Linear Polarization Resistance (LPR) General Information

Introduction

Linear Polarization Resistance monitoring is an effective electrochemical method of measuring corrosion. Monitoring the relationship between electrochemical potential and current generated between electrically charged electrodes in a process stream allows the calculation of the corrosion rate. LPR is most effective in aqueous solutions, and has proven to be a rapid response technique. This measurement of the actual corrosion rate allows almost instant feedback to operators. LPR monitoring has seen wide industry use for nearly 50 years.

Linear Polarization Resistance Theory

Electrical conductivity (the reciprocal of resistance) of a fluid can be related to its corrosiveness. A two or three electrode probe is inserted into the process system, with the electrodes being electrically isolated from each other and the process line. A small potential in the range of 20mV (which does not affect the natural corrosion process), is applied between the elements and the resulting current is measured. The polarization resistance is the ratio of the applied potential and the resulting current level. The measured resistance is inversely related to the corrosion rate.

The electrical resistance of any conductor is given by:

$$R = \frac{V}{I}$$

Where **R** = Effective instantaneous resistance
V = Applied voltage
I = Instantaneous current between electrodes

If the electrodes are corroding at a high rate with the metal ions passing easily into solution, a small potential applied between the electrodes will produce a high current, and therefore a low polarization resistance. This corresponds to a high corrosion rate.

Advantages

The major advantage to LPR monitoring is the speed in which it can provide a measurement of the corrosion rate. Changes in the corrosion rate can typically be detected in minutes, providing an almost instantaneous measuring system. This fast response allows an operator to evaluate process changes and is particularly useful in monitoring the effectiveness of a prevention program. For example, quick feedback means that inhibitor selection and quantities can be evaluated and fine-tuned in minimal time.

Another key advantage of LPR monitoring is that it can provide a qualitative pitting tendency measurement, such as whether the tendency for pitting will be shallow and infrequent, or deep and abundant. LPR monitoring can also give an indication of metal behaviour, for example when an alloy changes from a passive to an active state, thereby resulting in increased susceptibility to corrosion.

Caproco LPR probes can often have long lives, depending on the monitoring conditions and maintenance care. For projecting probes, the electrodes are replaceable, which extends probe life and offers options in electrode material types for different monitoring objectives.

Probe Types

Caproco produces a variety of LPR probes, each of which have different characteristics and applications. Consult the selection guide on the following page for information on different element types.

Caproco LPR probes come in three main designs: Retrievable, Retractable and Fixed.

Retrievable

Retrievable probes can operate in systems pressurized up to 6,000 psi. The probe is mounted on a hollow plug, through a high pressure access fitting. By using a Caproco retriever and service valve, the probe can be changed / inspected with no interruption to the system. Readings can be taken any time by connecting a portable instrument / data logger or probe signal transmitter to the probe's standard 6 pin electrical connector.

Retractable

Retractable probes are intended for lower pressure systems, and are rated up to 1,500 psi. The probe is inserted through a low pressure access fitting, and is secured in place by a safety clamp. It can be removed under pressure either manually or by using a Caproco Sidewinder Retractor, and readings can be taken at any time with no system interruption.

Fixed

Fixed probes are usually mounted on line through flanged or NPT threaded bodies. The actual probe body maintains line pressure, so they cannot be removed until the system is shut down, however readings can be taken at any time without system interruption. Certain models are rated for operating pressures up to 10,000 psi. Fixed probes provide an economical and easy-to-use option for electronic monitoring.

Instrument

A critical component to measuring corrosion rates electronically is the instrument used to interpret the data. Caproco has designed a high quality, field-proven LPR Analyzer instrument that can take an instantaneous corrosion rate measurement, or act as a data logger, storing information for later analysis.

CAPROCO LPR PROBE SELECTION GUIDE

Probe Style	Characteristics	Element	Most Suitable For Use In	Less Suitable For Use In	Element Diameter
Projecting	-Wide selection of element materials -Glass sealed element -Replaceable Electrodes	2 Element or 3 Element	Aqueous solutions/systems with water content -Areas that are not pigged or have hydrates	-Systems with dry gas or heavy oil	0.25"
		5 Element	-Situations where multi-functional monitoring is desired (Electrochemical Noise, LPR, Galvanic)		0.25"
Flush	-Not affected by edge corrosion or high velocity	Flush (2,3,5 Element)	-Measuring conditions at wall surface -Locations that require pigging	-Fluids which attack glass and ceramics (e.g. Fluorides) -Systems with dry gas or heavy oil	0.25"