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HIGH PRESSURE VESSEL LEAKAGE IN UREA PLANTS

(A case study)

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Abstract

In urea plant ammonium carbamate solution is very corrosive; all metals have corrosion problems with ammonium carbamate and the corrosion problems increase with temperature, a ten degree Celsius rise in temperature doubles the corrosion rate to the point where the duplex steel is no longer acceptable. The material plays a very important role in Urea plants. The space between the reactor liner and the shell is most often empty and employs various methods of detecting a leak ranging from conductivity measurements. Vacuum leak detection system, pressure leak detection system etc. Titanium, SS316L (urea grade), 2 RE-69 etc.) Over the years that can resist ammonium carbamate corrosion. Materials plays very important role in any industry. Selection of material is vital at design stage itself ,Wrong selection of material may lead to catastrophic failures and outage of plants & even loss of Human lives, Right selection of material leads to long life of plant. In the latest plants specialty duplex materials are used for liner. The actual reactor has been constructed using a variety of materials, e.g. Zirconium, Vessel inside a protective liner. This paper intended study of number of leakage in the HP loop vessels, e.g. Reactor, Stripper, Carbamate condenser etc. How to detect leakage and troubleshooting during detection and attending the leakages.

Key Word- Ammonium Carbamate. Carbamate Condenser , Liner, Leakage, Reactor, Stripper, Urea,

Introduction

National Fertilizers Ltd, (NFL) operates a fertilizer complex at Vijaipur, Distt. Guna (Madhya Pradesh) consisting of two units Vijaipur-I and Vijaipur-II, plants were commissioned in December 1987 and March 1997 respectively. Ammonia Plants are based on M/s. HTAS's Steam Reforming of Natural Gas and Urea plants are based on M/S. Saipem's Ammonia Stripping technology. The Vijaipur unit, which is an ISO 9001:2000 & 14001 certified, comprises of two streams. The Vijaipur have two ammonia plant M/S. Haldor Topsoe Technology, Denmark capacity 1750 & 1864 TPD for Line-I & line-II respectively and urea plant capacity 3030 and 3231 TPD for line-1& Line-II respectively.

Brief Description of Urea process

The urea process is characterized by a urea synthesis loop with a reactor operating at about 158 kg/cm2 (g) (for stripping process) with ammonia to carbon dioxide molar ratio at urea reactor inlet of 3.3 - 3.6. This allows a CO_2 conversion into urea of 64 - 66% in the reactor itself, also perforated trays which prevent back-flow maintained plug flow and favour gas absorption by the liquid. Different type of HET is used now a day to increase the conversion rather than vessel size and pressure. Different types of HET are developed like super cup etc. The urea process vessels are High Pressure Decomposition in H.P. stripper; Medium Pressure Decomposition in M.P. Decomposer and, finally, Low Pressure Decomposition in L.P.

Decomposer. The decomposition reaction is the reverse reaction of the first one above showed, viz.: NH_2-COO-NH_4 ↔ $2NH_3$ + CO_2 (- Heat) and, as can be inferred from the equation, it is promoted by reducing pressure and adding heat. The urea reactor effluent solution enters the stripper, under slightly lower pressure than the urea reactor, where a fair part of the unconverted carbamate is decomposed, due to the stripping action of either NH_3 or CO_2, so that the overall yield of the H.P. synthesis loop referred to CO_2 is as high as 80-85% (on molar basis). Ammonia and carbon dioxide vapours from the stripper top, after mixing with the carbamate recycle solution from M.P. section, are condensed at the same pressure of the stripper, in the H.P. carbamate condenser; thus producing the LS steam which is used in downstream sections. After separating the inert gases which are passed to M.P. section, the carbamate solution is finally recycled to the reactor bottom by means of a liquid/liquid ejector, which exploits H.P. ammonia feed to reactor as motive fluid. This ejector and the kettle-type carbamate condenser above mentioned, allow a horizontal layout, which is one of the main features of Stripping process. Downstream of the stripper residual carbamate and ammonia are recovered in two recycle stages operating at about 17.5 kg/cm^2 (g) (M.P. section) and 3.7 kg/cm2 (g) (L.P. section) respectively. Ammonia and carbon dioxide vapours coming from carbamate decomposition are condensed and recycled to H.P. section. The solution leaving the L.P. section arrives to the concentration section where process condensate is removed in order to reach a concentration of about 99.7 % which is required to feed prilling tower bucket. The weep holes are provided for the following Equipment's:

1. Urea reactor
2. Stripper
3. Carbamate condenser and
4. Carbamate separator

Weep holes are safe installation for protecting the above equipment in case of leakages from the lining welds, avoiding that process fluids could come in contact to the carbon steel material of equipment body. We had checked prior to start-up of the plant.

(A) CASE STUDY OF REACTOR LEAKAGES

The all four reactors(R-1) of Urea line 1 & 2 plants are 40 meters Height (Tan to tan). The liner of all reactors has SS 316 L (mod) while shell of line 1 & line 2 are differing. The line -1 both reactors are coil layered vessel while 31 unit has multi layered and that of 41 is mono block reactor. Detail as following table N0-1. The all four Urea reactor have 15 number of sieve trays. These have been provided to prevent the escape of gaseous CO2, which must react with NH_3 in the lower portion of the reactor. These trays also help in preventing the internal recycling of the reaction products with higher specific gravity products formed in the upper part of the reactor. Reactor shell is made of CS with a 7 mm liner of SS316L(mod) on the

Inner surface. Liner of the reactor is cladded to the CS shell and longitudinal seams and circumferential seams are differing in line-1 and line-2 urea reactors .For detecting any leakage in the liner a weep hole monitoring system has been provided. The line-1 urea reactors have 95 numbers weep holes. And Urea line-2 of 31-Urea reactors has 77 numbers weep holes and 41 reactors has 98 numbers weep holes. In the weep hole monitoring system there are two loops of weep holes covering the entire reactor.All four Urea reactor (R-1) have 15 number of sieve trays. These have been provided to prevent the escape of gaseous CO_2, which must react with NH_3 in the lower portion of the reactor. These trays also help in preventing the internal recycling of the reaction products with higher specific gravity products formed in the upper part of the reactor. Reactor shell is made of CS with a 7 mm liner of SS-316L (mod) on the inner surface. Liner of the reactor is cladded to the CS shell and longitudinal seams and circumferential seams are differing in line-1 and line-2 urea reactors.

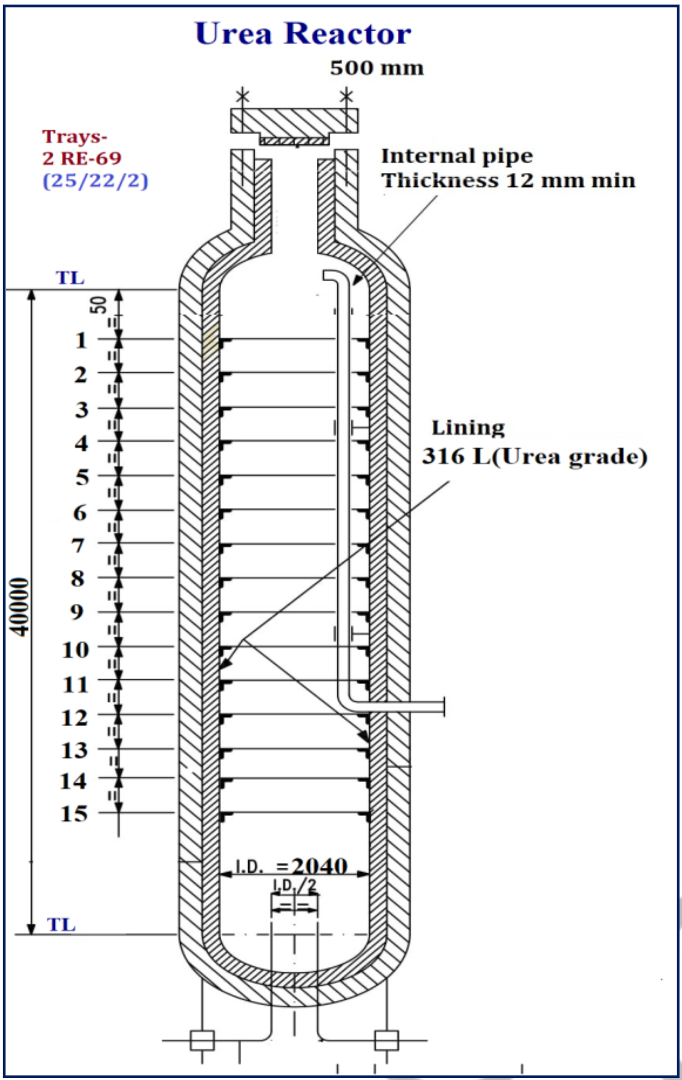

Fig-1

Reactors leakage detection and repairing

Reactor Liner Leakage on 28/01/2006.

Reactors Specifications			
Sr. No.	Parameters	units	Value
1	Working Pressure	Kg/cm^2	159
2	Design Pressure	Kg/cm^2	169 at top
		Kg/cm^2	169 +full of liq at Bottom
3	Hydro Test Pressure	Kg/cm^2	219.7 (Vertical)
		Kg/cm^2	224 (Horizontal)
4	working Temperature	^0C	188
5	Design temperature	^0C	200

Table-1

In Urea Line-I and 2 plants all the weep holes are connected to conductivity meter based monitoring system. On dated 28/01/2006 the leakage alarm appeared in weep hole number 23 of 11 stream. The weep hole was checked physically and vapour analysed in laboratory fond ammonia vapour and CO_2.Immedially shut down was taken and leakage found with instrument air and soap solution the leakage easily detected. For find out the leakage the liner plate behind the weep hole was pressurized with instrument air at the pressure of 0.5 kg/cm^2 and other three interconnected weep holes were plugged. Soap solution applied on opposite side of liner. The pin hole leakage easily detected. The pin hole repaired by welding. The repaired portion was passivated with 10 % HNO_3 solution and rinse with Demineralised water.The repaired portion was further checked with instrument air and soap solution no leakage was found. The shutdown duration was only 69 hrs Feed cut to feed in.

Reactor Liner Leakage on 28/11/2017.

On dated 28/11/2017, a weep hole leakage alarm from Weep Hole No. 34 was appeared on lectrotek system. Immediately checked the weep hole No.-34 and vapour analysed in laboratory found ammonia & CO_2 vapour and leakage was confirmed. Immediately shut down was taken at 11.15 hrs on dated 28/11/2017.draining of the H.P loop started at 11.15 hrs. For air purging 11 PT-05 A/B cover open for air purging. Man entry permitted at 18.15 hrs on dated 29/11/2017 after confirming ammonia contents less than 25 ppm and Oxygen contents more than 20 %. Four Numbers man ways were opened for detecting leakage the leakage above 5th tray. So the 4 man ways opened. First of all, leakage detection tried with instrument air & soap solution. For detecting the leakage, the instrument air introduced at the pressure of 0.5 $kg/cm^2$and other three interconnected weep hole plugged that the pressure retains inside the liner and shell. Soap solution applied on liner for detecting the leakage. Four hour tried to leakage but success did not get. After that our further step to detect the leakage with ammonia and phenolphthalein indicator. But leakage could not have detected. As the weep hole leakage was not clear, the exact location the leak could not be fund out with Soap solution and ammonia test. Finally the DP check and number of the spot found. Finally, all the circumferential Seam and longitudinal seam opposite of weep hole No. 34 between 4th& 5th trays welding done. After that ammonia is introduced at the pressure of 0.4 kg/cm^2 n weep hole No. 34 and hold up for 10 hrs. and liner and all welding seal checked by phenolphthalein indicator. No leakage was found and man hole cover boxed up. Start-up activities started and feed in done on dated 01/12/2017 at 11.1 hrs. Total time taken for this shut down was 72 hrs (3 days) feed cut to feed in.

Weep hole Monitoring

Urea line-1 weep hole monitoring with lectrotek system (Pune). In Urea line-2 Masibus weep hole monitoring system is incorporated. The Micro genie scan is a microprocessor based scanner which has been specially designed for resistance input to monitor reactor leakage easy and very simple in installation low pricing equipment's and easy in maintenance. This programme containing non-volatile memory for setup data, 4 duals and 4 digit display and LED bar for information RS -232 –C serial port.The instrument is housed in a ½ DIN extruded Aluminum rack suitable for control room mounting. A small but highly functional Keyboard consisting of 4 membrane keys is provided as the as the instrument operator interface electrical and I/O temperature are instruments rear Via Screw type terminals. As shown in the figure-2. The electronics is located on modularly designed board for easy field trouble shooting and maintenance. All cards are plug in type and segregated by their function Viz –including power supply CPU, A/D display. All the weep holes have to be checked by passing instrument air every week/fortnight for any leakage and blockage & the pressure of the testing medium should not be more than 0.5 kg/cm^2

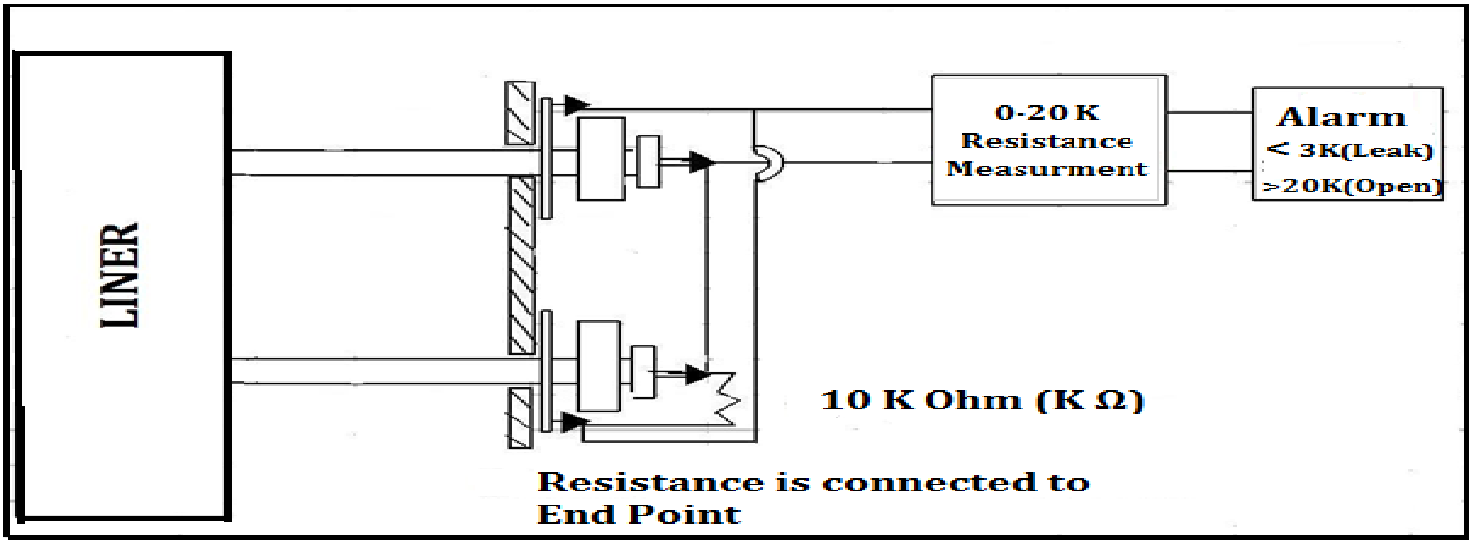

Fig-2

REACTOR (11-R-1) LEAKAGE JULY-19

The Leakage observed on dated 04/07/2019, during the hydraulic pressurization of the reactor. It was observed that HP loop pressure was not increasing beyond 65 $kgcm^2$, rather started decreasing (Figure 4). It was noticed that condensate was coming outside from 1st segment (L-seam) of the reactor from inside the insulation. Immediately insulation was removed and it was noticed that the outer shell plate of 08 mm got ruptured from its vertical weld joint (400 mm in length) at 1st segment (L-seam) (Figure 3). Hence, HP loop was depressurized and draining was carried out and top manhole cover was removed for internal inspection. Simultaneously, tray man ways were opened from 1st to 5th tray. To detect the leaky portion inside the reactor, DM water was supplied through flexible hose from outer ruptured portion of the shell course and thorough physical (visual) inspection was carried out inside the reactor. It was found that water was coming out through 1st tray's TSR's newly welded cleat. After insulation removal, it was also noticed that there was bulging on outer (8 mm) layer at the first and fifth segment from the top of the reactor Vertical joint of 1st segment outer shell 8 mm layer welding was found in ruptured condition and bulging of longitudinal pad plate of 5th segment was also noticed.

Reason for Failure of Vertical

Welding Joint of 1st Segment System hydro-test water entered through the damaged portion of newly welded TSR cleat of the first tray into the coiled layers and reached up to the last layer of 8 mm.

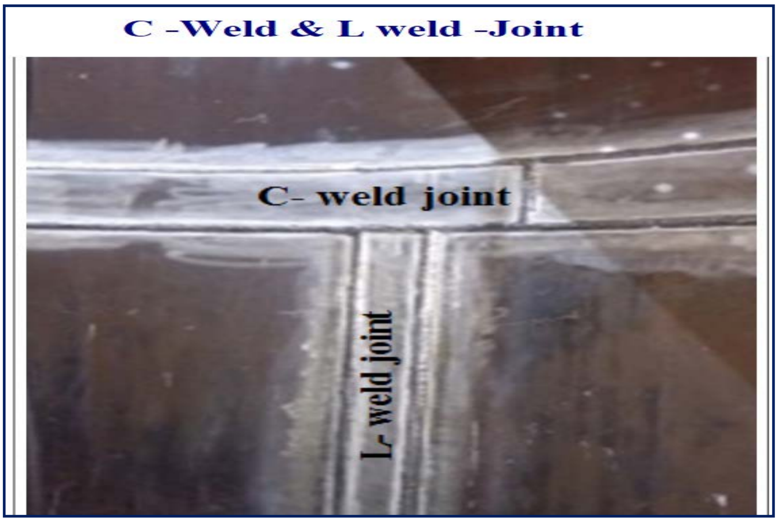

Fig-3

As the vent holes and vent tube of the segment were in plugged condition, this resulted in pressurization of the outer shell course, causing rupturing of the 8 mm outer layer vertical joint. The coiled layer welding remained intact; otherwise it could have un winded. Repair and Maintenance After thorough inspection of internal and external damage as well as consent and repair procedure approved from M/s. Saipem, rupture repairing company was contacted for rectification/repair of the reactor within minimum possible time at NFL Vijaipur site itself repair Procedure.

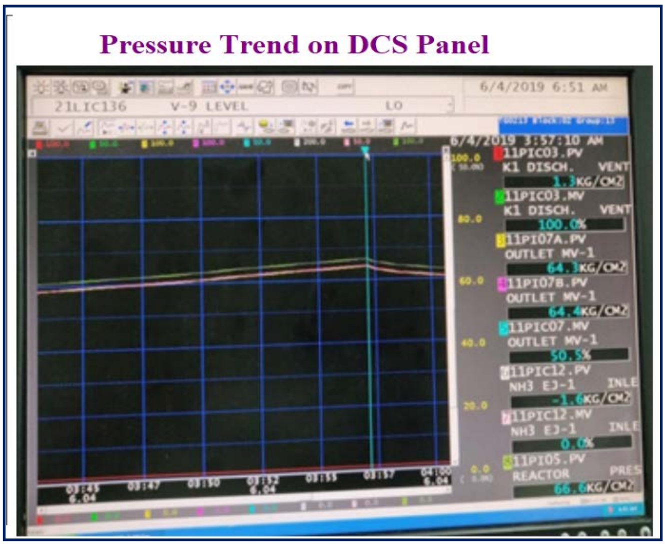

Fig -4

Temporary scaffolding was erected from ground floor to top of the reactor for approaching all vent..Tubes and vent holes as well as to carry out the job. Subsequently, whole Insulation was removed from reactor. All the vent holes and vent tubes plugs were de-plugged. All vent tubes' depth was measured, which was found in the range 62 mm and depth of vent holes was found as 40-42 mm. Further cleanliness of the vent tubes and connected vent holes of each segment was checked with instrument air pressure at 0.3 kg cm^{2}g and found at clear condition. Maintenance jobs executed to rectify the damaged portion of reactor are as follows:

Fig-5

The outer shells (8 mm) of first and fifth segment were removed and replaced with new semi-circular shells made of 16 mm CS plate (SA516 Gr70) in NFL Vijaipur workshop.

The TSR leaky point was removed in rectangular shape of size 300 x 200 mm to ensure that the internal layers of the reactor is not damaged and replaced with new patch plate, with separate weep hole for monitoring patch plate liner and welding.

The first to fifth TSR as well as its all cleats was replaced with new one.

Fig-6

The longitudinal pad plate of the fifth segment was replaced. test, dye penetrate test, magnetic particle test and ultrasonic test of all pressure seams (L, C and nozzle welds) were carried out on the external surface. Visual test, dye penetrate test, ferrite content test of all the internal attachment welds were carried out followed by air and ammonia leak test for weep holes as well as vent holes/vent tubes system of all segments inside the reactor. To facilitate air and ammonia leak test, small loops connecting weep and vent system of 2/3 segments each were made to cover up the whole reactor.

Reactor feed in was carried out on 08-07-2019 at 03.00 hours and prilling lined up at 07.30 hours.

Again shut down taken on 08/07/2019

Thorough physical inspection of reactor fresh urea deposition was observed at the exit of 70° top vent hole of 3rd segment. It was noticed that fresh urea melt was accumulating at the exit of the said vent hole . Again plant shutdown was taken. After draining/depressurization and flushing of HP loop, reactor manhole cover was removed. Man ways up to 4th tray were opened for inspection and repairing the internal defect. Repairs at 3rd Segment and Inspection Grinding of longitudinal and circumferential seam weld joints was carried out keeping weep holes system and vent tubes/vent holes system pressurized with instrument air at 0.3 kg cm^{2}g. One pinhole was found on C- seam weld joint of 3rd segment. Patch plate was welded over pinhole point.

NDT test was done and clearance received from mechanical team & M/s. L&T for leak test by air and ammonia on 12-07-2019 at 02.00 hours. This time air & ammonia tests were performed at 0.4 kg cm-2g for 2nd and 3rd segment and 0.3 kg cm-2g for 4th segment which was completed on 12-07-2019 at 21.20 hours. No leakage was found with air and ammonia leak test. Further, hydro test of reactor was carried out but water started coming out through 70° vent tube and 250° vent hole (bottom) of 3rd segment at HP loop pressure of 90 kg cm^{2}g.The leak observed again. Finally system was depressurized and drained. Air leak test as well as Helium test was carried for 2nd, 3rd and 4th segment on 19th and 20th July(Figure-6) The same instrument tapings that were used for the air and ammonia test were used for the helium test. First the system was purged with Nitrogen and then helium was charged from helium cylinder through the vent hole/tube and weep hole system, the system was kept at hold for 4.0 hours at a pressure of 0.3 kg cm^2g, to ensure the permeation of helium through leakage and cracks. Inside the reactor the segments were divided into smaller isolated portion using sheets and tapes for leak detection . After the hold duration was complete, the leak test was carried out by puncturing the sheet and inserting the analyzer in it. No leakages were detected in the test. Plant Start-up and Monitoring.

Helium Leak Test at Third segment of ,partition of segment carried out using polythene and duct tape

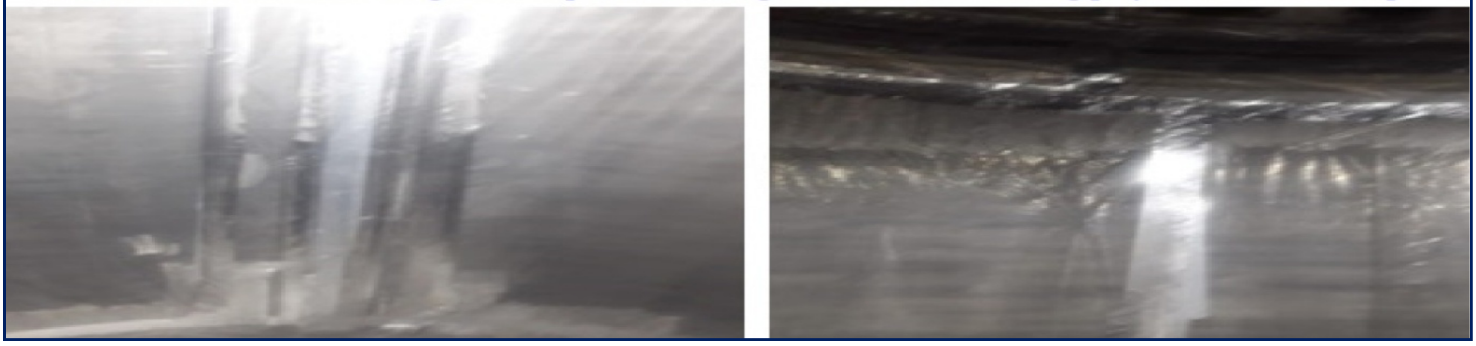

Fig--7

LEAKAGE FROM STRIPPER

Detail of Stripper

The Urea HP Stripper is the equipment where there are the most severe process operating conditions in the Urea Plant. This equipment, that basically is a falling film evaporator, must work under high pressure, temperature and very aggressive process media .Urea Stripper is considered as the backbone of Urea Plant performance and efficiency. Its performance determines production and profitability of end product which is Urea Fertilizer. The equipment design takes into account a trade off between cost and corrosion resistance against the aggressive process media. The result is a carbon steel body sized to withstand the stresses coming from the pressure and temperature loads, while it is protected by a corrosion resistant material barrier in all the parts in contact with the process media including the heat exchange tubes.

Reaction products leaving the reactor are sent into bimetallic stripper tubes sides for carbamate decomposition. The medium pressure steam (23 bar) is used for this purpose. The stripper is the high pressure vessel of H.P loop. Operating at 147 bar in tube side pressure and that of shell side is 24 bar. The top temperature of stripper is 190 ^{0}C and that of bottom is 205^{0}C.at this temperature approximate 80 % of carbamate presents in solution is decomposed and rest are decomposed in MP & LP section. The water is separated in pre-concentrator and two stages of vacuum evaporation sections. The decomposition reaction is a reverse reaction of urea formation.

NH_4COONH_2=NH_3 +CO_2- HEAT

As can be inferred from the equation, decomposition is promoted by reducing pressure and /or adding heat. In M/S. Saipem process decomposition is carried out in three steps. Decomposition is promoted by heating and stripping CO_2 by vaporized excess ammonia, according to Henry's Law of partial pressure under the same pressure level as urea reactor. The plant commissioned in 1997 till date stripper is running. During pre-commissioning 55 no of tubes plugged in presence of Saipem representative. Tubes were plugged as Zirconium lining of these tubes was found damaged. In present shut down one damaged old plug replaced with new one and others eight numbers minor

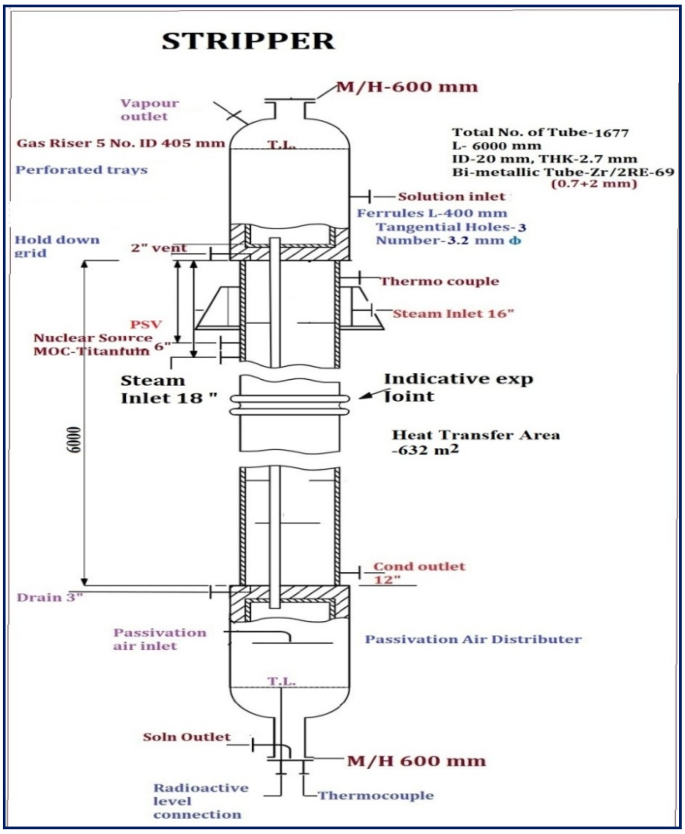

Fig-8

Leakage. Stripper used is falling film type heat exchanger decomposed and vaporized gases and liquid effluent are therefore in counter current contact and CO_2 concentration in liquid is gradually reduced from top to bottom of the stripper tubes.

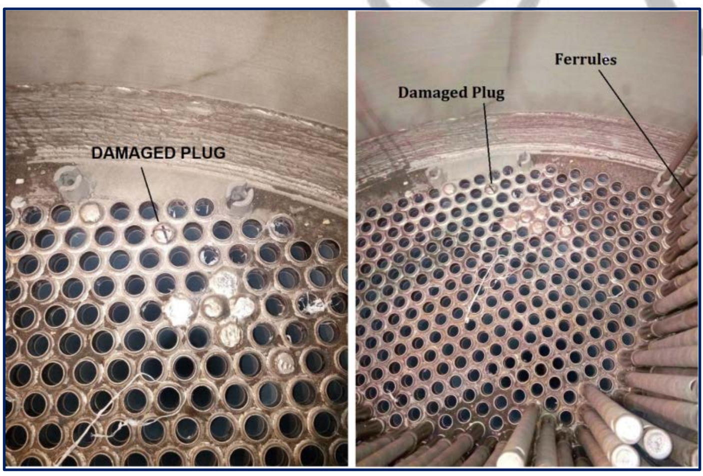

Fig-9

Besides the above, general corrosion has been observed on the bottom tube sheet, tube to tube sheet welding and bottom part of tubes (20 mm). Stripper has rendered service for around 21 years. Two types of stripping process are there; Viz: CO_2 stripping and NH_3 stripping. Both process work according to shift in partial pressure. This process is the most modern and energy efficient and therefore, widely used now a day. Decomposition at high pressure requires higher temperature, which means that much biuret has formed and the liquid becomes corrosive, but in the M/S. Saipem process the excess of ammonia and the use of Zirconium in the stripper permits minimizing these problems. The off gases generated in stripper are condensed in the high Pressure carbamate condenser where low pressure steam is generated. The NH_3 to CO_2 mole ratio of

3.5:1 is used and the reactor is operated at a pressure by which the carbamate solution is pumped to the reactor by ejector but not using Carbamate pumps.

For passivation of bottom parts of stripper, a passivation compressor also installed to give air in bottom dome. About 42 Nm^3/hr air is feed to stripper bottom.CO_2 fed to Reactor normally contains a small percentage of H_2, CH_4 & CO in addition to inerts like N_2& Ar. The passivation air also given to CO_2 in 1st stage suction of CO_2 compressor. We maintained 0.35 to 0.4% O_2in 3rd suction of CO_2 compressor. Together with O_2 contained in passivation air could give rise to explosiveness problem when sent to CPP for HRU fuel to avoid explosive mixture natural gas also fed to MP condenser so that explosive mixture in inerts gas could not be made. Passivation air presents a major issue for urea process. Designed to prevent the corrosion of stainless steel, passivation air constantly coats the inner surface of stripper tubes with an oxygenated process solution.An ammonia rich gas (CO_2 lean gas) rises from lower parts of the tube, then the gas at the upper parts of the tube becomes an ammonia richer gas as compared with equilibrium composition and the decomposition reaction in liquid phase correct the deviation from the equilibrium (the stripping effect). Carbamate is decomposed at reactor pressure with the help of one of the reactants. First thing that comes into mind while going to look for leakage in such high pressure vessel is that, what are the potential points that can lead to leakage in such thick metal walls. There are three surfaces in contact with highly corrosive Carbamate solution.

1. Tube sheet.
2. Tube itself.
3. Tube to tube sheet joint.

The tube sheet thickness is 255 mm including 10 mm overlay. The leakage develops when overlay eaten with corrosion/erosion, less passivation. The condensate outlet of stripper collects to steam condensate drum. The rest energy of this steam condensate uses in MP decomposer. In this line conductivity meter also installed for quick indication of leakage ranging 0-500 µ mho. Also if there is any leakage in Stripper tubes or tube sheet, it shall be picked up in steam condensate leaving Stripper shell side. This will appear in the form of high conductivity. Monitoring of fresh steam entering into steam drum and condensate leaving the steam drum is very important and its delta (increase in conductivity of condensate leaving steam drum with respect to incoming steam) will determine the extent of leakage.

Reason of leakage

The main reason of plug failure is old age of equipment i.e. 21 years old vessel. The old 55 numbers tube plugs failure one by one due to layers of welding gradually deteriorated. Corrosion and exposure of hidden defect in tube-to-tube sheet joint.

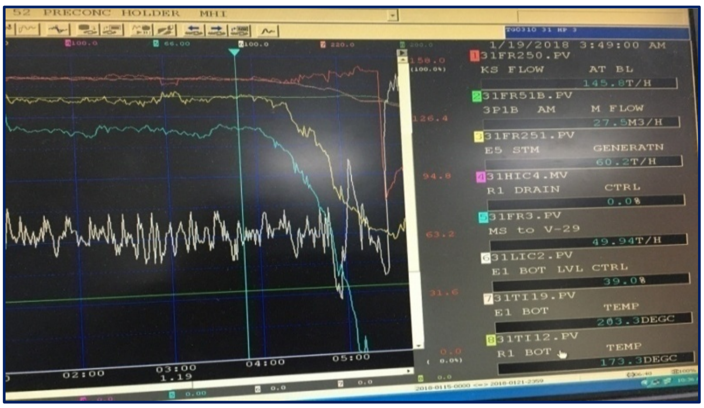

Fig 10

10

Detection of the leakage

Lack of passivation air. Leakage was so heavy that steam to stripper turned to zero immediately and stripper shell immediately pressurized up to PSV set value i.e. 26 bar, as shown in the Arrangement as shown in the figure- 12, was done for getting tube leakage detection. Blind are provided to following equipment lines.

1. Steam to shell side inlet line
2. Outlet line i.e. V-29 vessel

The Shell side pressurized with instrument air at the pressure 7.0 bar and leakage detects with soap solution in top & bottom dome (Channel). Air & soap solution test is the most effective and safe for detection of leakage. Although it is the time consuming test and finding the defects but increasing the inspectors during the test serves the purpose. The test was carried out by pressurizing the shell side with air at 6.5-7.0 bar. After pressurization, inspectors can readily enter into both the channel sides with soap solution and can start finding the leaking points. It requires much of attention and skill of inspector to look for all the defects. Full scanning is must and a cumbersome job. The salient features of this test are:

1. Reliable and effective but time consuming.
2. Good for all small and large leakages.
3. Safe and less risky than ammonia leak test.

After the confirmation of leakage in both the channel it's the responsibility of Inspection and welding by expert welder to arrest the leakage in Urea Stripper. Major culprit plug leakage detects easily without applying soap solution air was coming from the damaged plug. For further minor leakage detection, a team was deputed for top & bottom channel.

Fig-11

Old plug removing is very risky

When old plug removing the tubes filled with ammonium carbamate & urea solution. So the B.A set and protection apparatus are used to remove the old plugs. Preparation and Installation work can be done by experts of fitting & welding persons. In case of a leak one can easily check if there is any damage of tube sheet as corrosion would start from the inside the tube sheet hole. Replacing a new plug with 2 RE-69(25/22/2) takes max 15 minutes and can be done with a protection mask when ammonia is present.

Rectification of defects

The rectification of defects was carried out very carefully as it involves welding adjacent to the healthy tubes and tube-to-tube sheet joints. Following guidelines was follow listed below:

1. Grinding was done effectively in order to flush the pin hole completely. Ineffective grinding would never rectify the leaking point.

2. Welding was made after dye-penetrate testing of ground off area.
3. TIG welding with lower heat input was used for rectification.
4. Adjacent tubes and tube sheet weld joints avoided. Certain jigs used for the same in order to concentrate the welding heat where required.
5. Qualification of welder was made before welding in this sensitive area. High heat input will cause burn thru / HAZ area which would eventually be a potential point of leakage.
6. The 2 RE 69 (25/22/2) material plugs were applied on defected tubes. Each and every time leakage was detected with DPT and air/soap solution.

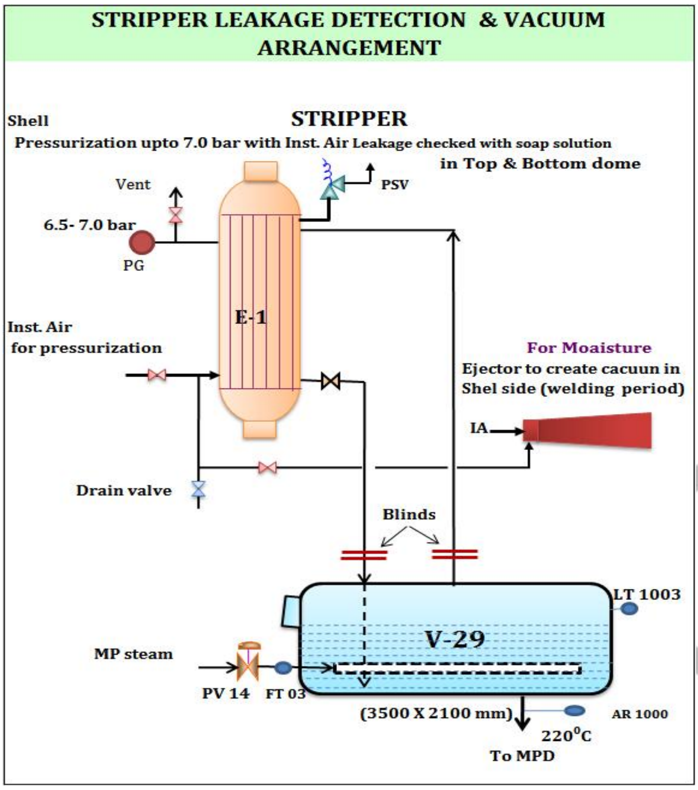

Fig-12

HP Carbamate Condenser Leakage

The gases leaving the top of the stripper are mixed with carbonate coming from the bottom of column medium pressure absorber where they are condensed. Low pressure steam is produced on the shell side of condenser and is fed to the steam network. Temperature of carbamate condensation is determined by shell side steam pressure which is kept constant by pressure controller on L.P. steam network. The vessel having 'U' tube bundle inside the carbamate. The solution after mixing goes to Carbamate separator then feed to reactor along with ammonia ejector.

Schedule for 41-HP loop shut down

HP loop draining	-5 hours.
Depressurization	-2 hours.
LS purging	-4 hours.
Water filling	-4 hours
Over flow	-4 hours

12

Draining -10 hours

PT-05(HP loop pressure) drop & air purging -

10-12 hours and contd. During shut down.

Detection of Leakage

For detection of leakage the tube(process side) manhole cover open and Partion plate removed after that preparation of leakages and inspection like NDT etc.

For leakage detection the blind provided at following lines

1. Both PSV Line
2. Condensate export line.
3. Steam cond import lines

After providing blinds the entry done in tube side for detecting of leakages with soap solution with instrument air pressurization. The shell side pressurized up to 3.5 kg/cm^2g as shown in the figure-13

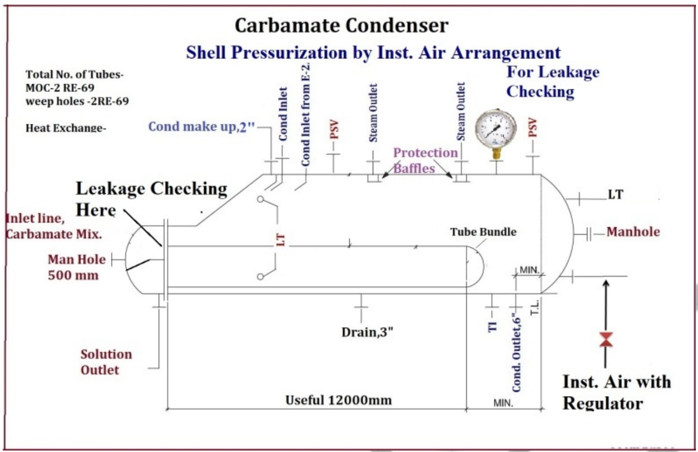

Fig-13

After that NDT was done for tube thickness as prier planed.

Report:

Health assessment of carbamate condenser tubes had been studied by the eddy current testing. A total 3230 tubes were tested in 04 working days with one machine and one technician. The study yielded 34 tubes which is >50 % and above in ID & OD , which need to be plugged to continue to take the unit for further service. The thickness reduction which is <50% will be given in the final report later for your reference.

Layout:

Condenser has named as 41-Carbamate condenser Top Portion Inlets has been identified top inlet starting from Top to Bottom (rows) left side(columns), and 41-E-5 Bottom portion outlets starting from Bottom to Top(rows) left side(columns). This will be the nomenclature followed throughout our report.

SUMMARY: Total Number of tubes to be Plugged

Top portion (Inlet) – 17Tubes

Total Tubes - 34 Tubes

Bottom Portion (outlet) – 17 Tubes

Conclusion

In HP vessels whenever the leakage started shut down must be taken after confirmation.In any leakage development of a specific welding/repair sequence taking into account item complexity, double lining construction and heat treatment requirements. Welders training to maintain a high and homogeneous High pressure welder quality.

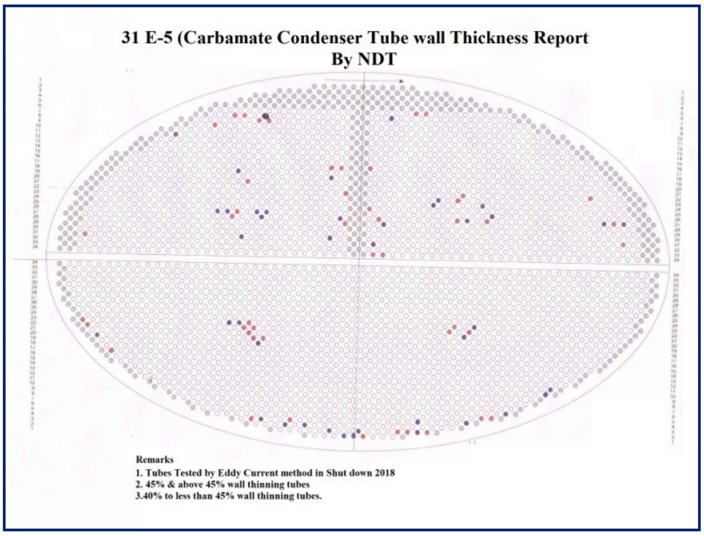

Fig-14

It is clear that this is an approach that takes into account only the direct cost of the equipment without any consideration on business losses that as in many cases like ours exceed by far the equipment cost. This option has the overall lowest life cycle cost of all the alternatives evaluated. Corrosion also observed in the stainless steel bimetallic tube next to the tube to tube sheet weld overlay. Corrosion in the 25-22-2 tube underneath the Zirconium tube caused by stagnant zone due to poor bonding.

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