# IMPORTANCE OF INSPECTION OF THE OIL-OIL SHELL AND TUBE HEAT EXCHANGER FOR NEEDS OF SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL PROTECTION

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*Abstract. Plant for oil stabilisation is enable to recovery and commercial exploitation of oil which is rectifying from excavated raw gas. Condensed hot liquid hydrocarbons that are separated from natural gas can be used to heat the fluid that enters in the process in which it is separated into liarder and lighter components. This paper presents the inspection of an oil heat exchanger and explains the importance of inspection regarding sustainable development and environmental protection. The visual test revealed some mechanical damages and surface corrosion; a liquid penetrant inspection method showed no cracks at the time of inspection. The thickness of the material is measured by ultrasound technique. Determination of corrosion rate and remaining life of oil-oil shell and tube heat exchanger is performed according to the API 510 and API 572 standards.*
***Key words:*** *Oil-oil heat exchanger, inspection, ndt methods, corrosion rate, remaining life*

Table 1 Design data of oil-oil shell and tube heat exchanger

| | Shell side | Tube side |
|---|---|---|
| **Design pressure (bar)** | 13 | 33 |
| **Design temperature (ºC)** | 128 | 100 |
| **Operating temperature (ºC)** | 98/70 | 45,7/70 |
| **Test pressure (bar)** | 16.9 | 42.9 |
| **Weld join efficiency (%)** | 0.85 | 0.85 |
| **Fluid** | Stabilized condensate (Hot-oil) | Wet oil (entering in process) |
| **Volume (S/H) (m2)** | 4354/2.49 | |
| **Material of construction** | SA516 Grade 70 | |

Table 2. Inspection plan for recertification pressure vessel

| No. | Activity | Reference | Acceptance | Verify | Inspection Level | | |
|---|---|---|---|---|---|---|---|
| | | Document | Criteria | Document | Req' | MOG | CA |
| 1 | Review Document | | | | | | |
| | - Drawing, Design/ Datasheet | ASME Sec. VIII | ASME Sec. VIII | General Drawing & Datasheet | Yes | R | R |
| | - NDT Equipment Calibration | ASME Sec. V | ASME Sec. V | Calibration Cert. | Yes | R | R |
| | - Previous Inspection Record | API 510 | API 510 | Inspection Workbook | Yes | R | R |
| | - Corrosion & Failure Threat | API 510 | API 510 | Corrosion Assessment | Yes | R | R |
| | - Advance NDT Procedure | | | NDT Procedure | No | A | R |
| 2 | Visual Inspection | | | | | | |
| 2A | External | Internal procedure | API 510 | Visual Inspection Report | Yes | P | M/R |
| 2B | Internal | Internal procedure | API 510 | Visual Inspection Report | Yes | P | W |
| 3 | Extended Non Destructive Test | | | | | | |
| 3A | Scanning Wall (shell, head) | Internal procedure | ASME Sec. V | NDT Report | No | P & T | M/R |
| 3B | Wall Thickness Check (Localized Scan) | API 510 | API 510 | NDT Report | Yes | P & T | M/R |
| 3C | Hardness | | ASME Sec. II | Hardness Report | No | P & T | M/R |
| 3D | MT or PT on selected W. joints | Internal procedure | ASME Sec. V | NDT Report | Yes | P & T | M/R |
| 3E | Other Advance NDT | API 510 | ASME Sec. V | NDT Report | No | W | W |
| 4 | Calculation Check | | | | | | |
| 4A | Corrosion Rate Calculation | API 510 | API 510 | Calculation Report | Yes | P | R |
| 4B | Remaining Life Calculation | API 510 | API 510 | Calculation Report | Yes | P | R |
| 4C | MAWP Calculation (if derated) | API 510 | API 510 | Calculation Report | No | P | R |
| 5 | Hydrotesting | Internal procedure | ASME Sec. VIII | Hydrotest Report | Yes | P & T | W |
| 6 | Completed Pressure Vessel Inspection Work Book Report | | | | Yes | P | R |

Figure 1. Oil-oil shell and tube heat exchanger

**Visual inspection activities of the shell and tube heat**

Figure 2. The tube bundle after cleaning
- in good condition without visible damages and deformations

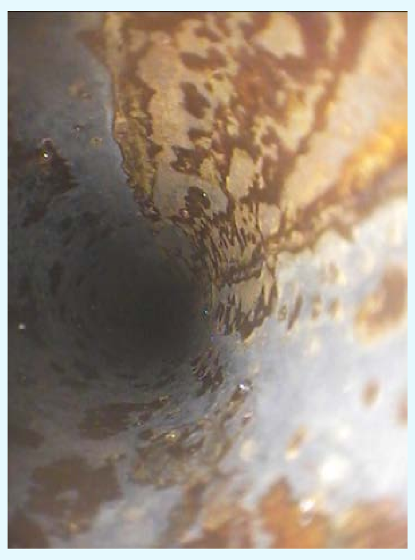

Figure 3. Surface corrosion was observed on the internal side of the tubes (all tubes were in the similar condition in time of inspection)

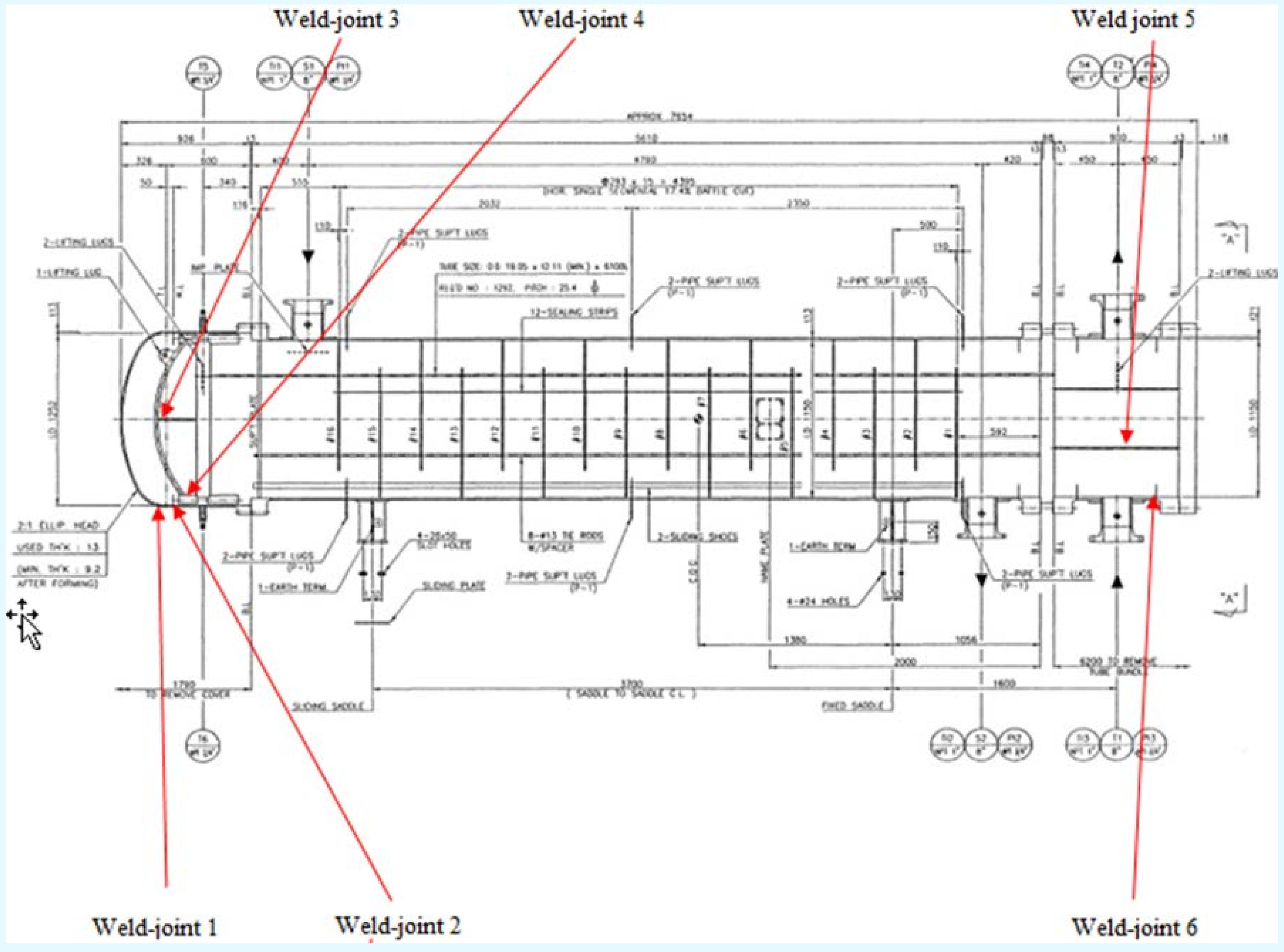


Figure 4. Sketch of PT tested equipment

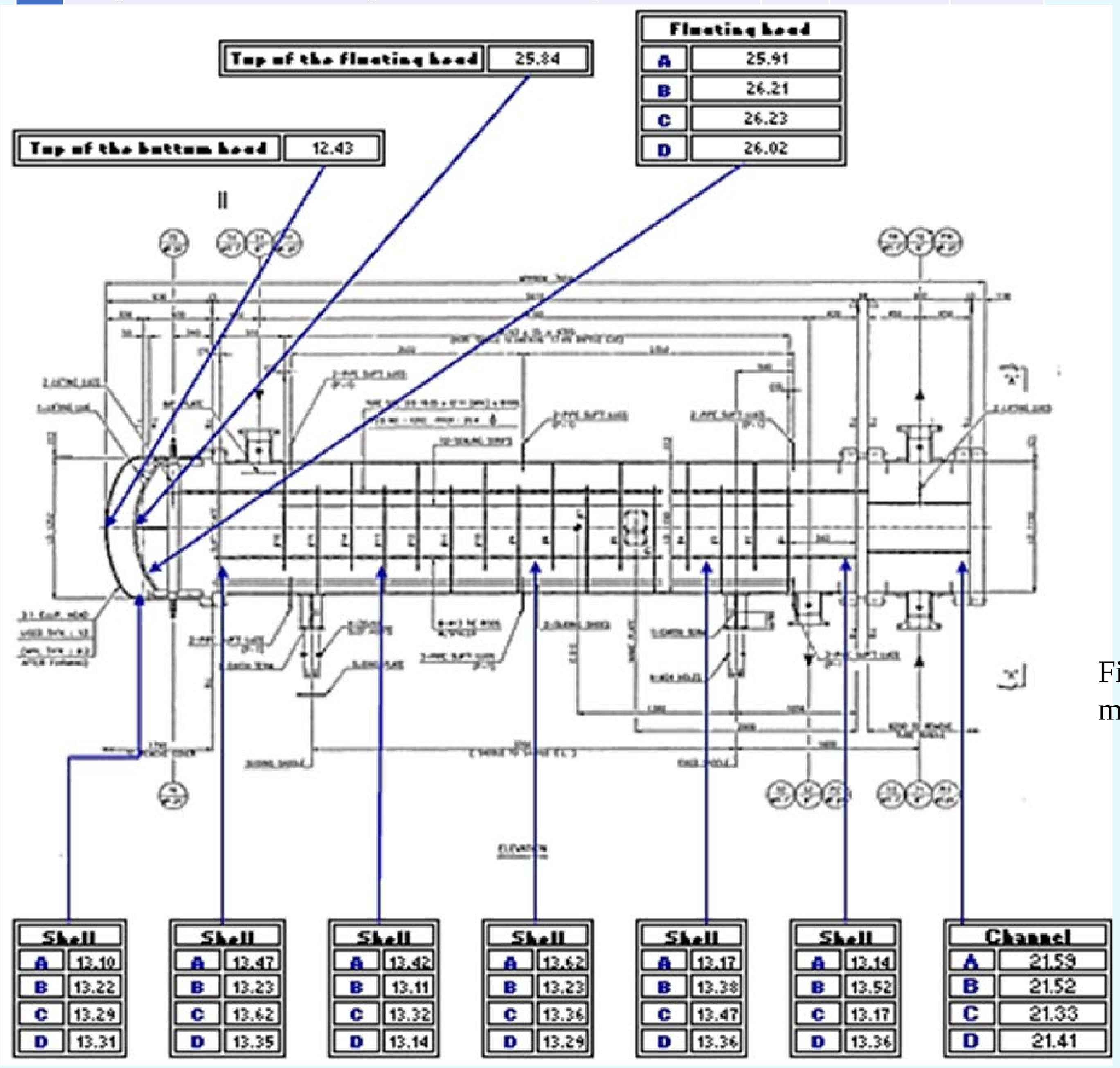


Figure 4. Sketch and results of UT thickness measurement of oil-oil heat exchanger

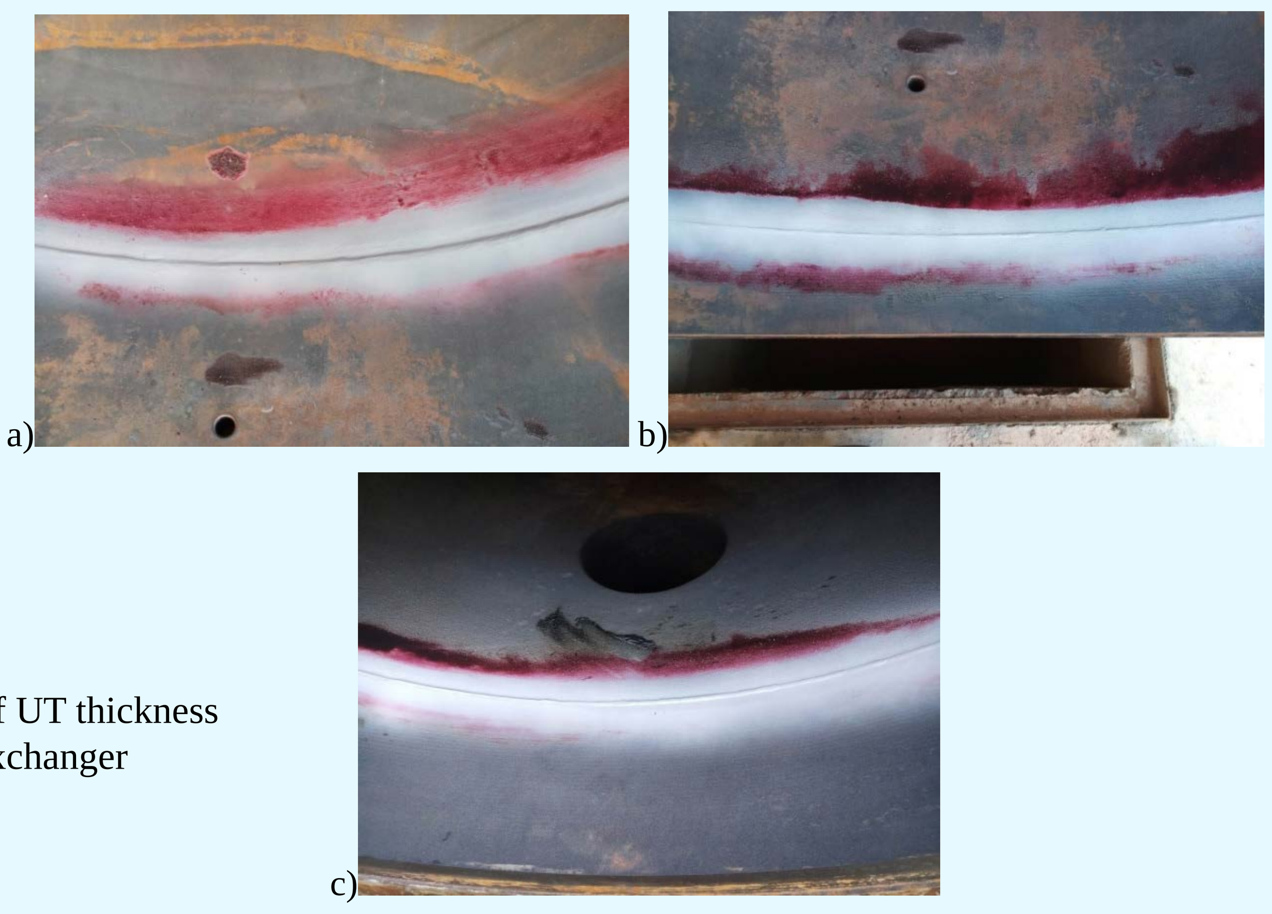


*Figure 5. Results of PT tested of the weld joints a) 1 b)2 and c)6.*

**The determination of corrosion rate and remaining life**

The corrosion rate is calculated according to the API 510 and API 572 as a corrosion rate long time (LT) according to the following equations:

Corrosion rate (LT) = ($t_{initial}$ – $t_{actual}$ )/time between $t_{initial}$ and $t_{actual}$ (years)

Corrosion rate (LT) = (13.208 -13.11)/18

Corrosion rate (LT) =0.005mm/year

Remaining life of the heat exchanger (in years) shall be calculated from the following formula:

Remaining life = ($t_{actual}$ – $t_{required}$) /corrosion rate

Remaining life is = 22 years

**Conclusions**

This paper presents the plan and results of oil-oil shell and tube heat exchanger's inspection as an important part for the environment protection and sustainable development.

The inspection included visual testing, liquid penetrate testing and ultrasound thickness measurements. The inspection revealed no corrosion or any damage and all of the essential sections/components of the oil-oil heat exchanger is safe to operate until next scheduled inspection.

Corrosion rate is calculated according API 510 and API 572 is 0.005 mm/year, hence remaining life of the oil-oil shell and tube heat exchanger is 22 years. Next external inspection, internal inspection and ultrasonic thicknesses measurements at the same position should be per-formed within next five years. Also grounding connections electrical resistance is recommended also to be measured according to the requirements of API 510 and API 572 standards.