Monitoring of Above Ground Storage Tank Floors Using Ultrasonic Guided Waves

Summary

Plant Integrity Ltd, together with its parent TWI, has developed a field-usable non-invasive method of monitoring tank floors to detect corrosion using ultrasonic guided waves in a joint industry funded project. This method allows forewarning of degradation of the floor without needing to take the tank out of service and provides evidence to support extensions between internal inspections if no degradation is reported.

Background

The guided wave monitoring method gathers data from the tank floor using transducers placed at regular intervals around 'chime', i.e. the accessible edge of the floor outside the wall, avoiding the need to enter the tank to perform the test, Figure 1. The method is currently limited to monitoring of tanks up to 30m diameter with welded overlapping floor plates.

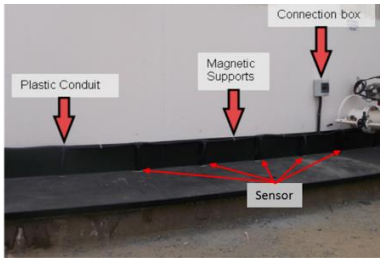

Figure 1 Sensor installation on an operational tank. The sensors are placed adjacent to the annular plate to shell weld.

The purpose is to provide additional information about the condition of the tank floor in between internal inspections to:

- Provide forewarning of degradation of regions of the floor that may require action to be taken before the next scheduled outage,
- Prioritise which tanks are in most need of attention,
- Predict (at a top level) the extent of degradation, enabling planning of inspection and repair activity,
- Provide evidence for justification of extension of the interval between internal inspections if no degradation is detected.

The Method

The method uses the low attenuation properties of low frequency ultrasonic guided waves to send signals across the tank floor in a transmit-receive configuration using a multi-channel Teletest ultrasonic pulser-receiver, without needing to remove the fluid from the tank. The aim is to detect changes over time by repeatedly collecting data at regular intervals and comparing the results with the baseline.

An image of the tank floor is formed from the ultrasonic data by collecting information at many angular positions around the circumference of the tank. Figure 2 shows the concept. The transmitted signal from a single transducer is captured by a number of similar sensors on the opposite side of the tank. This process is repeated for each sensor transmitting to allow full coverage of the floor area. The data from all these tests are summed to produce the image, changes in floor condition being indicated by a colour scale on the image.

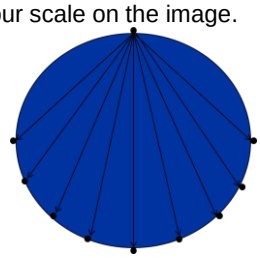

Figure 2 Schematic showing the transmission of ultrasound from one transducer and receiving on many others on the other side of the tank. This is repeated using each sensor in turn as the transmitter.

Results

If the test system is stable the baseline signal from the floor should not change over time. However, if a change occurs in the condition of the floor, for example if a patch of corrosion is initiated, then this information can be statistically extracted from the large sets of data. Figure 3 shows the comparison between the baseline and data collected 8 months later on an operational 19.5m diameter tank containing gasoline. The data shows a minimal variation of +2 to -1dB across the whole floor.

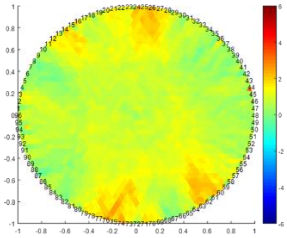

Figure 3 Image of the floor of the 19.5m diameter tank shown in Figure 1 showing minimal changes over 8 months.

Changes will result in a reduction in signal amplitude. Figure 4 shows the effect of simulating a localised defect on the data from Figure 3.

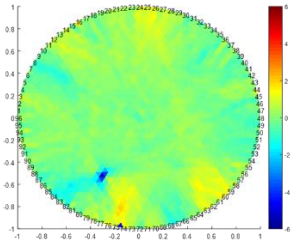

Figure 4 Effect of a simulated defect – a local 6dB reduction in amplitude occurs at the defect location (shown in blue)

Achievements/Outcome

The capability of the technique has been demonstrated on an operational tank provided by Navigator Terminals at Thurrock, UK. Other studies have shown that corrosion 80mm diameter and ½ wall deep can be detected. Plant Integrity is now seeking opportunities to roll this method out to other tank sites.

This work was supported by Petrobras, Chevron, ConocoPhillips and Shell.

Contact: Kai Yang (kai.yang@plantintegrity.co.uk)
or Ivan Pinson (ivan.pinson@twi.co.uk)