G.V. ABSORBER F-3303

A Case Study on failure due to corrosion on shell.

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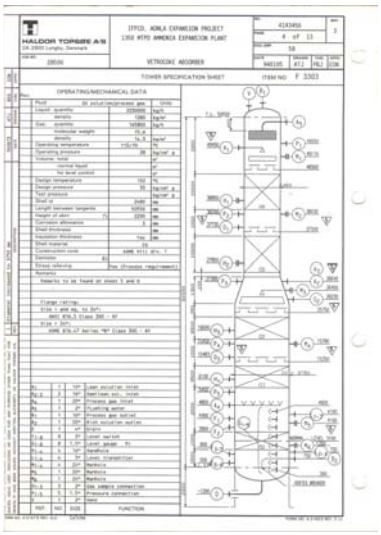
INTRODUCTION :

- Vetrocoke absorber (F-3303) removes CO2 from process gas by absorbing the CO2 content of the process gas in GV solution at high pressure and liberates it in re-generator at low pressure. Raw synthesis gas from separator B-3303 enters the absorber through an internal gas distributor located at bottom of absorber F-3303. Gas from inlet distributor passes through bed of IMTP which provides intimate contact of gas with down coming lean & semi lean solution. Bulk of CO2 is removed in lower two bed by semi lean solution entering at intermediate level. Final removal of CO2 takes place in upper two beds by lean GV solution at top of absorber.
- This tower was manufactured & supplied by L&T in 1996

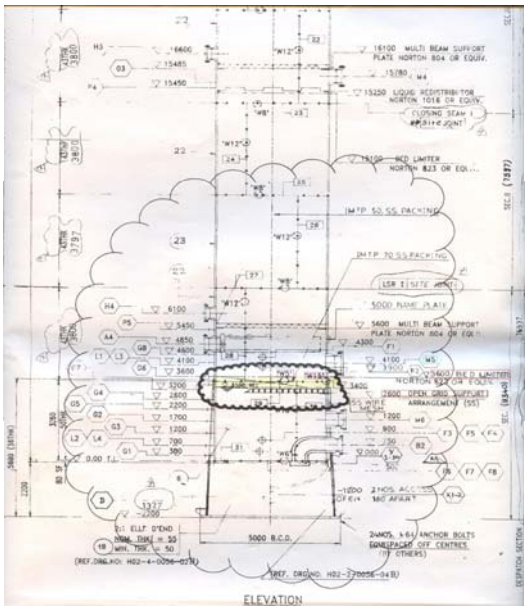
Schematic of Absorber F-3303:



THE LEAKAGE :

- A heavy gas leakage sound was observed at 11.45AM on 3/09/2010 from inside the vessel skirt. The exact location of the leakage could not be known immediately because the leakage was from C-seam joint which is just below the vessel to skirt joint inside the skirt.
- It was decided to stop the plant and open the absorber after proper purging of the vessel. In the mean while, to know the exact position of the leakage from outside, a window was cut on skirt of size 12”X 18” towards west side where some crystal deposits of GV solution in between skirt & pressure shell of absorber F-3303 was observed. But no leak was found there. After purging of the vessel by connecting vacuum blower at M1 and M6 manhole and running it for 12 hrs, the M5 manhole was opened for inspection and leaky area detection from inside. After opening the Manhole M5, the bed limiter was found in broken condition and it was observed to be lifted up from east side because of shifting of the entire pickings on that side. The complete bed (bed limiter, Tower Packing (IMTP 70) and grid support trays) was removed to approach the damaged shell area.

Drawing:



VISUAL INSPECTION FROM INSIDE M5 MANHOLE:

- A through hole was observed in ‘C’ seam in front of manhole M-5 (towards west side) between 105º to 110º. 0º has reference opposite to DM plant i.e. north side and degree clockwise increases. Erosion had been found at many places on ‘C’ seam. One meter height of shell area in complete circumference between both trays supporting ring (TSR) was found badly corroded/eroded. There were many notches & canals of varying depth of 5-15 mm over the entire circumference of shell between trays supporting rings (TSR). Both trays supporting rings (TSR) were found badly corroded. I-beam and brackets to support omega tray were also found badly corroded.

PHOTOGRAPHS OF CIC. SEAM & AFFECTED SHELL AREA IN SIDE M5 MANHOLE.


120°
90°
120°


270°
300°

NDT CARRIED OUT BEFORE REPAIR:

- Dye Penetrant test was carried out at entire C seam.
- Thickness & hardness measurement of entire affected area was carried out all around 360 º locations by preparing grids 15º apart on 6/09/10.
- Thickness below 37 mm was found at 9 locations between TSRs.
- Thickness below 36 mm was found at 5 locations between TSRs.
- Maximum hardness is found 141 BHN at 90º.
- Total patches where shell thickness was less than 38 mm between TSRs, were found 7 approximately. There were series of canals and notches of varying depth of 5-15 mm in these patches. The details are as below:

Patch No.1	0º	500 MM X 600 MM
Patch No. 2	90º	440 MM X 480 MM
Patch No. 3	105º	700 MM X 300 MM
Patch No. 4	270º	600 MM X 350 MM
Patch No. 5	285º	700 MM X 650 MM
Patch No. 6	340º	400 MM X 520 MM
Patch No. 7	315º	300 MM X 400 MM

REPAIR PROCEDURE:

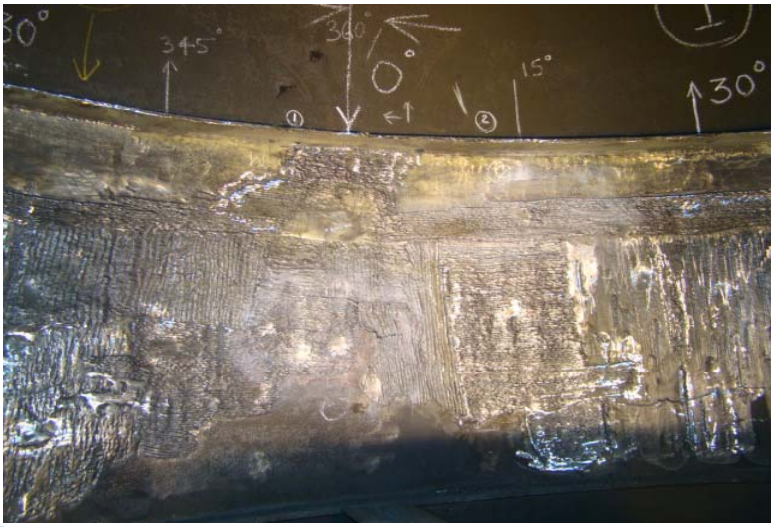
- Entire C seam was grinded and 'V' had been made in the leaky area. Preheat temperature of C seam was raised up to 150º c by electrical heating pads. The affected area where through hole was there was repaired by TIG welding using ER-70S filler wire while other part of C seam was repaired by Arc welding using E-7018-1 electrode. C seam was post heated by raising the temperature up to 250ºc by electrical heating pads, thereafter soaking for of 1 hr. at 250º C and then cooling up to 150º C. All the heating coils had been removed at 150ºc.
- Apart from this C seam, all the patches of affected areas were grounded properly before starting the welding repair work on inner surface of the shell.
- It was decided to build the shell thickness up to 40 mm. wherever shell thickness was found less than 40 mm, it was built up to 40 mm by arc welding using electrode E-7018-1.

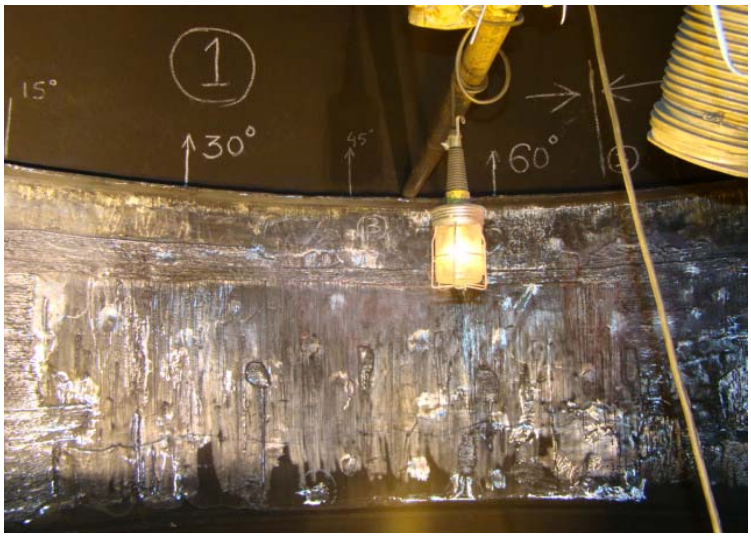
- For welding repair of the affected areas of main shell, preheating was done by using five gas burners over the surface area of marked 7 patches and temperature was raised up to 150ºc. First filling of notches and canals was done by welding and then material built up is done for raising the thickness of the affected areas.
- All these patches were post heated at 250ºc and soaked for 1 hour. All the sharp edges were smoothened by grinding.
- Entire area between TSRs was cleaned by rotary wire brush in order to remove scale. After welding & post heating, a visual inspection and NDT was carried out. Thickness at some places was found less than 40 mm. So, again affected area was preheated up to 150 ºc by using gas burners and then shell thickness was maintained above 40 mm by arc welding. After welding, thickness measurement was carried at these points.
- All the sharp edges and the edges of area where there was a sudden reduction in thickness had been smoothened. Weld spatters found during inspection, had been removed by grinding.
- Preheating temperature of the area on skirt, where window was removed was raised up to 100ºc. The removed window was restored by arc welding.

NDT AFTER REPAIR:

- Thickness & hardness measurement of entire affected area was carried out all around 360º locations by preparing grids 7½ º apart at minimum 5 locations vertically between TSRs on 10/09/10. Thickness measured at leakage area was found 50 mm. Thickness was found 40.2 mm to 51.00 mm in all places between TSRs.
- Hardness found near leakage was 139 BHN whereas hardness of the rest of the locations was found well within the limit.
- UT test was also carried out. No abnormality was found.

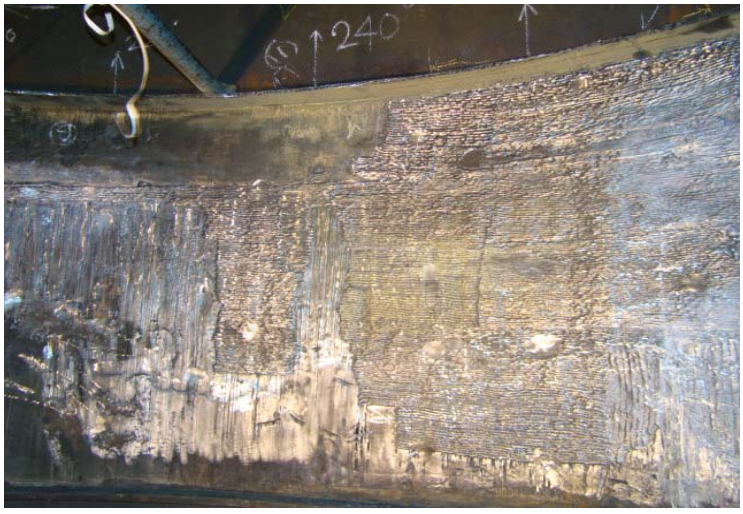
PHOTOGRAPHS AFTER REPAIR:



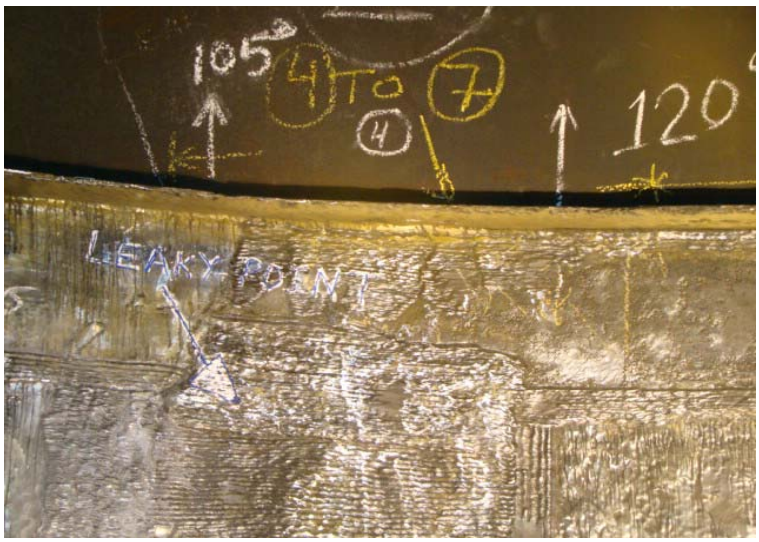



75
90°
105
3
4
4+5
6


195
8
9


240


LEAKY POINT


105
4
To
4
7
120
LEAKY POINT

MODIFICATION DONE:

- The bottom bed (Bed No. 5) was removed as per Halder Topsoe recommendation. Omega tray, packing ring and top bed limiter were decided not to be reinstalled. Four Nos. of support cleats which were removed, were re-welded at their respective position.
- Eight no. of sleeves were installed on skirt with orientation of 45º starting from existing cut-out on skirt in order to monitor thickness of the damaged area of shell during running of plant.

MATERIAL CONSUMED:

S.N	Material Description	Qty
1	Welding electrode Supertherme spl –E 7018-1, 4.0 mm	60 Pkts
2	Welding electrode Supertherme spl- E 7018-1, 3.15 mm	20 Pkts
3	Welding electrode Supertherme – E 7018, 4.0 mm	60 Pkts
4	Welding electrode Supertherme – E 7018, 3.15 mm	20 Pkts
5	Filler Wire ER-70S, 2.5 mm	2 KGs
6	Bosch Grinding wheel, Size: 125 x 600	50 Nos.
7	Bosch Grinding wheel, Size: 180 x 6mm	50 Nos.
8	Bosch Grinding wheel, Size: 125 x 600	25 Nos.