

Extended Major Turn Around at Heavy Water Plant (Kota) - A Great Challenge

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Abstract

India through Heavy Water Board (HWB) is the world's largest producer of heavy water and one of the heavy water exporting countries. Starting from a scarcity in 1970s, self-sufficiency in 1990s, indigenous development of heavy water technology has gone through various phases of transformation. All operating plants are subjected to appropriate health assessment strategies including In Service Inspection and Condition Monitoring techniques.

Heavy Water Plant, Kota, a constituent unit of Heavy Water Board under Department of Atomic Energy, employs bi- thermal Water- Hydrogen Sulphide Chemical Exchange Process for production of Heavy Water. The plant has been in safe, sustained operation during the past twenty seven years due to the best Operation & Maintenance practices including regular condition monitoring & In-service Inspection. The plant has crossed its intended design life and opportunities were not available to inspect entire quantum of weld joints, wetted surface areas of all equipment and extensive inspection of piping network under insulation during regular ISI campaigns.

Hence, Heavy Water Plant, Kota conducted an Extended Major Turn Around after removal of entire trays from all exchange towers & protective pyrite film near welds to identify any incipient, hidden degradation. Since the criteria and jobs for health assessment vary with the changing age and operating conditions of the components, several conventional and advanced techniques such as Phased Array UT, Remote Visual Inspection etc, were adopted with qualified professionals. NDE examinations and mechanical testing of specimens of aged materials have established the integrity of equipment and piping. We have acquired a broad spectrum of inputs which has improved the confidence, assured components reliability & strong optimism for sustained future operation. This paper discusses the scope including planning, identification of techniques for assessment of ageing related degradation, challenges encountered, measures adopted for timely execution and salient highlights of the campaign.

1. Introduction

India through Heavy Water Board (HWB) is the world's largest producer of heavy water and one of the heavy water exporting countries. Starting from a scarcity in 1970s, self-sufficiency in 1990s, indigenous development of heavy water technology has achieved excellence in all fields.

Heavy Water Plant (Kota), is designed to produce 85 MT per year of nuclear grade Heavy Water, based on Hydrogen Sulphide-Water dual temperature isotopic exchange process called Girdler Sulphide (GS) process. The plant is operating commercially at high capacity utilization and excellent steam factor with a team of about 600 well trained employees. The

plant commissioned in 1985, is in sustained operation for last 27 years creating new records in production and productivity breaking its own records.

H₂S gas is highly corrosive, explosive & toxic and stringent safety measures were to be adopted in the plant design, construction, operation and maintenance. HWP (K) also handles considerable quantities of other hazardous chemicals such as LPG and chlorine.

2. Regular Health Assessment and Life Management

Regular In service Inspection and condition monitoring including preventive maintenance of rotating equipment & critical components is being followed in the plant to ensure uninterrupted operation of the plant with maximum productivity and eliminate any accidental release of the hazardous fluids. ISI campaigns are being organized during every MTA based on the Code of Practice document for ISI of Heavy Water Plants.

3. Need for Extended Major Turnaround with Global Coverage

HWP, Kota has been in sustained operation since the past twenty seven years. The plant has crossed its intended design life and inputs from plant operation & maintenance & past ISI/M&OM campaigns confirmed the sound health of pressure vessels and other pressure components. However, opportunities are not available to inspect entire quantum of weld joints, wetted inside surface areas of all equipment and particularly piping network during every regular ISI campaign. Therefore, Heavy Water Board decided to proceed towards an Extended Major Turn Around with thorough overhauling and extensive in service inspection with several advanced NDE techniques.

4. Scope of EMTA

In view of the above mandate, a committee was constituted by Heavy water Board to decide the quantum of jobs to be executed during EMTA 2013. Jobs list was reviewed by Executive Director (Operation) & Director (Operation), HWB along with site management. Detailed discussion was also held with Shri S.C.Hiremath, Former Chairman & Chief Executive, HWB and his advice & suggestions were also incorporated in the scope of work. Valuable suggestions were also received from AERB particularly towards adoption of advanced NDE techniques for ISI activities. Based on these inputs, a master document was frozen for execution including following major maintenance & ISI jobs.

- Complete dismantling of equipment and removal of all trays from all Exchange Unit (XU) towers & Waste Stripper (WS).
- Thorough visual inspection of 100% inside surface area of all XU towers and WS.
- 100% UT examination of all weld joints, including nozzle welds of all XU towers, dump tanks, process tanks & WS from inside.
- PAUT of site welds having discontinuity weld joints and at tri-axial joints of XU towers & WS
- Thickness monitoring at 16 locations on each shell course of all equipment & process piping
- Hardness measurement of inside surface of all equipment.
- WFMP testing of all site weld joints.
- UT of weld joints of 4" NB & above pipe lines
- Visual inspection of small dia pipes (<4" NB) before & after removal of insulation.
- LPT of all drain & vent connection welds within 1st isolation valve.

- Maintenance of flange joint of XU piping
- PMI check of all SS lines within 1st isolation.
- Maintenance of HXs including thickness measurement / mapping of main shell and end covers including nozzle pipes for H₂S service. Eddy current testing of HX tubes.
- Maintenance & testing of all H₂S gas boosters including visual inspection & thickness measurement / mapping of volute casing.
- Maintenance & testing of all Double Discs Gate Valves (DD valves)& thickness mapping of fixed 1st isolation DD valves body & bonnet.
- Completion of ISI jobs of 2nd cycle.
- Replacement of vent & drain header including pump sealant drain header.
- Remote visual inspection of large dia gas pipelines & drain nozzle pipes.
- Replacement of entire seal oil piping with 316L material, seal oil over head tanks, drain pots, HP seal pot of flare stack.
- Electrical/instrumentation jobs
- Film formation of XU towers, waste stripper and purge towers.

5. Preparation for EMTA 2013

Prior to commencement of EMTA, ISI of all the five H₂S storage tanks i.e. shot blasting, internal visual inspection, UT of weld joints, metallography and thickness monitoring of liquid outlet lines; maintenance of their isolation valves and flange joints was carried out. All level and pressure transmitters of tanks were maintained and re-calibrated. Safety valves of storage vessels were maintained, tested and witnessed by approved agency of Department of Explosives. All five tanks were also hydro-tested and witnessed by approved agency of DOE. Thickness measurement of run down header in Exchange Unit was carried out before commencement of run down operation.

All the jobs were planned to be completed within 180 days including film formation activities. Department was not equipped to execute all these works with the available resources and manpower. Therefore, several contracts were finalized for carrying out various jobs such as dismantling/reinstallation of tower trays, surface cleaning by shot blasting, various NDE activities, fabrication & erection of piping, removal & renewal of insulation, maintenance of valves/heat exchangers and other miscellaneous jobs. Qualified and experienced engineers and supervisors from other Heavy water Plants were deployed for supervision of various NDE examinations and tower maintenance jobs.

6. ISI Techniques Used During EMTA 2013

- 6.1 Visual inspection
- 6.2 Remote Visual inspection
- 6.3 Ultrasonic thickness measurement
- 6.4 Manual Ultrasonic inspection of weld joints
- 6.5 Phased Array /TOFD Ultrasonic inspection of weld joints
- 6.6 Dye Penetrant examination of weld joints
- 6.7 Wet Fluorescent Magnetic Particle examination of weld joints
- 6.8 Hardness measurement
- 6.9 In-situ Metallography
- 6.10 Eddy Current testing
- 6.10 Hydrostatic/pneumatic test& Sensitive Leak Test

7. Major Observations & Actions Taken

- All XU towers, waste stripper, process & dump tanks and connected piping are found to be in good condition and existing with sound material properties.
- Various NDEs carried out on weld joints & many other identified components show defect free pressure boundaries for equipment, piping, isolation & control devices.
- There is no unusual loss of thickness noticed anywhere in the entire plant in its pressure boundary areas. General corrosion has been noted to be less than 2 mm except in few isolated areas and over a zone having a maximum dimension of 800 sq mm, around the Drain Nozzle of bottom dish end of IIStage Hot Tower, which have been repaired. Other equipment & piping where ever general corrosion related to thinning/degradation were observed, have been replaced.
- The results of in-situ metallography, mechanical testing of service exposed materials and laboratory analysis of corrosion products collected from various locations give confidence to sustain the plant operation, with periodic maintenance & continued In-Service Inspection of various components.

8. Challenges Successfully Managed

- Removal of adhering iron sulphide film from inside surfaces of XU towers
- Very limited access for movement from top to bottom of towers with very little scope for provision of scaffolding at all locations
- Parallel execution of several activities such as tray removal/reinstallation, surface preparation, audio/visual recording and NDE examinations at various locations/elevations inside the towers
- Coordination among various departmental/outside execution agencies to ensure smooth sequence of job flow with minimum interruption, total safety culture and zero loss of time.
- Provision of Logistics including accommodation, transportation and catering to several hundred personnel for healthy working environment. A separate canteen was operated for contractor personnel for extended hours with all necessary amenities.
- Implementation of smooth personnel /goods movement at the security gate ensuring foolproof internal/external security system.

9. Film Formation

The pyrite–pyrrhotitefilm in all XU towers was removed from areas around the weld joints of towers and waste stripper to facilitate various NDE examinations. After completion of all maintenance & testing jobs during EMTA-2013, protective pyrite–pyrrhotitefilm formation was successfully done in towers before plant startup.

10. Conclusion

The expedition, though challenging, has been quite a success. We encountered some surprise issues during the campaign but overcame them without long derailing of our EMTA schedule, by immediate deliberations, discussions and decisions at site and quick approval and guidance by Heavy water Board. The success is due to clear objectives, targets, well planning, guidance from Chairman & Chief Executive, HWB and self-disciplined & dedicated work force.

This extended major turnaround over a period of six months by Heavy Water Board deploying extensive manpower and financial resources has proved the sound health of the pressure components, structures and supports. We have reaffirmed the integrity & healthiness of all pressure vessels& pressure components.

The plant has been successfully restarted, heavy water production has commenced and the safe, successful journey continues with renewed confidence among employees and public in the neighborhood.

TOWER TRAY BEING SHIFTED



PHASED ARRAY UT



ULTRASONIC THICKNESS MAPPING



HX MAINTENANCE

