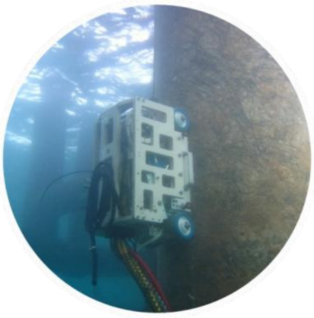
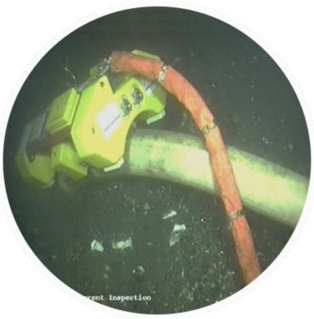
Magnetic Eddy Current (MEC)

Next Generation SLOFEC Technique





MEC Technique

MEC (Magnetic Eddy Current) is the next generation and a further development of the industry proven, fast corrosion screening SLOFEC™ technique.

MEC is a dynamic electromagnetic technique that operates on a high frequency Eddy Current field with a controlled direct current magnetic field and specially developed sensors to achieve a high sensitivity in the detection of pitting and corrosion defects in ferromagnetic and non-ferromagnetic materials including through various types of coatings.

By utilising the superimposed direct current magnetisation, the depth of penetration is increased to such an extent that internal defects can be detected from the external surface.

The specially developed Eddy Current sensors are not only capable of generating a higher density Eddy Current field for increased defect detection sensitivity but also enable the measurement and adaptation of the magnetic field strength.

By analysing and controlling the magnetic field strength to operate at the retentivity point of the hysteresis curve and combining it with higher operating frequencies and improved signal to noise ratio, the MEC technique offers enhanced inspection capabilities including the detection and sizing of internal and external defects at a higher wall thickness and coating range.

The MEC technique is applied to most of Innospection's next generation topside, splash zone and subsea inspection tools for integrity and lifetime assessment support:

Topside Inspection Tools

- MEC-Floorscanners for storage tank inspection
- MEC-Pipescanners for pipeline and pressure vessel inspection

Splash Zone Inspection Tools

- MEC-MPS Marinised Scanners

Subsea Inspection Tools

- MEC-Combi Crawlers for subsea inspection
- MEC-Hug Crawlers for flexible riser, umbilical and mooring line inspection

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Principle of MEC Technique

The MEC technique works with a combination of direct current magnetic field lines and Eddy Current field lines. A direct current magnetic field is induced into the steel wall to be inspected to a level along the hysteresis curve called the Retentivity Point which is way below the magnetic saturation level of the material.

In case of defects on the far side of the steel wall, the direct current magnetic field lines have an increased density in the remaining wall thickness of the material. The additionally induced alternate Eddy Current field in the area then changes due to the change of the direct current magnetic field density.

While the defects on the far side of the material have an effect first on the direct current magnetic field and consequently on the Eddy Current field, the defects on the near side of the material directly affect the Eddy Current field. Due to the different Eddy Current field responses, the indications are almost 90 degree in signal phase difference between far side and near side defects which are therefore well distinguishable.

The changes in the Eddy Current field lines are measured and analysed against the calibration in terms of the signal amplitude, phase and shape to provide the following evaluations:

- Differentiation between internal (vertical signals) and external defects (horizontal signals)
- Distinguishing defects from false calls, laminations or inclusions
- Analysis of defect volume and severity in terms of wall loss
- Separation of noise signals from defect signals

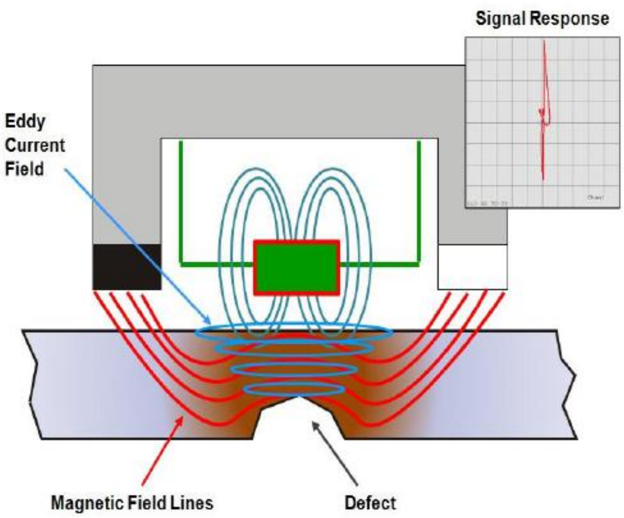

Figure 1: Detection of far-side defects with vertical signal response

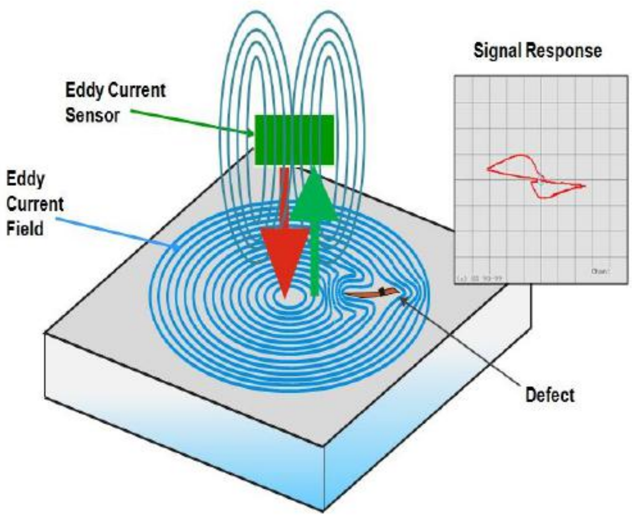

Figure 2: Detection of near-side defects with horizontal signal response

With the use of specially developed Eddy Current sensors able to generate a higher density Eddy Current field and sensor adaptation that enables magnetic field strength measurement, the MEC technique operates at the retentivity point of the hysteresis curve in combination with high frequencies to offer enhanced defect detection and sizing capabilities at a higher wall thickness and coating range.

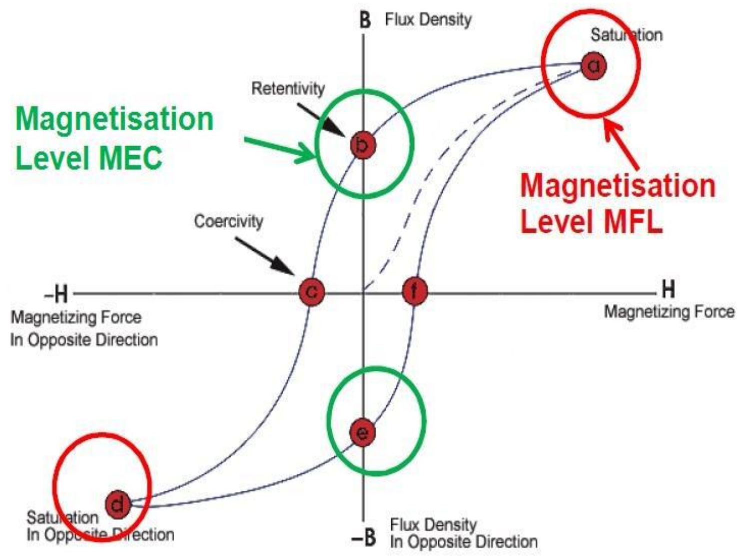

Figure 3: Controlled magnetic field of MEC technique

Key Features of the MEC Technique

As an electromagnetic technique, direct surface coupling between the sensor system and the inspection object is not necessary. As a result, the MEC technique can be utilised for risk based inspection and as a Non-Intrusive Inspection (NII) strategy.

- **High defect detection sensitivity and reliability**

  The MEC technique is highly sensitive in the detection of defects such as corrosion and pitting in ferromagnetic and non-ferromagnetic materials such as carbon steel, stainless steel, duplex and super duplex materials with wall thickness up to 42mm.

  It is also capable of inspecting through coatings and cladding types such as Epoxy, CRA, TSA or Monel clad without the coating removal. The maximum inspectable coating thickness to date using the MEC technique is 35mm of fire protective coating.

- **High inspection speed**

  The MEC technique enables the fast screening of large areas with low surface preparation prior to inspection. Cleaning of the inspection surface to the bare metal is not required to produce good quality inspection data which serves as a major advantage over the Ultrasonic technique and makes it uniquely suitable for subsea inspection applications.

- **Distinction between internal and external defects**

  The MEC technique is highly sensitive in the detection of internal and external small and shallow volumetric defects. The types of defect profile detected by the MEC technique include:
    - single isolated pits
    - shallow and narrow pits in the early stage of defect development
    - shallow rounded pits with different diameters that are particularly difficult to be detected with conventional manual Ultrasonic
    - Microbiological Induced Corrosion (MIC) or CO_2 corrosion

- **High inspection temperature range**

  The MEC technique enables the inspection to be performed at high temperatures with to date experience of up to 170°C.

- **Real time scan results with colour mapping for defects**

  The scan results are mapped out in real time which allows the immediate defect indication of the inspected object. The coloured reporting of the Innospectit Software provides an overview of the condition of the inspected object to enable the evaluation, determination of corrective actions and modifications to future maintenance and inspection strategies.

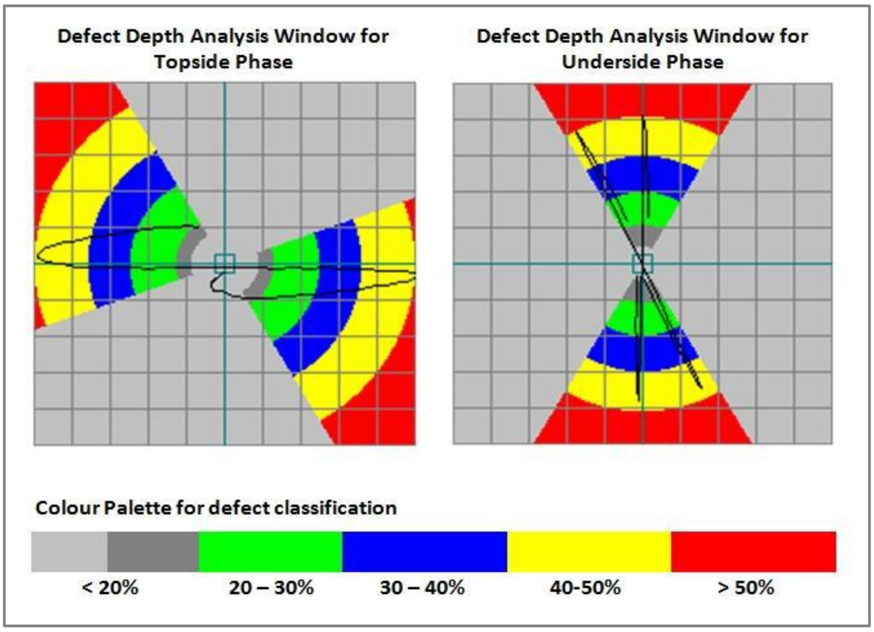

Figure 4: Simultaneous Signal Phase and Amplitude Analysis

As with all electromagnetic based techniques, the MEC technique is not an absolute wall thickness measurement technique. It is a comparison technique which means that a calibration sample as close as possible in the material properties and geometry of the object to be inspected is required to perform the inspection.