Survey of Underwater NDT Technologies for Offshore Assets

Ayman Amer, Fadl Abdellatif, Ali Outa, Hassane Trigui, Sahejad Patel, Ameen Obedan, Fernando Diaz Ledezma, Hamad Al Saiari and Ihsan Taie, Saudi Aramco
Intelligent Systems Team - R&D KAUST Satellite Center
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4. Acoustic: AE
5. Electromagnetic
6. CP measurement
7. Multi inspection technology
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Introduction

• Safety and operational efficiency in offshore production sites are of paramount importance.

• Inspection of offshore assets in the oil and gas industry involves mainly platforms and subsea pipelines.

• Inspecting pipelines for maintenance and repair includes complex tasks involving extensive utilization of various resources because pipelines extend for thousands of kilometers, in both shallow and ultra-deep waters.

• Among the inspection techniques are nondestructive testing (NDT) methods that provide real-time monitoring under actual operational conditions, remote sensing, cost-effective operation, safety and reliability
Introduction

Motivation:

• Growing demand for underwater inspection technologies.
• Use of divers is becoming more prominent.
• Execution of tasks by a human diver is usually expensive, slow and dangerous.

Semi-automating these operations provides safer and more effective solutions.
Underwater Visual Inspection

• Conventional Visual Inspection
  
  Level I - General Visual Inspection (GVI)
  ▪ does not usually require cleaning

  Level II - Detailed Visual Inspection (DVI)
  ▪ requires minimal cleaning by using wire brush or high pressure water jetting

  Level III - Close Visual Inspection (CVI)
  ▪ requires a cleaning process to remove the marine growth completely
Underwater Visual Inspection

- Conventional Visual Inspection
  Level I - General Visual Inspection (GVI).
  Level II - Detailed Visual Inspection (DVI).
  Level III - Close Visual Inspection (CVI).

- Advanced Visual Inspection

DimEye Video Laser Scan (VLS): http://dimeye.com/vls-by-dimeye
Echoscope 3D sonar: http://codaoctopus.com/products/echoscope
Acoustic Nondestructive Testing methods

• Ultrasonic Methods

_Ultrasonic Testing (UT)_

• One of the most used external inspection methods

• Inspected surface needs to be exposed and that it can only be performed at a single point at a time, unless a scanner is used

Cygnus ROV & DIVE Underwater Gauge
http://www.cygnus-instruments.com/thickness-gauge-underwater/
Acoustic Nondestructive Testing methods

• **Ultrasonic Methods**

Ultrasonic Testing (UT)

**Guided Wave Pipeline Inspection (GWPI)**

- Used to screen in-services pipes and pipeline over long distance
- Inspect pipes with limited access from a single position
- Inspecting with guided waves avoid coating removal

TWI Bracelet tool for long range guided wave testing
http://www.twi-global.com
Acoustic Nondestructive Testing methods

• Ultrasonic Methods
  Ultrasonic Testing (UT)

Guided Wave Pipeline Inspection (GWPI)

Time of Flight Diffraction (TOFD)

• TOFD provides a wide area of coverage and a rapid scanning with imaging.

• Based on diffraction, so relatively indifferent to weld angles and flaw orientation.

OLYMPUS TOFD scanner for Weld Inspection
Acoustic Nondestructive Testing methods

• Ultrasonic Methods
  Ultrasonic Testing (UT)

Guided Wave Pipeline Inspection (GWPI)

Time of Flight Diffraction (TOFD)

Phased Array UT (PAUT)
  - PAUT can be used as a separate inspection method as well as to assist in pipe weld inspection with TOFD.
Acoustic Nondestructive Testing methods

• Ultrasonic methods
  - Ultrasonic Testing (UT)
  - Guided Wave Pipeline Inspection (GWPI)
  - Time of Flight Diffraction (TOFD)
  - Phased Array UT (PAUT)

• Acoustic Emission (AE)
  - AE is based on the detection and conversion of high frequency elastic waves to electrical signals by using piezoelectric transducers.
Electromagnetic Methods

- Magnetic Particle Inspection (MPI) & Magnetic Flux Leakage (MFL)

Used to detect the crack is located in between the poles of the magnetic field, the magnetic flux leaks out of the material by collecting ferromagnetic particles spread on the surface.

Consists of permanent magnets used to temporarily induce a magnetic field in the body of a pipe to measure the magnetic leakage field.
Electromagnetic Methods

• Eddy Current Testing (ECT)
  When a coil is placed over a conductive part, opposed alternating currents are generated; these are the eddy currents.

  The induction of eddy currents in a conductive material has limited penetration.

• Alternating Current Field Measurement (ACFM)
  Used for detection and sizing of surface defects without the need for a calibration measurement.
Electromagnetic Methods

- Eddy Current Testing (ECT)

- Alternating Current Field Measurement (ACFM)

Used for detection and sizing of surface defects without the need for a calibration measurement.

TSC U31 ACFM for surface crack detection: http://www.tscis.com
Electrical Nondestructive Testing methods

- Cathodic protection (CP)
  - An electrical test performed periodically to evaluate the level of protection and corrosion control.
  - The condition of the CP is assessed by taking readings of the driving voltage between a probe and an external anode that is connected to the metallic surface.
Multi-inspection Technology Approach

- ROV is capable of carrying a multitude of inspection tools and logging a large amount of data gathered from the onboard sensors. This allows for a more comprehensive inspection compared to what a diver can achieve.

ECA Hytec Roving ROV
http://www.ecagroup.com
Multi-inspection Technology Approach

- ROV is capable of carrying a multitude of inspection tools and logging a large amount of data gathered from the onboard sensors. This allows for a more comprehensive inspection compared to what a diver can achieve.

- In-Line Inspection (ILI) tools that carry multiple inspection techniques for internal pipeline inspection

LineExplorer UC in-line inspection tool (ILI)  
http://www.ecagroup.com
CONCLUSION

- NDT techniques provide a cost-effective and efficient way for inspecting oil and gas assets in a non-invasive manner allowing real-time inspection under actual working conditions, and without interrupting day-to-day operations.

- Use of inspection ROVs is becoming more attractive and replacing or at least complementing diver operations.

- Utilizing multiple inspection technologies on a single ROV would enable executing multiple measurements simultaneously to provide a more complete picture of the asset integrity.