

Pipeline inspection using EMAT.

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Abstract

In recent years advancement in NDT Technology has taken place in a very great pace. Among all NDT methods, Ultrasonic testing has undergone many developments and is evolving with more methodologies using sophisticated equipments.

Among that Electro Magnetic Acoustic Transducer – “EMAT” Technique has gained large adaptation and is proving to be highly beneficial. The basic understanding of EMAT is very important for effective, optimum and appropriate application of this technique.

In-service pipeline inspection of critical piping’s particularly in refinery and fertilizer plants has always been a matter of concern and challenging to the industry to access the condition of the pipe as well to ascertain the remaining life. These critical piping’s are great threat to catastrophic failure and safety. Many fatal accidents have occurred in the past leading to loss of human life and economy.

Complete 100 % volumetric inspection of these critical piping’s has now become reliable, fast and easy by the application of EMAT.

1.0. CORROSION – EFFECT AND DETECTION CHALLENGES

The biggest ever challenge in the process pipeline inspection is corrosion detection with 100 % coverage. The integrity of the pipelines needs to be monitored frequently by pipeline operators to mitigate potential hazardous conditions.

Once the initial corrosion begins it leads to reduce the life of the pipeline at a faster rate. It is observed that cyclical loading, temperature, residual stress, and bending load act on the initial corrosion site to develop a crack or a colony of cracks. Normally with stress, the corrosion area transform into a crack. Further Cracks in the pipelines can reduce the integrity of the pipe and most importantly result to catastrophic failure.

Severity level of Corrosions in pipelines are again categorized based on shape, size, orientation, location etc.etc.

Hence precise and exact corrosion detection at initial stage is very much essential in process pipelines.

Detection and inspection challenges:

- 100 % Pipeline inspection for Corrosion detection with 360° inspection.
- Corrosion detection on high temperature process pipelines.
- Pipelines with rough surfaces.
- Corrosion detection under pipe supports.
- Fast inspection coverage.

2.0 GENERAL INDUSTRY PRACTIC AND INSPECTION LIMITATIONS.

Use of Conventional Ultrasonic inspection on suspected areas as determined by past failure studies, experience and on suspected areas.

Engagement of Long range Ultrasonic for corrosion detection under pipe supports. Guided waves is again limited to certain limitations.

High temperature pipelines are not possible to be inspect during process expect during the plant shutdown.

Pipelines with rough surfaces are confined to limited localized inspection with conventional Ultrasonic testing methods.

Pipeline inspection on pipe racks in refinery with difficult approach are left without periodic inspection except plant shutdown.

3.0 CORROSION DETECTION IN PIPELINE BY EMAT

3.1. BASIC PRINCIPLE OF EMAT

EMAT- Known as “ Electro-Magnetic Acoustic Transducer” is considered to be a transducer that uses the interaction of a magnetic wave and eddy current to transmit ultrasound in the test pieces.

Unlike piezo-electric transducers which generate the ultrasonic waves in a crystal, an EMAT actually generates the ultrasound in the body of the test piece.

The EMAT does not touch the test piece and maintains a lift of approximately 2mm form the test surface. Thus it does not require couplant for transmitting of sound waves.Usage of no couplants

provides an immense advantage in inspecting of high temperature test objects as well as provides a very fast inspection result.

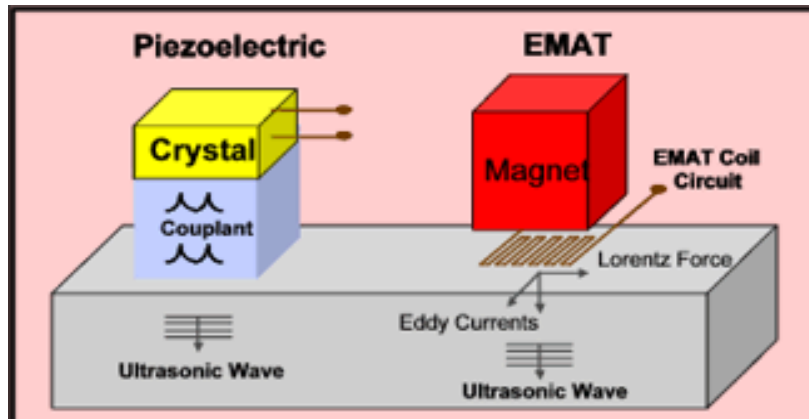


Fig.1. Illustration of the comparison between generation of conventional ultrasonic waves and EMAT waves.

3.2. APPLICATION – IN PROCESS PIPELINE.

It uses two Sets of Transducers to emit and receive the ultrasound. For transmission into the pipe wall, an alternating current in a wire induces an eddy current in the metal surface. When this is combined with a static magnetic field, a force is produced which causes the steel metal grid to oscillate, thus launching a guided ultrasonic sound wave in the pipe wall.

More often the frequency selection is critical to adjust the ultrasound waves to fully cover the thickness along the cross section of the pipe and as well response to anomalies. Usage of multi frequency also finds more adaptability.

Loss of wall due to corrosion will result in reflections of the sound wave. These reflected waves encountering the magnetic field will generate an eddy current, which in turn, induces a current in the wire. This current forms the received signal, which is then processed and analyzed.

In principle a magnetic field is applied in the steel while the transducer coil is placed (approximately 1 mm to 2 mm) above the pipe surface. The receiver sensors are very sensitive to pick up the signals.

The mounting carrier with transmitting and receiving sensors is mounted circumferentially to the pipeline axis. The sound waves travel circumferentially in the pipe.



Fig.2. EMAT on a pipeline - Showing the transducer position and a typical set up.

4.0. INSPECTION COVERAGE AND RESULT:

EMAT is considered to be a volumetric inspection responding to the volumetric loss of energy or sound waves reflected from anomalies along the pipe cross section.

- Accurate detection of corrosion (wall loss).
- 360° Inspection of process piping
- 100 % inspection coverage of process pipelines.
- Determine corrosion under pipe supports.
- Corrosion detection on High Temperature process pipelines.
- Inspection of rough surface pipelines.

5.0. INSPECTION LIMITATION.

- It's a volumetric inspection.
- Initially requires long set up and calibration time.
- Require technicians with high experience.
- Usually a large set up on a moving trailer.
- Requires UT and VT for locating exact location of the anomalies.
- Requires conventional UT for exact sizing.

6.0. CONCLUSION.

Corrosion detection using EMAT has proved to be a fast accurate corrosion detection tool. In addition it has also turned to be economical for the asset owners.

EMAT can now also be used for crack detection in process pipelines. It has also proved very successful for detecting SCC in process pipelines.

It can also be used on tank shells, pressure vessels, heat exchangers and tube inspections.

Speed, accuracy of EMAT is superior to other automatic inspection systems and hence the benefit of using EMAT has to be reaped.

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