PSA vessels welding inspection using TECA technique

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Agenda

- PSA vessel inspection
- TECA Technique
- Project scope
- Inspection
- Results
- Conclusion
PSA vessel inspection
What is a PSA Vessel?

Pressure swing adsorption (PSA) is a technology used to separate some gas species from a mixture of gases under pressure according to the species' molecular characteristics and affinity for an adsorbent material. Specific adsorptive materials are used as a trap, preferentially adsorbing the target gas species at high pressure. The process then swings to low pressure to desorb the adsorbed material.

Important point for us: **Pressure cycle**
- Stress which could generate crack
FFS (Fitness For Services) on PSA pressure vessel

- Fitness-for-service (FFS) assessment is a multi-disciplinary approach to determine, as the name suggests, whether equipment is fit for continued service.
- The outcome of a fitness for-service assessment is a decision to run as is, repair, re-rate, alter, or retire the equipment.
Surface defect detection using MT on carbon steel weld

— **Advantages**
  - Easy use
  - Reasonable cost
  - Easy certification

— **Disadvantages**
  - No traceability
  - No depth sizing
  - Time of application
Alternative solution to MT for weld inspection

- Penetrant testing
- Conventional ET
- ECA
- ACFM
- TECA
TECA Technique
Basic principle

- Coils’ arrangement
- Eddy Current density nearby surface indication

Plan view

Depth view
Basic principle

– Eddy Current Density

No defect

1 mm deep crack

5 mm deep crack
What can it do?

Surface-breaking cracks in CS

Length and depth sizing

Accommodate weld crown in the "as is" condition

Lift-off tolerance: coating/paint up to 2-3mm (0.080"-0.120")
Example

TECA Technique
Which cracks can be detected?

- Surface breaking cracks
- Minimum 2 mm long
- Minimum 0.5 mm deep
- Detection and measurement of axial cracks
- Detection of transverse cracks

TECA Technique

Depends on Lift-Off and surface roughness.
Lift-Off signal on carbon steel
Crack signal on carbon steel
Crack signal on carbon steel
Crack signal on carbon steel

1.0 mm
2.5 mm
5.0 mm
Effect of Lift-Off on crack signal

3 mm LO  2 mm LO  1 mm LO  0 mm LO
Automatic Lift-Off compensation
Transverse signal
Sharck Butt Weld (Eddyfi solution)

- 64 channels
- 53 mm (2.09 in) coverage
- 22 fingers (11 x 2 rows)
- Weld cap, toes and HAZ in one pass
Key Benefits

- Single-pass detection of longitudinal and transverse cracks
- Fast - Maximum scan speed of 200 mm/s
- Wide coverage - Cap, toes and HAZ in one go
- Automatic readings - Crack length and depth, liftoff
- Automatic compensation - Live monitoring of liftoff and permeability variations
- Full data recording and archiving capabilities
Sharck Pen probe

- To inspect surfaces that other Sharck probes cannot
- Coverage of 7 mm
- 1 depth/length channel
- Scan speed up to 200 mm/s
  - Recommended at 50 mm/s
Project Scope
Inspection project

— Location: Middle East
— In service weld inspection of 12 PSA vessel
— Semi-automated inspection using TECA system
— Scope: Detection and characterization of surface indications that could be present in welding and adjacent material.
Customer need for TECA inspection

- Quick inspection (Shut down window)
- Data traceability (periodic inspection)
- Flaw sizing
PSA Vessel details

- Material: Carbon steel
- Thickness: body: 38mm, head 48mm
- Weld preparation: Double V
- Diameter: 3,3m
- Height: 9m
- Overall weld length: 37,5m / vessel
Welds configurations

- Circumferential head weld
- Circumferential body weld
- Longitudinal weld

![Diagram of weld configurations](image)
Code

• ASTM E3052-16 (Standard Practice for Examination of Carbon Steel Welds Using Eddy Current Array)

Designation: E3052 – 16

Standard Practice for Examination of Carbon Steel Welds Using Eddy Current Array

\(^1\)
Details

• Inspection of 12 vessel has been done in 4 days
• The refinery stop 2 to 4 vessel per day to allow inspection
• Large weld needed two pass
• Circumferential weld at the junction with the Head need special attention because of the change of thickness
Surface preparation

- Sand Blast
- No preparation
Scan at the thickness change

- The top weld of each vessel
- Difficult to fit the probe
Special scan

- Junction between circumferential weld and longitudinal weld require Single element probe scan
Results
Data interpretation

- Resulting data is assessed based on scans display on Magnifi which consist of three different views (C-Scans) per layout which make interpretation simple.

- There are two layouts useful for data analysis: Axial (for axial cracks) and Transverse (for axial and transverse cracks).

- In order to cover both indications type, the three used C-Scans for the present project are: Length, Depth Short and Transverse.
Data interpretation

- In order to call a defect, an indication is needed on both “Depth” and “Length” C-Scans (Axial layout). On the “Length” C-Scan, a differential signal should be going negatively first and then positively after: **blue-red** sequence on C-Scan.

- “Transverse” C-Scan should be used for transverse cracks detection. **Length** signal will be **red-blue** (inverse of axial cracks).

blue-red: axial indication  red-blue: transverse indication
Typical scan without indication
Example of detected indication
Documentation

- A hard copy of all scans
- TECA report for each vessel
- FFS Report including TECA results

### Results

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<th>Filename</th>
<th>CS1</th>
<th>CS2</th>
<th>CS3</th>
<th>LS1</th>
<th>LS2</th>
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<td>Accepted, no relevant indications were noticed</td>
<td>Accepted, no relevant indications were noticed</td>
<td>Accepted, no relevant indications were noticed</td>
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<td>Accepted after grinding and ECA retesting</td>
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</table>
Conclusions

Benefit vs conventional

- Quick inspection
- Data recording
- Sizing

Technique limitation

- Surface breaking defect only
- Eddy current certified people required
- Software training needed
- Equipment cost
Question?