Electromagnetic Guided Wave Technologies for Addressing Casings
The Successes and Challenges

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Overview

- Understanding Electromagnetic Guided Wave (EMW-C) Technology
- Guidedwave Inspection Methods
  - Similarities and Differences
- Annulus Inspection with EMW
- Applications for ECDA
- Successes and Challenges
The EMW-C is a patented inspection process for cased and thermally insulated pipe.

It is a long range electromagnetic scanning method that has been developed and refined for over 15 years.

Similar to RADAR, electromagnetic waves (EMW) are transmitted and received allowing location and identification of materials and conditions.

EMW fills the annulus between the carrier pipe and casing or jacket and travels lengthwise to the end of casing.
• Long range detection of anomalies and corrosion indicators:
  – Corrosion Product
  – Corrosion Under Insulation (CUI)
  – Electrolytes (water, soil)
  – Metallic Shorts
  – Wet Insulation and Voids
• Location of mechanical structures or deformations:
  – Spacer location
  – Carrier pipe sag / change in offset
  – Crushing of the casing.
• Down/Upstream location and length of a single or multiple anomalies within a cased or jacketed section.
• Characterization of the magnitude of the anomaly based on data and equivalency models.
• Continuous or periodic monitoring to detect changes over time.
  – Permanent connectors may be installed.
• Connection is made to the carrier and casing (or jacket) using coaxial connectors and cables.
• A pulse generator creates electromagnetic waves (EMW) in the annulus (Dielectric).
• The casing and carrier pipe guide the waves, which travel through the annulus and through the dielectric material(s) in the space between.
• The waves are reflected back to the equipment from material changes in the annulus.
• Changes in dielectric material (rust, water, spacers, wax) are seen as variations of amplitude and polarity of reflections.
• Lengthwise distance to reflectors (anomalies) are determined by time of return.
EMW-C
Non-Intrusive Connections

Buried Casing Connectors
EMW-C
Example of Corrosion Growth Detection

Data showing change as corrosion increases.
Consecutive data traces with increased corrosion at 10 foot mark.
EMW-C
Detection of Shorts

Data showing various pipe to casing short locations.
(Individual data traces overlaid).
### Comparison of Guided Wave Inspection Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Wave Type</th>
<th>Wave Source</th>
<th>Waveguide</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRUT, GUL</td>
<td>Mechanical-Acoustic</td>
<td>Piezoelectric Transducers</td>
<td>Pipe cross-section</td>
</tr>
<tr>
<td>MsS</td>
<td>Mechanical-Acoustic</td>
<td>Magnetostrictive Sensors</td>
<td>Pipe cross-section</td>
</tr>
<tr>
<td>EMW-C™</td>
<td>Electromagnetic</td>
<td>Pulse Transmitter / Coaxial Connectors</td>
<td>Annular space between pipe and casing</td>
</tr>
</tbody>
</table>

**Cross – Sectional view of pipe and casing. The dashed sections show the waveguide and “inspection area” for each method.**
EMW-C
Additional Points

• Though this technology is technically a guided wave method, the characteristics of GWUT do not necessarily apply.

• EMW-C uses electromagnetic waves which are not affected by bends and turns and attenuation is caused by (certain) materials in casing rather than coating on carrier.
• Using EMW to Inspect the Annulus provides unique information about the environment and corrosion conditions inside the casing.
  – Corrosion Product
  – Trapped Water
  – Electrolytic Contact
  – Casing to Carrier Shorts

• Volumetric Component to the Data
  – Wax fill levels can be verified and monitored
  – Working with GTI on procedure development
Applications for ECDA

- For Pre-Assessment -
  - Collect otherwise “unknown” data about casing construction
    - Are Seals working as expected or allowing earth/water inside?
    - Are there shorts, if so how far in?
    - Are there spacers / are they where expected?

- For Indirect Inspection -
  - Identify locations of possible corrosion / water / shorts – Corrosion Likelihood
  - Can work with other GWUT tools as two complimentary tools
    - Where EMW identifies corrosion product or water does GWUT find metal loss?
    - Where EMW identifies as short does GWUT show an indication?
Successes and Challenges

• Some Successes -
  • Have been able to inspect full length of most casings from one end. Both ends for shorted or casing packed with debris.
  • Providing data otherwise unavailable – locations of water, spacers, and electrolytic contact inside the casing.
  • Working with operators and GWUT contractors to compare data findings for ‘complimentary’ requirements.
  • Working with GTI to develop wax fill detection.

• Some Challenges -
  • Shorts near launch can attenuate quickly – look from both ends
  • Pipe/Casing offset at launch location can limit number of connectors
  • Communicating the complimentary differences between EMW-C and GWUT.
Thank You!

For Answers please contact:

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