Information : 20100610

Pipeline Corrosion Risk Analysis

LINAR : Resistivity Surveys

Observations of electrical resistivity can be used to indicate **corrosive soils**. Several survey methods may be used during an evaluation depending on local conditions.

Resistivity can be readily measured using the **Wenner or Dipole-Dipole four-point** method (ASTM G-57). This method measures the average resistivity of large volumes of soil based on the spacing of the individual electrodes.

The **LINAR** survey method used by **Elorane** resembles the Dipole-Dipole Linear Array but no fixed electrodes are required; ground contact is wholly capacitive allowing for relatively rapid traverse speeds resulting in much higher productivity.

Corrosive Soils

Measurements of soil resistivity have been used for many years as an indicator of risk caused by pipeline corrosion. Corrosion is an electrochemical activity associated with a current flow between two sections of pipe. Conductive soils provide an external link between any two sections containing an anode and a cathode. Consequently soil resistivity surveys can provide an indication of the maximum potential corrosion rate for critical pipeline assets.

The process occurring at the corroding anode location involves a transfer of metal into ions in the electrolyte or a conversion into insoluble corrosion products such as rust. The flow of electrons between the corroding anodes and the non-corroding cathodes forms the corrosion current, the value of which is determined by the rate of production of electrons by the anodic reaction and their consumption by the cathodic reaction.

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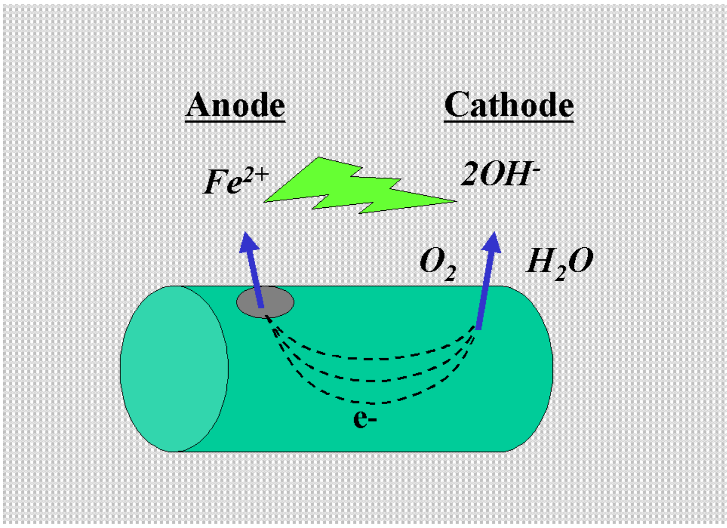
The rates of electron production and consumption, must be balanced by external equilibration of ions in the soil to avoid a buildup of charge at the pipe surface. Dry resistive soils provide a barrier and consequently limit the corrosion rate. In contrast damp saline sections with low resistivity favour rapid equilibration rates and maximum potential corrosion activity.



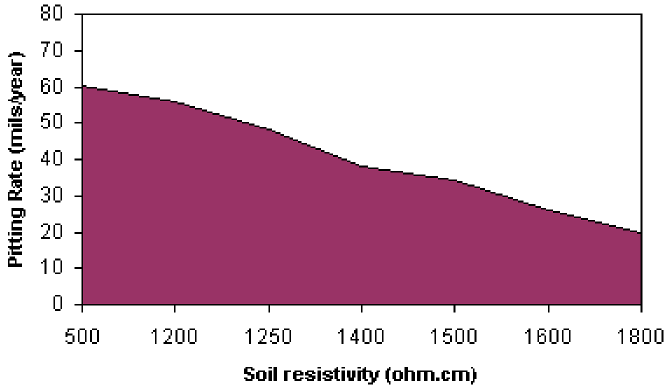
Resistivity is a property of both the bulk volume of soil and the electrolytes surrounding a pipe system. Although there is no absolute standard, it is generally agreed that the classification shown below, or other similar classifications, reflect soil corrosivity as a function of in-situ resistivity.

Resistivity (ohm-m)	Corrosivity
0 to 5	Very Corrosive
5 to 10	Severely Corrosive
10 to 20	Moderately Corrosive
20 to 100	Mildly Corrosive
> 100	Progressively Less Corrosive

Tables of this type provide a qualitative indication of corrosion potential for a metal buried in a soil of known resistivity. In general, deterioration can be expected to be rapid and relatively severe in soils below 10 ohm-m. Normally severe corrosion will not occur in soils of higher resistivity (except for some unusual chemical conditions) since equilibration currents are highly restricted.

A driving force (a voltage or EMF) is necessary for electrons to flow between the anodes and the cathodes. This driving force is the difference in potential between the anodic and cathodic sites. This difference exists because each oxidation or reduction reaction has associated with it a potential determined by the tendency for the reaction to take place spontaneously. The corrosion potential is a measure of this tendency; it can be measured using Tafel analysis of soil samples in the laboratory or directly observed as a self-potential at the pipe surface.

Pitting Rates

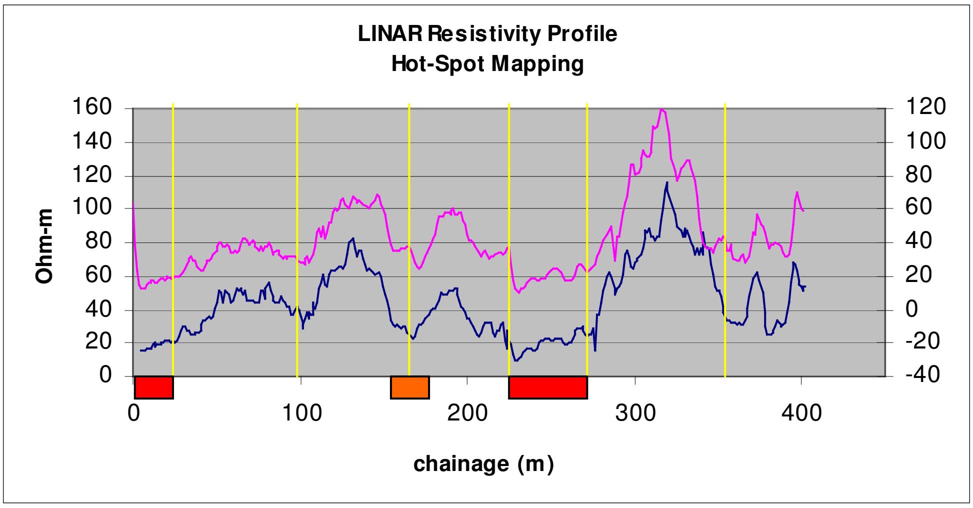


Soils of low resistivity are also likely to cause more rapid pitting attacks on ductile iron at rates that increase as the resistivity decreases. The shaded area in this Figure gives a typical range for the average maximum pitting rates for ductile iron pipe as a function of soil resistivity. It is compiled from data found by various surveys and studies done in the U.S., Canada and Europe.

LINAR Surveys

Resistivity variations along a critical pipe main may be readily assessed using the LINAR survey method. Surveys can be conducted at a relatively rapid rate with no surface impact and minimal disruption to traffic. Data can be obtained at close spacing to identify any lateral changes in soil properties which provide a focus for local corrosion "hot-spots".

LINAR Surveys provide the most effective method for any initial pipeline risk analysis. A comprehensive knowledge of soil properties can provide a direct indication of the potential for corrosion at any location and assist with the selection of test pits for more direct NDT investigations. LINAR data also allow the extrapolation of local NDT results over significant lengths showing similar electrical response.



LINAR resisitivity profiles indicating potential corrosion "hot-spots" and lateral variations in soil condition. Two traces from separate surveys indicating consistent response in urban setting.