

Inline Cathodic Protection Current Mapping – Applications

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Abstract

While inline cathodic protection (CP) current mapping is not necessarily a new technology, it has not been available to corrosion professionals for several years. It has recently been reintroduced for commercial use in liquid pipelines. The body of corrosion professionals needs to be made aware of the unique advantages that Inline CP current mapping offers in certain applications. This technology directly and continuously reads voltage drop in the pipeline wall that is created by the flow of CP current returning to its source. These voltage drops are then converted to current values using a simple Ohm's Law calculation. The resulting current values are then plotted against pipeline footage to create a map of all the current pickup, flow direction, and magnitude for the pipeline. This map reveals all sources and drains of current, provides a visual representation of all current flow to and on the pipeline, and allows changes in current density to be readily identified and measured.

This paper will present several applications where inline CP mapping provides clear, easily understood information to help operators understand and mitigate pipeline CP issues.

Keywords: Cathodic Protection, Current Mapping, Pipeline Integrity, Current Density

Introduction

Inline cathodic protection current mapping is a unique method of assessing a pipeline's cathodic protection. This is accomplished by measuring the actual current received by the pipeline continuously along the entire pipeline length. Unlike pipe to soil potentials, which can have a great deal of error in them due to forces often beyond our control, the CP mapping tool uses the physical properties of the pipe itself to measure the CP current. The pipe is a very stable part of the circuit, unlike the soil surrounding it. In a CP mapping inspection, there is no need to interrupt current sources and drains to eliminate IR drops that cause potentials to be erroneous. CP mapping inspections are conducted with all current sources and bonds in their normal day to day operating mode.

This paper will show specific applications where inline CP mapping provided otherwise unobtainable data that assisted greatly in making integrity decisions about the pipelines inspected.

Pipeline Access

Traditional above ground CP surveys require access to the pipeline right of way. This is problematic for some pipelines. Difficult to access areas are quite often simply skipped during a traditional pipeline CP survey. Rivers, lakes, swamps, major highway crossings, airports, etc, are not impossible to conduct surveys through – they are just time consuming and therefore expensive and impractical. They also happen to be areas where product releases could have devastating consequences. Unfortunately, due to the expense to conduct valid surveys through these types of difficult access areas, operators are quite often somewhat blind to the protection levels on their pipelines in these areas. Since inline cathodic protection current mapping is done from inside the pipe, it is an excellent choice for assessing pipelines that have access issues. Whether access is limited due to swamps, marshes, pavement, or terrain difficulties, the inline CP mapping tool can still provide detailed information about line current, current densities, and therefore coating quality without having to step foot on the right of way.

Figure 1 below demonstrates how lack of access contributed to a long-standing CP issue that was only discovered after an inline CP inspection. In this figure, a pipeline that originated on one side of a river had always exhibited good pipe to soil potentials at the pig launching facility. The next downstream opportunity to take a pipe to soil was at a buried mainline valve approximately 2 miles downstream and across the river. This location had historically exhibited acceptable pipe to soil potentials as well. There was a large 70+ amp rectifier just 2000 feet downstream of the valve. Based on these observations, it was assumed that the pipe under the river was receiving adequate current to protect it as well. However, results of the inline CP inspection revealed that an undocumented bond to an abandoned water line just downstream of the launcher was stealing most of the current from the launcher area and that the valve at 10,000 feet was in fact isolated and preventing current from the 70+ amp rectifier from protecting any further upstream. This left roughly 10,000 feet of pipeline with little to no protective current – underneath a major US river.



Figure 1

Overall Current Map

In figure 2 below, the overall current direction and magnitude on a 6.5 mile pipeline is shown. Studying the current map reveals a good deal of data that is not available by observing pipe to soil potentials solely. The current map identifies each current source, the coverage area of each current source, and reveals the coating quality for every foot of the pipeline. In this map, we see that this pipeline has relatively long areas of what appears to be good coating as indicated by the low current density (flat current plot), but it also shows short areas with extremely high current density (sharp increases in the current plot). This map also reveals that the third rectifier is heavily biased to send most of its CP current downstream rather than upstream. This is due to a recent pipe replacement upstream of this rectifier and very poor coating downstream of this rectifier as indicated by the many short, sharp current increases.

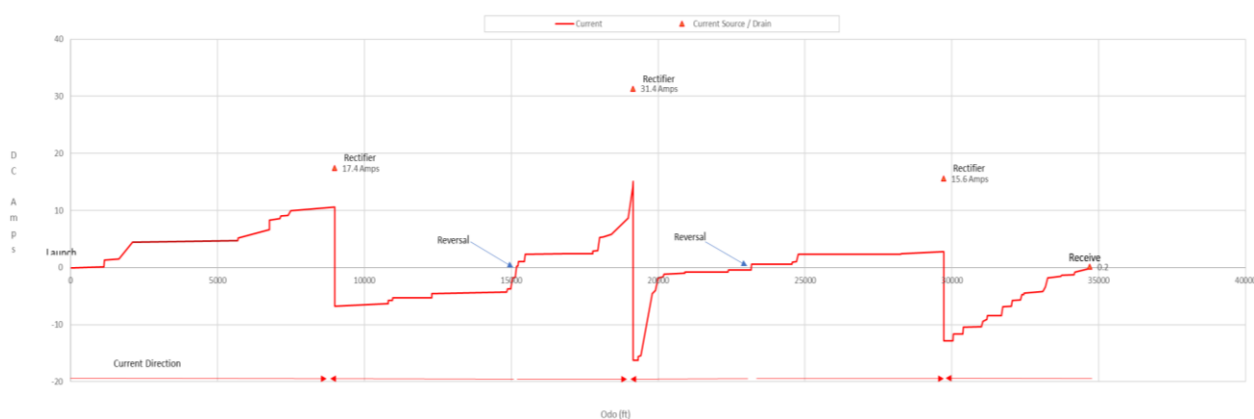


Figure 2

A current map such as this provides the ability to visualize the CP current that is protecting the pipeline in a manner that has been previously unavailable. It provides greater understanding of current distribution and therefore better understanding of how a pipeline will react to changes in current if rectifiers are adjusted.

Unknown/undocumented bonds

Inline current mapping technology excels at identifying bonds. Historical CP mapping data has proven that operators do not always know about all pipeline bonds. Current mapping inspections regularly locate electrical connections to other pipelines that the operator did not know existed. These undocumented bonds can introduce significant error if they are not accounted for in current interruption plans. Undocumented bonds can happen for a variety of reasons. They can result from test station wiring becoming shorted together inadvertently, or simply be the result of pipelines in close proximity settling and contacting one another. Regardless of the cause, it is quite important to know the location of each bond so that these can be interrupted along with all other current sources and drains when obtaining IR free pipe to soil data.