

# GE RCM Allows Refinery to Precisely Measure Pipe Corrosion When Processing High Acid Opportunity Crudes

## Background

Knowing the types, locations and severities of possible impacts to the refinery processes allows GE and Refinery Engineers to jointly develop appropriate mitigation strategies. The core of these strategies will be NDE tools, essential for establishing baseline conditions in certain high impact areas, gauging these impact and interpreting the level of control, and mechanical and chemical recommendations designed to maintain system control and integrity. Implementation of these strategies will allow the refiner to take full advantage of the profit opportunity.

System monitoring is an essential component of every refineries risk based inspection strategy. Unfortunately, as more unknown crudes are produced and processed the reliance on past history for corrosion monitoring becomes less reliable, and dependence on real time monitoring becomes more critical. Monitoring experiences, with traditional techniques like ER probes, UT, radiography and hydrogen activity, show there is not one technique or method that provides all the information necessary to effectively monitor an entire refinery system for high temperature naphthenic acid corrosion.

Fortunately, recent monitoring advances by GE technologists have gone a long way to address some of the limitations and deficiencies of these traditional techniques, and to establish new standards of accuracy in data acquisition and interpretation. The patented RCM (Resistance Corrosion Monitoring) provides actual pipe wall thicknesses to within 2% of total pipe wall thickness to a  $6\sigma$  design, or 3.4 defect reading in a million readings, accuracy. The RCM operates on the same underlying principal as traditional ER probes and other similar devices, but provides much more accurate and

meaningful information. From the principal, as corrosion reduces the amount of metal, the resistance to a current flow increases so by measuring the change in voltage the wall thickness can be calculated and actual pipe condition determined. With the RCM, a grid or array of pins is welded directly onto the section of pipe to be monitored. The pins are then attached by wires to a data collection device that measures the voltage drop across the pins. To enhance this simple principle and assure accurate measurement, GE Engineers applied advanced signal processing techniques to correct for thermal gradients, EMI, parasitic thermocouple voltages and other common mode noises. So unlike ER probes that provide a corrosion rate measurement, which can then be used to extrapolate system metal loss and equipment life expectancy, the RCM provides a direct measurement of pipe wall thickness and change in pipe wall thickness over time that can then be used to directly determine equipment life expectancy and indirectly calculate a corrosion rate. The advantage of accurately defining the condition of the pipe provides the refiner with data needed to make reliable processing decision.

In addition to the aforementioned advantage, the RCM has additional advantages over other similar devices. These advantages of the RCM over other traditional methods for monitoring pipe wall integrity or summarized in the Table 1:



Find a contact near you by  
visiting [gewater.com](http://gewater.com) or  
e-mailing [custhelp@ge.com](mailto:custhelp@ge.com).

**Global Headquarters**  
Trevose, PA  
+1-215-355-3300

**Americas**  
Watertown, MA  
+1-617-926-2500

**Europe/Middle East/Africa**  
Heverlee, Belgium  
+32-16-40-20-00

**Asia/Pacific**  
Shanghai, China  
+86 (0) 411-8366-6489

Table 1: Advantages of RCM vs. Traditional Monitoring Methods

Feature	RCM	UT	X Ray	ER
Extensive area coverage	Yes	No	No	No
Read multiple times per week	Yes	Costly	More Costly	Yes
Monitor inaccessible piping with no scaffolding	Yes	No	No	Yes
Direct measurement of pipe wall thickness	Yes	Yes	Yes	No
Install without breaching pipe wall or impacting corrosion	Yes	Not Installed	Not Installed	No
Measure a 2% wall loss to 6 sigma accuracy	Yes	No	No	No

## Challenge

A North American refinery processing a high acid opportunity crudes, with TAN values in all high temperature streams in excess of 2.0 mg/gm TAN, was experiencing corrosion at a rate of approximately 15 mpy and as indicated by ER probes. The pipe experiencing the corrosion was segment of piping from the atmospheric tower heavy oil stripper to the stripper bottoms pump.

The ER probe was located in a straight run of pipe and was more than 10 pipe diameters from any elbows. The system was being treated with a corrosion inhibitor. Refinery personnel questioned the accuracy of the ER probe, and were concerned that the 15 mpy metal loss could be worse in areas of high wall shear stress. The concern was that the limited visibility into the actual pipe condition, and the absence of valid data made an accurate assessment of the remaining pipe life impossible. Without the remaining pipe wall life expectancy operational and business decisions would be made

without complete information and would expose the refinery to unknown risk.

## Solution

An RCM was installed on a segment of pipe from the bottom of the stripper to the pump in an area that was immediately up stream of the ER probe. The RCM pin array was placed over an area that contained both an elbow as well as straight run pipe.

## Results

The data from the RCM and ER probe were compared. Corrosion rates of the piping under the RCM array were significantly lower than the corrosion rate observed by the ER Probe. (Figures 1, 2, 3) Not only was the corrosion rate observed by the RCM much lower than that measured by the ER probe but the only loss of metal noted by the RCM was indeed located immediately after the elbow in the area of highest shear stress. Because of the data, the refinery personnel were able to determine that the corrosion in the loop was being controlled and the pipe wall integrity had not been compromised.

The complete analysis of the data also revealed an interesting trend on the one pin pair of the RCM that was showing metal loss. Figure 4 clearly shows an increase in the rate of metal loss (to a rate of 6 mpy) from April through July and an additional stepwise increase in metal loss (to a rate of 12 mpy) from July through August. The data presented in this manner provides for direct analysis of cause and effect relationships so that any fundamental changes in results can be quickly analyzed, and cause and effect relationships defined so that operational changes can be implemented.

Using the data from the RCM, refinery personnel were able to make clear, concise and unambiguous operating and business decisions.

### RCM

Wall < 318 mils  
 Start Date: 2/3/2005  
 Stop Date: 8/23/2005

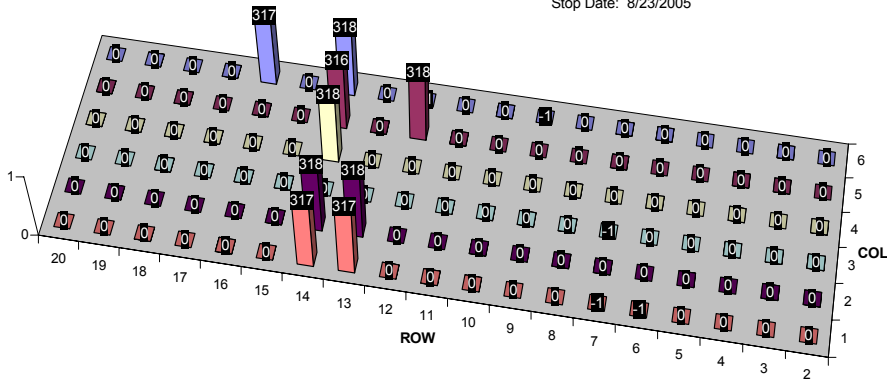


Figure 1: RCM Results Wall Thickness

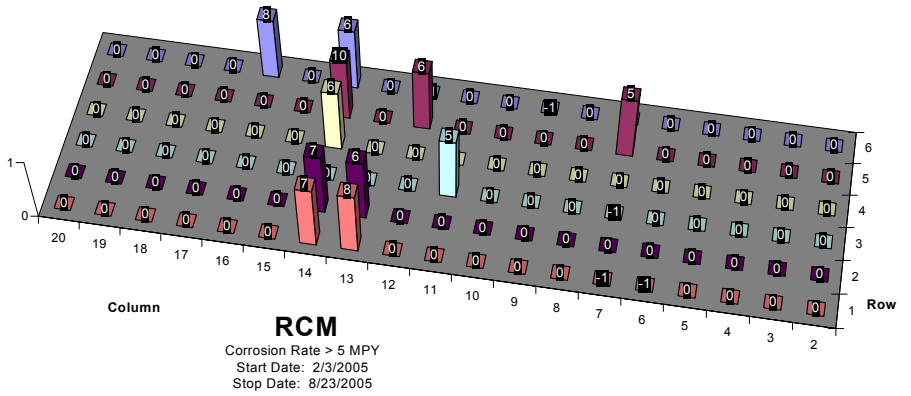


Figure 2: RCM Corrosion Rates

### Process Capability Analysis for ER Probe Cor

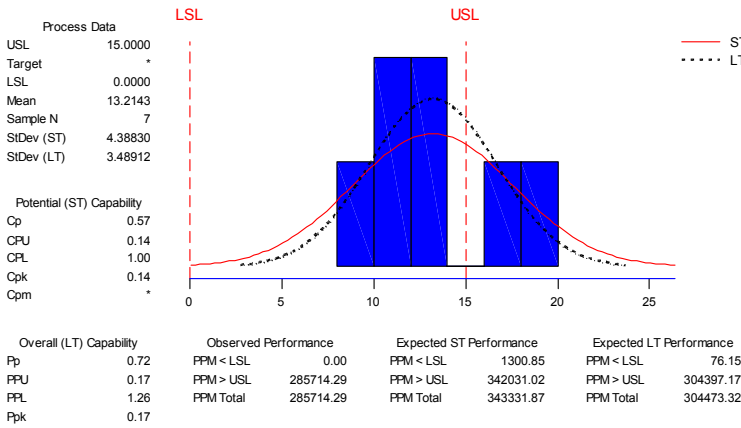


Figure 3: Process Capability Analysis for ER Probe Corrosion

### RCM % Change

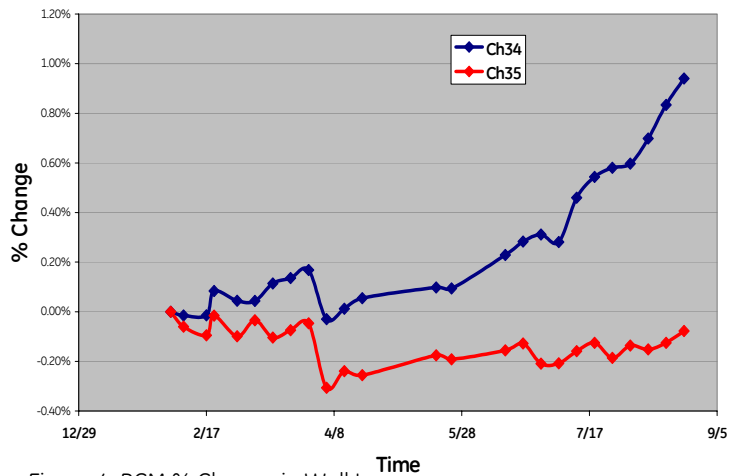


Figure 4: RCM % Change in Wall Loss