eventually causes corrosion and plugging problems. A biocide is added to the system ahead of the filters. Chlorine is usually used in this location because bacteria cannot build up a resistance to it as with other biocides.

The next step in the process is oxygen removal. The diagram shows a deaeration (mechanical) unit which may be either a vacuum deaerator or a natural gas scrubber-type deaerator. Some systems using produced water or well water which have not been contaminated with oxygen do not require deaeration. In any case, the oxygen content needs to be reduced to 50 ppb or less to maintain reasonable corrosion control.

When a natural gas-scrubber type deaeration is used where the carbon dioxide content of the scrubbing gas is high, the pH of the water at the deaerator outlet can drop into the range of 3.5 to 5.0. This will cause additional corrosion problems unless corrected. An oxygen scavenger should be added to the water to ensure a consistent low oxygen content. To prevent reintroduction of oxygen into the prepared water, care must be taken to blanket all storage with inert gas.

The water is fed to the booster pumps which raise the pressure to as much as 3000 psi for injection.

MONITORING DISCUSSION

Monitoring corrosion in three strategic areas will provide information on the corrosivity of the injection water and help operation personnel pinpoint the causes of off-specification water.

Deaerator Outlet:

Monitoring corrosion at the deaerator outlet detects problems with deaerator operations and insufficient scavenger injection rate.

Storage Tank Outlet:

Measurement of corrosion rates at the outlet of the storage tank detects problems with the inert gas blanket or other sources of oxygen contamination.

Downstream of the Booster Pumps:

At this point, where pressure and velocity are greatest, corrosion monitoring is very important. Although the water composition is the same as in the storage tank, the corrosion rate will be dependent on the velocity and on the partial pressure of oxygen in the system, which will be highest in this area.

Corrosion weight loss coupons, galvanic probes, and linear polarization resistance (LPR) probes are the monitoring methods of choice. Coupons, placed in the system for a fixed time period, will provide a single, averaged corrosion rate for that amount of time. As such, coupons are best suited for those locations where "long-term" corrosion data is used as a verification of other monitoring information.

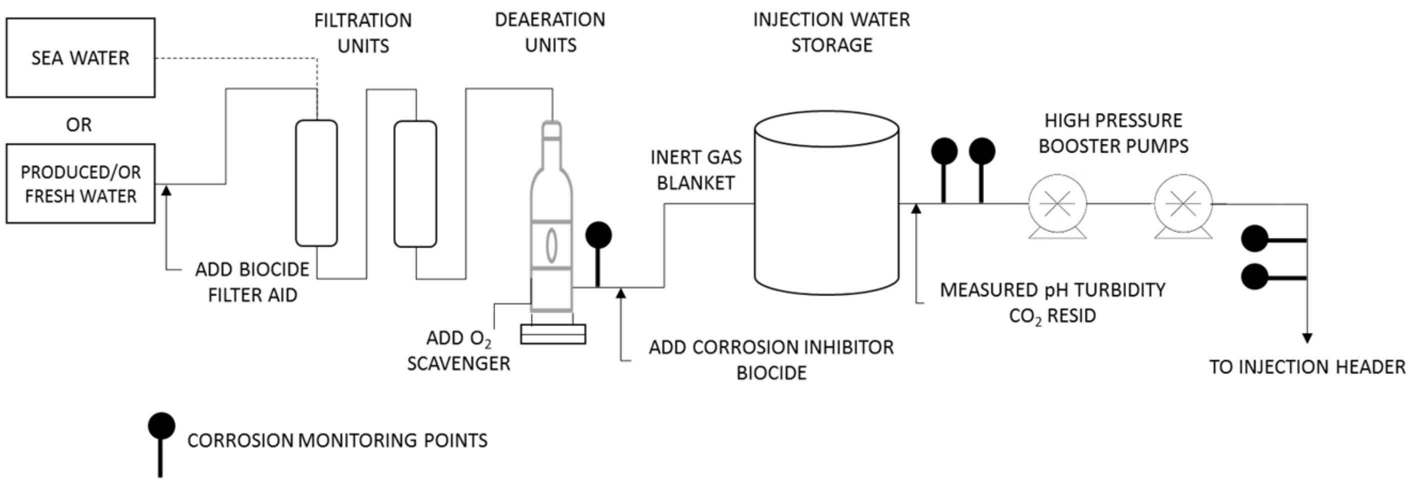


Figure 1: Typical Injection Water Preparation Plant

LPR probes will provide instantaneous corrosion measurements and, therefore, signal upset or changing conditions at the time it is occurring. This allows the ability to make immediate system control changes to optimize conditions within the plant and prevent serious corrosion problems.

Galvanic probes can also play an important role in this system. Galvanic probes utilize two electrodes of dissimilar metals as the sensing device, and therefore establish a potential difference which will remain at a given value within a corrosive environment. If any change in the corrodent occurs at the point where the probe is located the potential of the electrode will also change. The galvanic probe, therefore, signals any upset conditions almost immediately. This probe is especially useful for detecting oxygen leaks, or changes in the concentration of oxygen downstream of the booster pumps or in other areas where sudden changes are likely to occur.

Careful consideration must be given to the choice of metallurgy and design of the coupons or electrodes. The intent is to have the corroding coupon or electrode most closely match that of the system component being monitored since it is the device that is affected by and is monitoring the corrosion process. Coupon and electrodes can be constructed of virtually any metallurgy desired. Coupons can also be of any design: cylindrical, strips, or discs.

Consideration of the methods of introducing the monitoring device into the system is also of importance. Typical holder styles are:

Fixed: Welded into a hex busing or flange, this holder is will be threaded into or mated with the corresponding pipe nipple or flange. Insertion and removal of the monitoring device is achieved only during plant shutdown and system depressurization.

Retractable: Equipped with a sliding body through a packing gland assembly, this holder will attach to a valve/nipple connection and allow insertion and removal of the monitoring device while the system is still online at pressure up to 1500 psi.

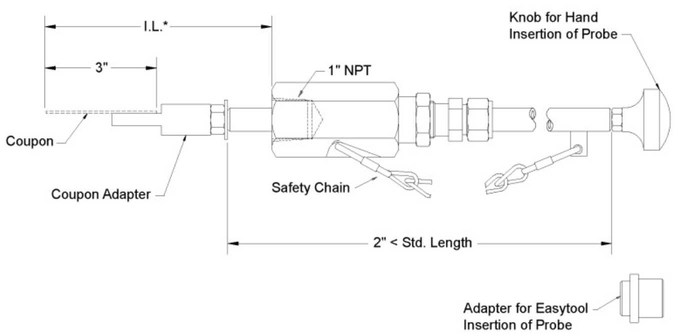
Retrievable: This style requires an access fitting assembly that is welded to the pipe or vessel, and a service valve. The sensing device can then be inserted into the process utilizing a retriever tool while the system is under operating pressure up to 3600 psi.

COUPON MONITORING RECOMMENDATION

The following are samples of equipment which Metal Samples offers for coupon monitoring. Other holder styles, coupon types, and metallurgies are available as standard items, or can be custom made to a particular requirement. If further information is desired, please refer to http://www.alspi.com/coupons.htm, or contact Metal Samples directly.

RT4000

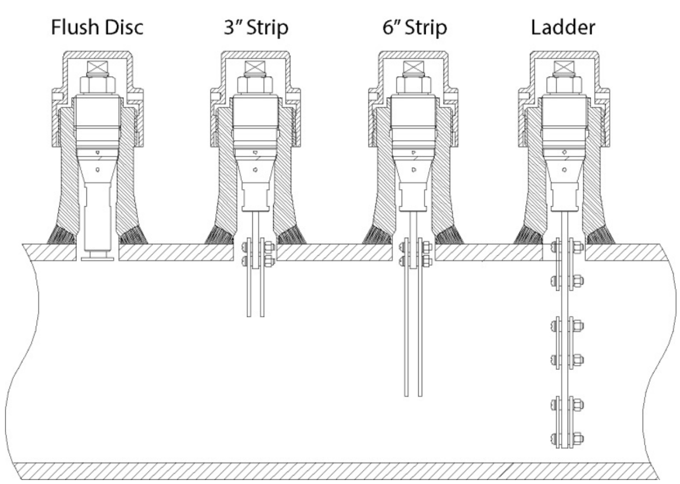
Retractable coupon holder with choice of one of three interchangeable tips for cylindrical, disc, 1-hole strip, and 2-hole strip coupons. Rated 1500 psi, 500° F with Teflon® or 850° F with Grafoil.



RT4000 Retractable Coupon Holder

HC series coupon holder

High pressure coupon holder for industry standard 2-inch high pressure access fittings for strip coupon, flush disc coupon or ladder (strip or disc) coupons.



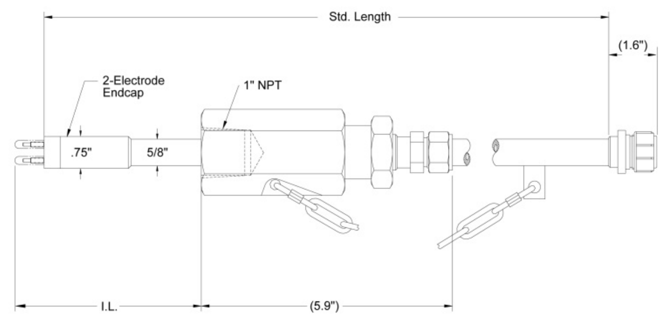
HC Series Coupon Holders

LINEAR POLARIZATION RESISTANCE (LPR) MONITORING RECOMMENDATION

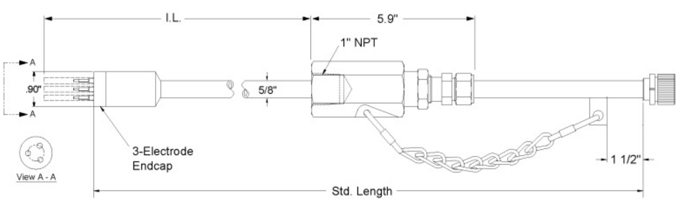
The following are samples of equipment that Metal Samples offers for LPR monitoring. Other probe styles and electrode metallurgies are available as standard items, or can be custom made to customer requirements. If further information is desired, please refer to http://www.alspi.com/lprintro.htm or contact Metal Samples directly.

LP4000 and LP4100

Retractable LPR probe with packing gland in 316L stainless steel for 2-electrode and 3-electrode systems.



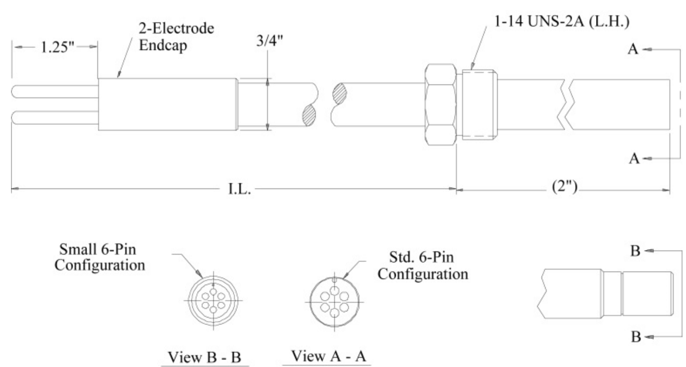
LP4000 LPR Probe



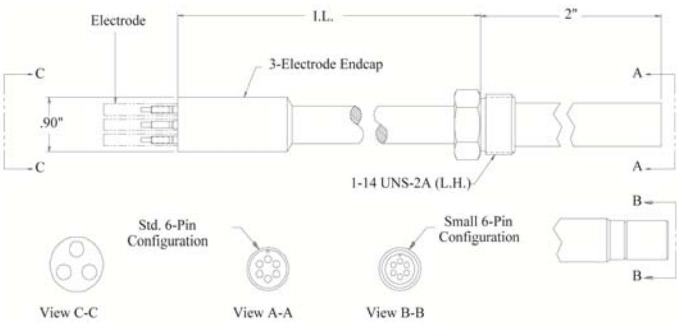
LP4100 LPR Probe

LP7000, LP7100 and LP7210

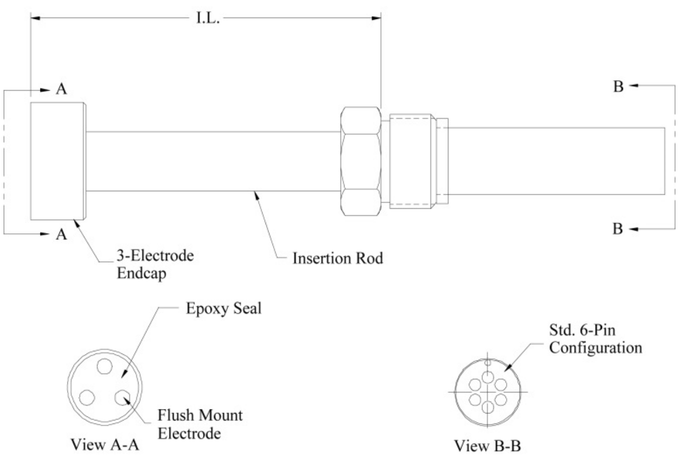
High pressure LPR probe for industry standard 2-inch high pressure access fittings for 2-electrode and 3-electrode systems in 316L stainless steel.



LP7000 LPR Probe



LP7100 LPR Probe



LP7210 LPR Probe

MS1500L

Portable LPR Instrument

MS3500L

Battery powered standalone LPR Data Logger

MS2900L

Advanced electrochemical measurement transmitter with 4-20mA/HART output for continuous monitoring.

METAL SAMPLES SUPPORT SERVICES

Each corrosion monitoring system's design requirements will vary according to the application and the plant infrastructure requirements. Metal Samples' application support team is recognized in the industry to provide plant-specific design support, subsequent implementation and maintenance of the entire system. This allows corrosion engineers to concentrate on the corrosion monitoring data and their analysis of that data to get the maximum benefit from the implemented system.