The challenge to asset owners and operators is to use new systems to reduce out of service time during inspection and improved inspection schedules

Increasing inspection activity

Storage tanks are an essential part of the distribution network and are vital in buffering the varying demands of end users. They are most commonly built from steel with thickness from 5-15mm. Steel is a relatively cheap and strong material that can be easily fabricated on site but does have the inherent problem of corrosion over time.

The inevitable corrosion of the floor plates is a particular issue as it requires emptying and cleaning of the tank, taking it out of service during the work. This is an expensive exercise, and even more so when a storage site is near capacity, resulting in lost income as well as the cost of inspection.

Inspection of atmospheric storage tank floors presents the tank engineer with the combined problems of needing to inspect large areas up to thousands of m² efficiently whilst also identifying millimetre sized corrosion that could lead to leakage.

This challenge was first investigated over 20 years ago which resulted in wide use of the magnetic flux leakage (MFL) technique to provide a rapid screening of the floor, followed by detailed ultrasonic thickness measurement of suspect areas. These first MFL scanners were somewhat crude, giving the operator an indication of magnetic anomaly, but little else. This certainly saved time on floors with relatively little corrosion, requiring modest follow up with ultrasonic thickness measurement and/or visual inspection, but as the amount of corrosion increases the advantage of pre-screening is lost.

The next generation of scanners improved productivity with thresholding of signals to remove indications below agreed limits, reducing prove up of insignificant corrosion. These systems were designed to either 'stop on defect' so the operator could make the indication on the floor, or use automatic paint marking. The disadvantage of thresholding is that MFL signals respond in a non-linear way, with the amplitude related to material loss, rather than remaining floor depth. For example, the amplitude from a small but deep indication can give a very similar response to shallower corrosion over a wider area. The result was increased speed of inspection, but potentially less accurate indication of small but critical areas of corrosion.

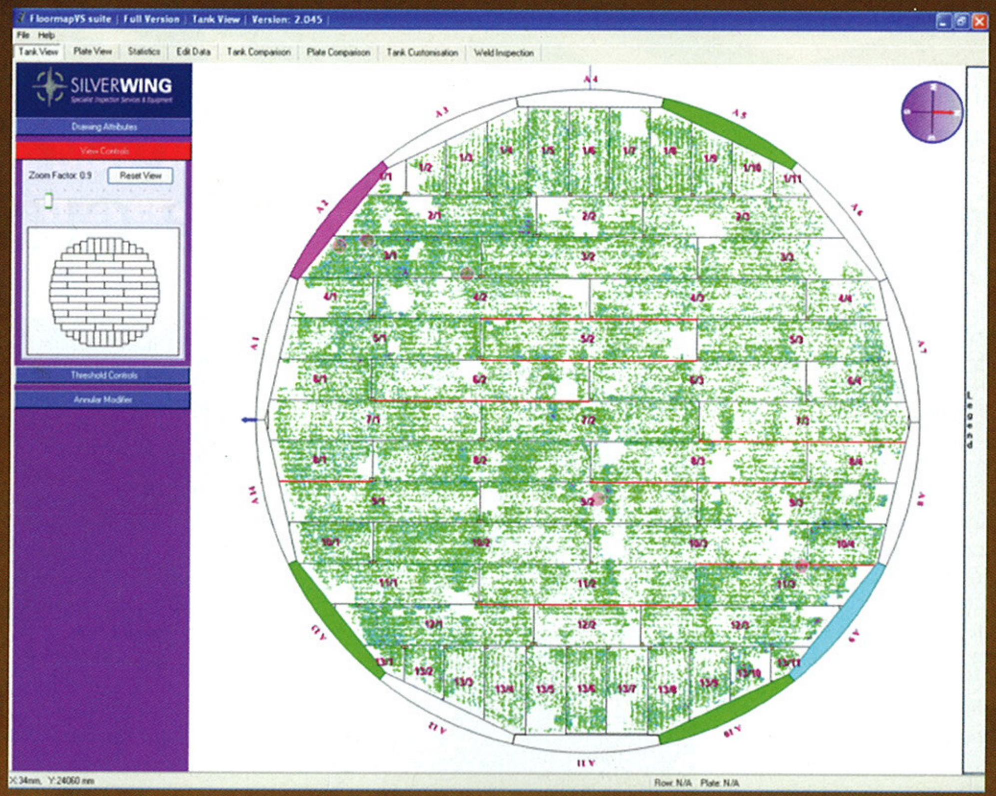
Further development was brought about by portable computers and full recording of MFL signals. The first, possibly most obvious benefit of computerised MFL scanning of tank floors, is the detailed record that is created during the inspection and reporting procedure. Good automated recording software ensures a consistent format is used in the final report. This is a clear benefit for the tank engineer who may have to make data comparisons and interpretations for many sets of tank inspection results over a period of several years.

Most computerised MFL reports will automatically show the areas that have been covered by the scanner. The report can tell exactly which areas of the tank floor have been inspected, and more importantly, which areas have not. This helps the tank engineer decide if any additional inspections are required, and also introduces a further layer of basic quality control and reduces human error - it is actually quite difficult to accidentally miss out any areas during a computerised MFL inspection. The data acquisition software will ensure that each plate is scanned in an efficient and methodical fashion. If any data is missing at the end of the inspection, the area will need to be scanned and the data included in the final report.

Tank floor mapping in progress

The second benefit of computerisation is the ability to process the MFL signals to interpret the response and improve the identification of different types of flaws. A significant amount of research has been conducted into how MFL responds to defects, and the present state-of-the-art uses non-linear amplitude mapping to give more accurate sizing. This improved accuracy allows reduced ultrasonic prove up post scanning, which can be in the region of 10% of indications to validate the MFL data. This delivers significant improvement in productivity, coupled with a higher probability of detection.

One of the limitations of MFL has been the ability to identify which side of the floor the corrosion is on. The MFL scan data needed to be cross checked visually to determine this information, which is a key factor in the preventative maintenance strategy. Topside corrosion is typically as a result of the product stored, and deterioration can be reduced by lining or coating the tank, whereas underfloor corrosion is as a result of underfloor conditions which may be harder to overcome. Visual inspection is relatively easy, but requires separate logging of the results which may cause errors, and could be impossible on previously coated tanks without expensive removal and re-coating.



Tank floor with superimposed corrosion data. Plate layout can clearly be seen along with distribution of corrosion

There have been a number of alternatives to MFL, developed to help overcome the top/bottom identification, and also to try and improve defect sizing accuracy. These typically use eddy current methods, sometimes on their own, and sometimes in conjunction with MFL sensors in the same system. These techniques have been growing in popularity, although they can require a higher level of operator training to ensure correct setup, and be less portable in the tank environment due to higher power requirements.

UK-based MFL inspection specialist Silverwing, in conjunction with Swansea University, has undertaken key research to improve both the accuracy of MFL defect sizing and identification of top or bottom side material loss. The resulting patents have been developed and incorporated into the Silverwing Floormap 3D product, released in February 2012.

The system uses a very high number of MFL sensors in multiple orientations to detect all magnetic field changes, giving much improved resolution for detection of smaller defects below 3mm, and application of data processing to differentiate between short, deep indications and longer defects with less wall loss. An additional set of sensors detect the magnetic effects from top side defects, giving clear identification of top and bottom corrosion without the need for visual checking. The advanced magnetic designs also achieve inspection through coatings up to 6mm thick, depending on base thickness.

The end goal of all floor mapping systems is to achieve the objectives set out in the original project of 20 years ago, high productivity, high probability of detection of defects and accurate sizing. The quality of data collection and reporting today gives the tank engineer a clear analysis of the state of the tank floor on which to make repair assessment, and also to monitor degradation over time to help in risk base inspection programmes. At this time the mapping systems still require some follow up detailed inspection, either through pit gauging or ultrasonic measurement, but with continuing research, inspection methods are close to achieving a complete full integrated condition assessment.

Using this information, operators can develop improved inspection schedules based on knowledge of historical corrosion rates. By specifying higher quality of inspections with data recording, rather than 'scan and patch' activities, a storage operator can maximise operational lifetime with optimised inspection programmes potentially reducing out of service periods and therefore achieve greatest value.

For more information:

This article was written by Wayne Woodhead, MD of Silverwing, wwoodhead@silverwinguk.com