CAPROCO
INTERNAL CORROSION MONITORING SPECIALISTS

Electrical Resistance (ER) General Information

Introduction

One of the most common electronic methods of monitoring corrosion is using the electrical resistance technique. This technique involves measuring the change in electrical resistance of a conducting element, and using this rate of change to calculate the corrosion rate. ER monitoring has been used in industry applications for over forty years and is a proven on-line measurement technique in wet and dry conditions.

Electrical Resistance Theory

Electrical Resistance probes operate on a straightforward concept. As a conductive metal element is exposed to a corrosive environment, its surface area will be reduced, thereby lowering its conductivity and increasing its electrical resistance. Readings from the sensing element are relative to a non-corroding reference element sealed within the body of the probe. Small changes in resistance can be detected by a sensitive measuring instrument.

The electrical resistance of any conductor is given by:

$$R = \frac{\rho L}{A}$$

Where **ρ** = Resistivity
L = Element length
A = Cross sectional area of the element

A separate reference element allows testing of the internal integrity of the probe. Through careful design, the reference element also serves in eliminating thermal variations. Since temperature variations can have an effect on resistance, the reference element is subjected to the same temperature as the exposed element, which ensures consistent measurements.

Probe elements are made of a material similar to that of the pipe or vessel in which it is placed, in order to simulate as closely as possible the corrosive environment. By taking periodic readings over a fixed time interval, the rate of metal removal can be determined and a corrosion rate in mils/year can be calculated.

Advantages

Caproco ER probes allow readings to be taken at any time with external connections to a Caproco ER Instrument or Data Logger, thereby eliminating the need to remove the probe from the line or interrupt operations. Continuous monitoring in a control room can be achieved via hardwiring or remote telemetry, thereby providing instantaneous feedback on process changes.

ER probes are the most flexible of the electronic probes in terms of their possible applications. Because the technique is not dependant on an electrochemical reaction, a current-carrying electrolyte is not necessary. ER monitoring can be used to measure virtually all environments, such as solids, non-aqueous liquids, gases and vapors; all of which can be of high or low conductivity.

By complementing probe readings with corrosion coupons exposed over the same time interval, the two measurement techniques will verify the quantitative results. ER probes can rapidly indicate changes in corrosion rates, and will show when the changes took place, which is helpful in evaluating process decisions.

Probe Types

Caproco produces a variety of ER probes, each of which have different characteristics and applications. The lifespan of all probes is inversely proportional to their sensitivity. A probe becomes more sensitive as the element thickness is reduced, and therefore the time interval in which it can measure a change in resistance is decreased, providing faster response. However in a highly corrosive environment, a thinner element will degrade faster, thereby reducing the life of the probe. A clear understanding of the environment being monitored and the urgency in which information is needed will help in selecting a probe that will optimize the lifespan/response time decision. Consult the selection guide on the following page for information on different element types.

Caproco ER 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 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 held 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 bullplug-style 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 ER Analyzer instrument that can take an instantaneous corrosion rate measurement, or act as a data logger, storing information for later analysis.

CAPROCO ER PROBE SELECTION GUIDE

	Probe Style	Characteristics	Element	Most Suitable For Use In	Less Suitable For Use In	Element Thickness	Element Code
Most Sensitive ↕ **Most Robust**	Loop	-Greatest sensitivity -Wide selection of element materials -Glass sealed element	Tube Loop	-Areas of low corrosion -Situations that call for rapid detection of changes in corrosion rate	-Fluids which attack glass and ceramics (e.g. Fluorides)	4 mil 8 mil	TL4 TL8
		-Second most sensitive -Element constructed of single length of solid wire	Wire Loop	-Areas of general corrosion	-Locations susceptible to pitting or heavy deposits	40 mil 80 mil	W40 W80
	Flush	-Not affected by edge corrosion or high velocity	Flush	-Measuring conditions at wall surface -Locations that require pigging	-Extremely high temperature locations	10 mil 20 mil	F10 F20
		-Not affected by edge corrosion or high velocity	Flush Strip	-Specialized underground, concrete and underwater probes	-Extremely high temperature locations	8 mil 20 mil 40 mil	S8 S20 S40
	Cylindrical	-Most rugged element design -High integrity seal -Element welded directly to probe body -Less susceptible to bridging	Tubular	-Highly corrosive environments prone to deposit buildups, pitting -Situations that require more exotic alloys -High temperature or high velocity settings	-Suitable for virtually all applications	10 mil 20 mil 50 mil	T10 T20 T50