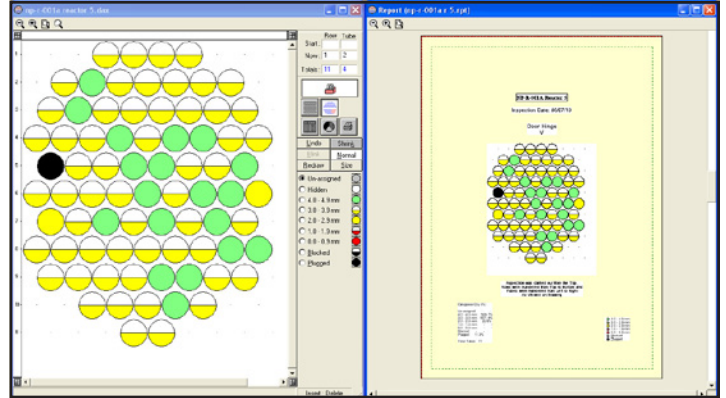


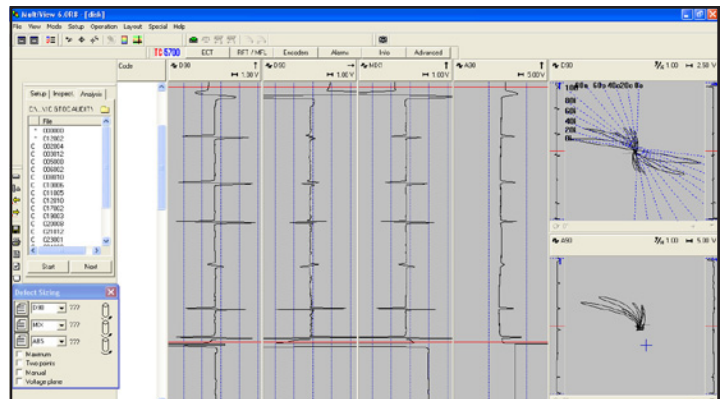
TUBE INSPECTION



Typical Report

Oceaneering Asset Integrity provides a range of systems to inspect tubes in Heat Exchangers, Air Coolers, Feed Water Heaters, Condensers, and similar items using a selection of inspection techniques.

Tubes can be inspected periodically to detect and size discontinuities e.g. pits, erosion, cuts, grooves and wear. Correct technique selection is critical and depends on the tube material; ferromagnetic or non-ferromagnetic and the type of discontinuities expected.

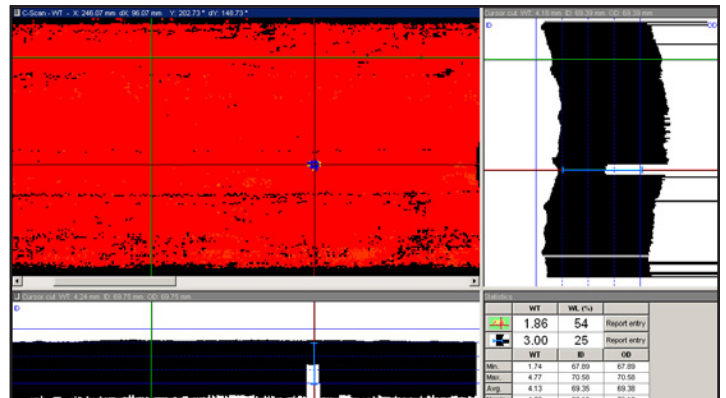


Eddy Current Data Presentation

Techniques include:

- Internal Rotary Inspection System (IRIS)
- Eddy Current Testing (ET)
- DinSearch
- Remote Field Testing (RFT)

Eddy Current Testing, DinSearch and Remote Field Testing are electromagnetic techniques and tend to be used as screening tools in order to select tubes for IRIS, especially in the case of ferromagnetic materials, e.g., Carbon Steels.



IRIS Data Presentation



TUBE INSPECTION

Internal Rotary Inspection System (IRIS)

Internal Rotary Inspection System (IRIS) consists of a high frequency ultrasonic immersion probe inside a rotating test head, used to examine tubes for internal or external corrosion or erosion damage. It can accurately measure remaining wall thickness in most instances.

Features:

- Inspection, typically 70 - 100 tubes per shift
- Can test all of the tube (straight lengths only)
- Applicable to most materials
- Accurate wall thickness measurement
- Sensitivity - 1.5 mm diameter, 5% loss (variable with tube size / cleanliness)
- Not affected by baffle plate/tube sheet
- Tube has to be flooded
- Bore surface has to be very clean
- Can not detect cracks
- Requires 110 / 240 Volt power supply and potable water supplies

Eddy Current Testing (ET)

Eddy Current Testing (ET) is an electromagnetic technique for the rapid inspection of non - ferromagnetic tubes and is capable of detecting internal and external defects. An Eddy current field is induced in the tube under test and defects present will influence the characteristics of this field.

Features:

- Inspection, typically 500 - 1000 tubes per shift
- Computerized analysis
- Can be used as a standalone technique if advanced systems are used
- Cleanliness is less critical than for IRIS
- Bends can be tested using special probes
- Cracking is detectable
- Less accurate than IRIS
- Can only be applied to non-ferromagnetic tubes
- Sample of tube required for calibration
- May require IRIS back-up for critical applications
- Defects close to the tubesheet are difficult to detect
- Requires 110 / 240 Volt power supply

DinSearch

DinSearch is an electromagnetic technique for the rapid inspection of ferromagnetic tubes and is capable of detecting internal and external defects. Conventional eddy current techniques cannot be applied to ferromagnetic tubes due to their high magnetic permeability that results in low field penetration and high noise levels. The DinSearch technique relies on partial magnetic saturation of the tube using electromagnets. The presence of defects in the tube causes variations in magnetic flux density that are detected using eddy current sensors. The technique can provide an indication of tube condition, but wall loss measurement capability is very limited.

Features:

- Inspection, typically 500 tubes per shift
- Ferromagnetic materials can be inspected
- Cleanliness is less critical than for IRIS
- Good for detecting pitting
- Poor wall thickness measurement capability
- Calibration tube required
- IRIS backup essential in most cases
- To be used as a screening tool only!
- Will not detect generally thinned tubes
- Requires 110 / 240 Volt power supply

Remote Field Testing (RFT)

Remote Field Testing (RFT) is an electromagnetic technique for the inspection of ferromagnetic tubes. The technique is based on measuring the amplitude and phase lag of the remote eddy current field. The technique has good detection and measurement capability for general thinning, but sensitivity to pit type defects is limited.

Features:

- Inspection, typically 500 tubes per shift
- Equally sensitive to ID & OD defects
- Computerized analysis
- Good for general wall losses
- Phase plane analysis allows estimation of wall loss
- Cleanliness not critical
- Limited sensitivity to pitting
- Speeds from 0.1 - 0.5 m/s
- Faster than IRIS, but slower than other electromagnetic methods
- Main application - Power plant HP Feed Water Heaters
- Requires 110 / 240 Volt power supply

