APPLICATION OF NEW TECHNOLOGIES FOR DETECTION & MITIGATION OF CORROSION AT HALDIA REFINERY

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ABSTRACT

The detection and mitigation of corrosion problems in a coastal refinery like Haldia is a big challenge for corrosion engineers. Apart from the conventional corrosion detection techniques, newer and advanced NDT techniques are being regularly employed at Haldia Refinery for detection of internal and external corrosion. On detection of corrosion problems, various measures are also adopted to mitigate corrosion of various equipment /pipelines.

In recent years, Haldia Refinery has adopted various kinds of online and offline advanced NDT techniques for health condition monitoring of piping and equipment. Among them, Low Frequency Electromagnetic Testing (LFET), Acoustic Emission Testing (AET), Remote Field Electromagnetic Technique (RFET), Long Range Ultrasonic Testing (LRUT), Eddy current testing (ECT), Automatic Ultrasonic scanning (AUS), Remote Visual Inspection (RVI) etc are widely used for online and offline health assessment of the tank bottom, surface condenser tubes, air fin cooler tubes, boiler bank tubes, heater tubes etc. The effective application of these advanced NDT techniques has proved beneficial in detection of various damage mechanisms affecting the equipment and piping.

The paper describes the success story of implementation of new technologies in the field of detection and mitigation of corrosion leading to enhancement of reliability of equipment and piping and extension of useful life of components.

Keywords: Advanced NDT, LFET, AET, RFET, LRUT, AUS

INTRODUCTION

In the present scenario of competitive market, it is becoming imperative to have longer and trouble free run length of the process units at refinery. Corrosion related failures and interruptions can have significant impact on the profitability. Haldia Refinery is more vulnerable to such failures as it falls in the most severe zone in the atmospheric corrosivity map of India. Corrosion damage is manifested as increased maintenance, reduced reliability, reduced safety, loss of production and poor product quality. Haldia Refinery is continually implementing a lot of measures and initiatives to minimize the effect of corrosion and eliminate the corrosion related failures and interruptions. Adoption of new technologies is one such initiative taken by Haldia Refinery for detection and mitigation of corrosion and damage mechanisms.

CORROSION DETECTION TECHNIQUES

A variety of conventional and advanced techniques are employed at Haldia Refinery for timely detection of corrosion and estimation of corrosion rates. Increased schedule for visual inspection of the equipments and piping, along with conventional ultrasonic techniques has been an effective way for detection of metal loss which subsequently help in planning for repair and replacement of equipment and piping. Apart from the conventional techniques, Haldia Refinery also employs various kinds of online and offline advanced NDT techniques for health condition monitoring. Among them, Low Frequency Electromagnetic Testing (LFET), Acoustic Emission Testing (AET), Remote Field Electromagnetic Technique (RFET), Long Range Ultrasonic Testing (LRUT), Eddy current testing (ECT), Automatic Ultrasonic scanning (AUS), Remote Visual Inspection (RVI) etc are widely used for online and offline health assessment of the tank bottom, surface condenser tubes, air fin cooler tubes, boiler bank tubes, heater tubes etc. The effective application of these advanced NDT techniques has proved beneficial in detection of various damage mechanisms affecting the equipment and piping.

NEW TECHNOLOGIES ADOPTED AT HALDIA REFINERY

The following new technologies have been successfully adopted recently at Haldia Refinery for detection and mitigation of corrosion related problems:
Low Frequency Electromagnetic Testing (LFET)

This technique is used to scan the tank floor plates for topside and underside corrosion and is based on the electromagnetic principle. It detects the surface and sub surface crack, pitting and any kinds of metal loss over the floor.

The advantages of LFET of tank bottom plates are as follows:

- 100% scanning of bottom plates can be done directly over coated / painted bottom plate without removing the lining. No couplant or magnets are required.
- Fast scanning resulting in minimization of tank outage time.
- Real Time Data Display and storage in CD.
- Topside and Bottom side defects evaluated in a single scan using new dual frequency electronics option.

LFET is being successfully carried out in storage tanks of Haldia Refinery for health assessment of tank bottom plates during tank maintenance and inspection. This reduces considerably, the duration of shutdown and hence maximizes run length of tanks. The effective use of this technique has considerably reduced the requirement of bottom plate replacement of tanks during their M&I since it accurately pinpoints the exact area of damage. The technique has also been adopted for health assessment of tubes of boiler firebox for the detection of internal corrosion as well as internal damage mechanisms like caustic gouging etc.

Remote Field Electromagnetic Technique (RFET)

This technique is used for health assessment of tubes of heat exchangers/ air coolers and works by inducing an electromagnetic signal into the tubes to detect any internal wall thickness loss. It detects and sizes corrosion/erosion, pitting etc.

**LFET being carried out**  **LFET signals at defect location**  **Tank bottom mapping**

**LFET being carried out at boiler tubes**  **LFET phase signals at defect location**

**RFET Schematic**  **RFET signal showing wall thickness loss near baffle**
The principle is based on remote field eddy current testing where an exciter coil generates eddy current at low frequency in the circumferential direction and electromagnetic field transmit through the thickness and travels on the outer diameter. A receiver coil is placed at remote field zone of exciter and picks up this field. In this zone wall current source dominates the primary field directly from exciter. The separation between the two coils is between 2 to 5 times of tube ID. As the magnetic field penetrates the tube wall twice, it will undergo a delay (phase lag) and attenuates (amplitude attenuation). The phase lag and attenuation incurred will depend on the local wall thickness and it is measured.

The advantages of RFET of heat exchanger/ air cooler tubes are as follows:

- The technique detects the wall thickness loss along the length of tube.
- It does not require much cleaned surface and does not require couplant.
- The technique is suited for ferromagnetic tubes.

RFET has been successfully employed for health assessment of air cooler tubes during shutdown of process units at Haldia Refinery. This technique gave very accurate result in short duration, about the health of air cooler’s tube health which, conventionally would have taken much longer time which might not even be as accurate and practically feasible. Hence, the reliability of the heat exchangers/ air coolers has been considerably enhanced by the effective application of this advanced non-destructive technique.

Long Range Ultrasonic Testing (LRUT)

This technique uses low frequency guided ultrasonic waves to detect a length of piping. It locates the affected area in terms of distance from transducer and serves as a screening tool to inspect large lengths of piping especially at difficult to access locations.

The advantages of LRUT for assessment of piping are as follows:

- Assessment of inaccessible areas like culverts, tank dykes etc is possible.
- 100% screening coverage.
- Detects thickness loss from both internal and external side.

The LRUT is being successfully carried out for health assessment of offsite piping in inaccessible areas under culverts, dykes at Haldia Refinery. The effective utilization of this technique has considerably enhanced the reliability of piping at Haldia Refinery.

Acoustic Emission Testing (AET)

AET is an on-line technique for assessment of condition of tank bottom plates. The specialized AE sensors pick up the acoustic emissions released by the corrosion process taking place inside the tank which are processed to assign the rating of the tank based on which the future actions required for the tank is determined.
The advantages of AET for tank bottom assessment are as follows:

• Tank bottom plates together with the steam coils can be inspected while the tank is in service. However, the tank needs to be in non turbulent condition without any product movement / circulation including isolation of steam coils for about 8 – 12 hrs, prior to test and also during the test.

• Quick on-line inspection method as internal cleaning of tanks and tank outage avoided.

• Effective re-scheduling of M&I activities.

• Internally painted tanks, insulated tanks can also be inspected. However, pockets need to be provided in insulation for installation of sensors.

• Generates database for future reference.

The acoustic emission testing (AET) has successfully utilized for condition assessment of large diameter crude and heavy oil tanks at Haldia Refinery. As per earlier practice, health assessment of crude tanks was possible only during tank shutdown. With AET, the inspection of the same could be done in running condition without requiring shutdown. The scheduling of maintenance and inspection of the storage tanks at Haldia Refinery are presently being done based on the findings of AET.

**Composite repair solution for pipelines**

This new technology is adopted for refurbishment of corroded and deteriorated piping ensuring reliable extended service life without replacement or weld repair. The composite repair system is designed for the pressure rating of the piping component on which it is applied. The application of the composite repair system involves surface preparation (manual) followed by base layer of Mixed Reinforced Epoxy Paste (REP) and subsequent layers of Composite Repair Compound (CRC) with wet glass fiber rolls and finally tightening by rubber strips (uniwraps) which are removed after drying period.

The composite repair methodology was successfully adopted for refurbishment of a corroded piping at Haldia Refinery. The technology is being planned for refurbishment of other corroded locations of piping which are difficult to isolate and repair by conventional methods. The process is being used for online repair of FO, Lube and Cooling Water lines at Haldia Refinery.

**Detection of Corrosion under insulation (CUI)**

Corrosion under insulation (CUI) is caused by the ingress of water into the insulation, which traps the water like a sponge in contact with the metal surface. The water can come from rain, leakage, deluge systems, wash water, or sweating from cycling temperatures. For detecting the water ingress inside the insulation, advanced water detectors are being installed at
insulated locations of piping at Haldia Refinery which will raise alarm when the moisture level reaches critical limit. This detector has been installed at several circuits identified for severe corrosion under insulation at Haldia Refinery.

CONCLUSION

The effective use of technological advancements in the field of corrosion detection and mitigation has greatly helped in increasing the safety and reliability of plant and equipments at Haldia Refinery. Newer technologies are being tried and successfully implemented for achieving the reliability mission of minimizing/eliminating interruptions through enhanced performance and reliability of equipment and plant.

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