NDE Solutions

*Imaging SCC with Acoustic Techniques*

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Context

• 2014 meeting at EPRI resulted in a 5 year plan to:
  – Provide point inspection on SCC → once an area of concern has been identified visually (e.g., camera), can we interrogate this specific area?
  – The interrogation technique should be able to quantify penetration depth + orientation of the SCC and indicate if through-thickness penetration is occurring.
Time Table

- **2014**
  - **Feasibility:** Can the proposed technique be used for SCC imaging?

- **2015**
  - **Deployability:** Integration in a tool for use in tight/confined spaces?

- **2016**
  - **Understanding the Physics:** What happens when acoustic waves interact with SCC?

- **2017**

- **2018**
Proposed Approach

- Time reversal (TR) acoustics is used to focus energy onto a specific area and inspect this area.
Previous Work – Orientation

- TR can focus acoustic energy independently in different directions:

  x-ray
  Vibro-thermo
Previous Work – Orientation

- SCC – Sample 1
Penetration Depth

- Energy is focused on sample surface but also penetrates the sample, with a depth proportional to frequency.

\[ f = 75 \text{ kHz} \]

\[ f = 50 \text{ kHz} \]

\[ d \sim \frac{c}{4f} \]
Penetration Depth

- SCC – Sample 2
Penetration Depth

The SCC crack actually goes below the weld line.

Focal spot depths:
@100kHz = 9.75 mm
@200kHz = 4.87 mm
Deployability

• Experimental setup for the proof of concept

Steel pipe fitted in a block of sandstone
Sensor: laser head mounted on wheels
Source: transducers on inflatable device
Deployability

Use of laser head inside pipe

Acoustic source inside pipe
Deployability

- Focusing and probing inside a steel pipe fitted in a block of sandstone and consolidated with cement
Understanding the Physics

• In experiments, we scan the surface of the sample

• We need to complement experiments with numerical modeling:
  – Analysis of the results related to what is below the surface
  – Resolution of an inverse problem on the size of the crack
Understanding the Physics

- Finite-element method
Conclusions and Path Forward

- **2014**
  - **Feasibility:** TR can image SCC.

- **2015**
  - **Deployability:** TR can be integrated in a tool for imaging in tight spaces – we need to go beyond proof of concept now.

- **2016**

- **2017**

- **2018**
  - **Understanding the Physics:** Numerical analysis seems essential at this stage.