

Composite Repairs with Embedded Thickness Monitoring Technology

Composite Repairs with Embedded Thickness Monitoring Technology

UK

Summary

A European chemical manufacturer and producer of pharmaceutical-grade reagents experienced pipe erosion and corrosion, including an internal through-wall defect in a heat exchanger. The exchanger was an important part of an aging unit in a chemical plant that produces ethylene vinyl chloride. The unit was scheduled to be completely replaced in a major plant rebuild two years away. The asset owner not only required repairs that would mitigate the through-wall defect and restore the structural integrity of the pipe, but also required a means to monitor wall thickness of the pipe moving forward. The Inductosense thin, battery-free, ultrasonic thickness measurement (TM) sensor, combined with [ThermoWrap® MT](#), allowed the asset owner to assess conditions remotely, eliminating the costs of more complex in-person inspections. The ThermoWrap MT repair with the embedded sensor system made it possible to monitor conditions proactively and keep the heat exchanger in service until the required replacement date.

ThermoWrap MT Benefits Inductosense TM Sensors Benefits

- | | |
|--|--|
| <ul style="list-style-type: none">• Extends the life of aging and corroded assets• Seals leaks and restores pipe strength• Prevents future external corrosion• Designed for high-temperature, high-pressure environments• Eliminates unplanned down time for high-consequence piping• Easy installation and rapid curing• No pipe cutting or welding | <ul style="list-style-type: none">• Ultra-thin, low-profile TM sensors embed easily under ThermoWrap MT• Battery-free and wirelessly powered sensors• Easier, less labor-intensive than other ultrasonic non-destructive testing (NDT) methods• Repeatable wall thickness measurements allow for trending of data• Sensors eliminate need to remove fiberglass repair materials to measure pipe thickness• Thickness measurements can be taken through ThermoWrap MT in less than a second, no NDT skill required to collect data• Can be easily upgraded with a retrofittable device to acquire data remotely• Unique RFID for each sensor delivers traceability and automated data management |
|--|--|

Problem Statement

The defect itself was easily addressed per standard CSNRI design protocols. CSNRI performed a type B defect analysis per ASME PCC-2 Article 4.1 for a 26 inch line (heat exchanger) with external corrosion. The assumed leak was a 0.6 inch circumferential hole. The design calculations required a repair thickness corresponding to six layers of ThermoWrap MT, with a total repair length of 207 inches.

However, applying composite repairs to a damaged area of a vessel or pipe means that the area underneath becomes less accessible for subsequent inspection. While not an issue, due to the design of the composite, some operators prefer to see the growth of internal corrosion and erosion as an external composite will not inhibit future growth. Identifying accurate growth of these defects can reassure operators of continued use.

The Solution

To enable the asset owner to monitor any internal wall loss at critical points, the Inductosense Wireless and Non-Destructive (WAND) system can be utilized. This system uses inductive coupling to engage a wireless, battery-free sensor and make ultrasonic measurements on a structure. The system hardware consists of two main parts: sensors, which can be embedded under a composite wrap repair system, and the WAND data collector device. The WAND system can be used to acquire ultrasonic thickness data cost effectively in remote and hard-to-reach areas. The WAND system has been tested extensively to demonstrate its accuracy and effectiveness in securing readings through an engineered composite system, including specific tests with ThermoWrap MT.



Sensors were positioned seven inches inside the boundaries of the repair.



Sensors were permanently installed with high temperature adhesive.

The Application

The line was prepared by grit blast to have a minimum surface profile of 30 microns. The surface preparation extended beyond the repair zone up to the nozzles. The surface of the line was degreased before and after preparation of the surface.

Inductosense TM sensors were then embedded under the six-layer ThermoWrap MT repair. Due to the operating temperature of the heat exchanger being 80° C, a suitable high temperature adhesive was employed to permanently install the sensor. A total of eight Inductosense TM Sensors were positioned seven inches inside the boundaries of the repair area on both ends at the 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock positions. Localised heating was used during the installation to heat up the installation area to the sensor adhesive curing temperature.

The repair area was coated with an even layer of epoxy coating with an average 200 microns thickness. The composite repair was then installed ensuring that the ultra-thin sensors were embedded under the ThermoWrap MT repair. The repair was then wrapped in six layers of compression film. A heater blanket was then applied over the repair area at a temperature of 50° C for a minimum of four hours and allowed to cure at ambient temperatures for another eight hours to ensure it had reached a shore D hardness of at least 74.

The Results

The structural integrity of the pipe was restored with the ThermoWrap MT composite repair. With sensors embedded under the ThermoWrap MT, the asset owner was able to collect and record data as often as desired with the use of the WAND hand-held data collector it to determine real-time wall thickness measurements. The WAND data collector devices (hand-held or remote) are able to connect with installed sensors to measure the wall thickness of the exchanger at any time for the life of the repair. This provides valuable information and an understanding of the continued fitness for service of the repaired area.

Managing the accumulated RFID-tagged measurement data with the iDART software, a corrosion rate can be determined from the historical measurements of the WAND system. This enables the end-user to plan better and operate infrastructure more efficiently, particularly for repaired components



With the WAND system, thickness measurement data can be accessed wirelessly through the ThermoWrap® MT repair.