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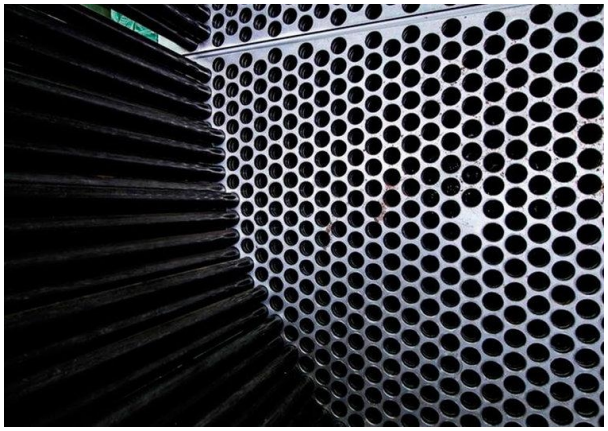
Inspection of ferromagnetic tubes by Remote Field Testing and Partial Saturation Eddy Current testing

Eddy Current testing is a non-destructive testing (NDT) method commonly used to inspect heat exchanger tubes. However, conventional eddy current testing can't be deployed on tubes of ferromagnetic materials, such as carbon steel, due to the permeability (magnetic behavior) of the tube material. **For inspection of ferromagnetic heat exchanger tubes, Applus+ utilises Eddy Current-based techniques, Remote Field Testing, and Partial Saturation Eddy Current, as well as the ultrasonic IRIS technique.**



THE Applus+ SOLUTION

When conventional eddy current testing is deployed on ferromagnetic materials like carbon steel or duplex, two major restrictions are encountered:

- **The permeability reduces the depth of penetration of the eddy currents to only a few tenths of millimeters.** Detection is limited to surface-breaking defects only, and the sizing of deeper defects is very limited.
- **Local variations in permeability are causing significant disturbance to the eddy current signal.** Relevant signals can be distorted and difficult to interpret, while non-relevant signals can be mistakenly perceived as defect indications.

To overcome these restrictions when inspecting ferromagnetic tubes from the inside, Applus+ utilizes **Remote Field Testing (RFT)** and **Partial Saturation Eddy Current (PSEC)** techniques. Both techniques have their own merits, thus their own field of application.

Remote Field Testing (RTF)

RFT uses a strong send coil to generate an alternating magnetic field. A receiver coil is placed approximately 3-4 times the diameter of the probe behind the send coil to pick up the "remote field" generated by the send coil. This remote field is, among other things, a function of the wall thickness of the tube; a change of wall thickness will result in a change of the measured remote field. By comparing this measured field with the measurements obtained from a reference tube (a tube with several artificial wall thickness reductions), the measured value can be "translated" to a corresponding wall thickness reduction.

RFT is most suitable for detecting and sizing relatively large volume defects, such as erosion or general corrosion. Although RFT is equally sensitive to both external and internal defects, it can't distinguish between them. The fitting of the probe in the tube isn' t crucial for a reliable inspection. This makes RFT an appropriate tool in case proper cleaning of the tubes' ID is impossible. The method is unsuitable for inspecting fin-fan tubes.

Partial Saturation Eddy Current

In addition to conventional eddy current coils, a **Partial Saturation Eddy Current (PSEC)** probe contains a magnet (either a permanent magnet or an electromagnet) to suppress the negative influence that the permeability of the tube material has on the eddy currents. This results in a better signal-to-noise ratio, enabling the detection of both internal and external defects. Just like with RFT, defect indications obtained during a PSEC examination are sized by comparing them to the signal received from a reference tube.

PSEC is most suitable for detecting local defects, such as internal and external pits. It can also differentiate between internal and external defects. Unlike RFT, PSEC is suitable for inspecting finfan tubes.

To provide even better inspection results, additional IRIS examination can be performed on a selected number of tubes to verify and fine-tune the RFT and/or PSEC results.

Defect indications are assessed immediately on-site and entered into the reporting software. As a result, we can typically provide a report with test results immediately after the inspection is completed.

Target customers

RFT and PSEC tube inspections can be deployed in any sector that uses heat exchangers, boilers, or finfan coolers, including the petrochemical, power generation, pharmaceutical, industrial air-conditioning, commercial heating units, and food industry.

Key customer benefits

The most obvious benefits of RFT and PSEC, when combined with IRIS, are their suitability for examining ferromagnetic tubing. Because each has its own merits and field of application, one of the techniques, or a combination of them, is likely to cover the customers' requirements. Other benefits of RTF and PSEC include a high inspection speed and immediate test results.