Getting to the Bottom of It

Case Study

The benefits of tank bottom inspection data for the RCA of corrosion

THE CHALLENGE

The leading damage mechanism that affects storage tanks is corrosion. This is due to the fact that most storage tanks are built from carbon steel, which is prone to reacting with the oxygen in its environment, thereby forming iron oxide – also known as rust. Efforts to passivate this material through proper foundation material, external coating as well as corrosion inhibitors do not always prove effective throughout the service life of a tank. One part of a storage tank that is particularly susceptible to corrosion is the bottom. Factors that facilitate corrosion in the tank base include water within the product stored, aggressive product sediments, or a damaged or ineffective floor-to-base seal. As corrosion can occur both internally and externally, its monitoring is difficult.

OUR SOLUTION

In order to best insure their assets' integrity by taking the appropriate mitigation measures, operators of storage tanks need excellent inspection data and – at least as importantly – a way of managing this data. Utilizing high-resolution magnetic flux leakage (MFL) in combination with eddy current (EC) technology for bottom scanners has become a common practice within the industry over the last decade. When analyzed thoroughly, this method is capable of providing detailed inspection data per anomaly, including:

- size (length and width)
- depth (metal loss percentage)
- location (X, Y coordinates)
- discrimination (top versus bottom side)
- C-scan view

It is crucial to gather data of the entire tank bottom, including difficult-to-reach areas, i.e. areas near lap welds and critical zones, such as underneath steam coils and piping, in order to obtain a reliable overview of the overall condition of the tank bottom including any critical defects.

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For coated tank bottoms, lift-off inspection data, such as measurement of the coating thickness throughout the bottom plates, can be used to improve the sizing accuracy and the reliability of the MFL inspection data results.

For an effective asset integrity management, data collected during the inspection process must be assessed and integrated with a database containing detailed tank information, such as information on design and construction, inspection frequency considerations, or additionally installed safeguards. Only if all information on a specific asset is stored and managed in one place, can a sufficient maintenance strategy be planned and implemented. Moreover, the documentation of detailed MFL inspection data enables the creation of corrosion histograms and the execution of risk-based inspection and similar service assessments, which allow for the proper application of the methodologies.

To this end, the ROSEN Group has designed a software solution that provides filtering options that enable the user to visualize different repair scenarios based on budget constraints or maximum allowable intervals. ROSOFT for Tanks features an exact layout of the tank bottom that will show all anomalies detected by the inspection, thus providing a full overview of bottom's structure. The outcome of MFL inspection data that reveals specific visible corrosion patterns in the bottom layout may form the integral part of root cause analyses (RCA) described in the following two case studies.

Mixing things up – the right way

The first case it that of a storage tank for crude oil with a capacity of 400,000 barrels (ca. 63,600 cubic meters). The tank was located in a coastal region and situated on a concrete ring wall. The bottom aged between 10 and 15 years and featured no internal coating. It had never been previously inspected.

Here, the tank bottom inspection exposed extreme top-side pitting corrosion that affected all bottom plates. As the storage tank was on a 10-year operational inspection circle, the severity of the deterioration was again not expected. The visualization of the defects in the software's bottom layout presented a fan-shaped corrosion pattern with major corrosion in four locations that were positioned at a 90-degree angle to each other, and minor defects in the areas in between. The RCA showed that the four locations where little corrosion was visible, coincided with the location of the tank mixers. As a result, during the investigation, it was anticipated that the tank mixers were not properly positioned around the circumference of the tank to allow a proper product circulation. Instead, the tank mixers were positioned at a 90° angle affecting the product to flow inwards, thus, creating product sediment outside of the four locations and causing accelerated internal pitting corrosion.

Turning the system upside down

The second case is that of a tank of 500,000 barrels' capacity (ca. 79,500 cubic meters), which also stored crude oil. It was located in a coastal region and its foundation was a concrete ring wall. Since its bottom was less than 10 years old and disposed of a thin film as internal coating, no inspections had previously taken place. On the soil-side of the tank bottom, a cathodic protection (CP) system was installed in order to prevent corrosion.

The tank bottom inspection using MFL and EC technologies revealed severe soil-side corrosion. Since the bottom plates were considerably new and equipped with a CP system, the amount and severity of the corrosion was not expected by the operators. When integrated in the ROSOFT for Tanks software, the bottom layout showed a distinct corrosion pattern in the form of a straight line across the entire tank bottom. This led the operators to perform an extensive RCA during the repairs, comprising soil samples, material verification analysis, testing of cathodic protection, review of construction records, and others. It was then discovered that the CP system had been installed incorrectly, namely in an inverted fashion. In this way, the bottom plates became the sacrificial anodes, which, in fact aggravated corrosion instead of preventing it.

YOUR BENEFITS

Since the combination of increasing environmental concerns and more stringent regulations has led to an intensification of preventive maintenance schedules for storage facilities, innovative solutions for tank integrity and risk management are needed. Software solutions that have a strong focus on ownership, responsibilities, authority, and skills for maintenance activities are essential to the integrity and reliability of storage tanks. The ultimate goal is to strike an optimal balance between risk mitigation and cost reduction, thereby enabling operators to stay one step ahead of integrity problems at all times.

The two cases above clearly show that visualizing the actual patterns of the corrosion in the tank bottom may be of great help in this endeavor. Finding the actual origin of tank bottom deterioration enables operators to treat not only the symptom, but also the cause – and thereby to take far more effective mitigation measures.

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