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Amine Solution Recovery Package and Controlling Corrosion in Regeneration Tower

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Abstract**—**Sarkhoon gas plant, located in south of Iran, has been installed to removal H2S contained in a high pressure natural gas stream. The solvent used for the H2S removal from gaseous stream is 34% by weight (wt%) Di-ethanol amine (DEA) solutions. Due to increasing concentration of heat stable salt (HSS) in solvent, corrosivity of amine solution had been increased. Reports indicated that there was corrosion on the shell of regeneration column. Because source formation of HSS was unknown, we decided to control the amount of HSS at the limit less than 3% wt amine solvent. Therefore, two small columns were filled by strong anionic base and carbon active, and then polluted amine was passed through beds. Finally a temporary amine recovery package on industrial scale was made based on laboratory's results. From economical point of view we could save $700000 beside corrosion occurrence of the stripping column has been vigorously decreased.

Keywords**—**Amines, Corrosion, Heat Stable Salt, Resin anionic.

I. Introduction

THE amine treating unit is of great importance in gas processing and refinery operation. Historically regarded as a secondary piece of equipment, the amine plant now attracts increasing attention due to high pressure for environmental compliance and quality of H2S and CO2 removal.

Two major upsets show a significant threat to an amine gas treating plant. Corrosion and instability of operation result in unscheduled operational problems and outages.

High corrosion rates, typical for a number of amine plants, as well as stress corrosion cracking of stainless steel, usually attributed to chloride, create serious safety concerns.

High corrosion leads to high repaid costs, potential environmental implications as well as lost production .The results of a survey conducted by the national association of corrosion engineers (Nace) indicate, that 60% of total 24 amine plants surveyed experience stress corroding cracking in the amine absorbers [1].

Inefficient and unstable amine unit operation is often a result of the accumulation of impurities in the amine circuit. These contaminants include metals from the unit equipment, specific ions that interfere with the absorption, amine degradation products and amine by products in the form of heat stable salts. These heat stable amine salts in the solvent / solution reduce the amount of amine available for gas treatment, thereby reducing the unit's productivity.

Amine plant operation problems such as excessive foaming, corroding and capacity reduction are often attributed to the accumulation of amine heat stable stats. There are different was to remove heat stable salts from amine solvent. One of the methods is ion exchange technology. The first installation of this type which has been bench marked from Eco – tecinc, is amine recovery package. The purpose of the installation was to protect amine regeneration from further corrosion and to maintain level of neat stable salt at a low level. On a batch bases the amine recovery package is processing 6.5 gpm slip stream of lean DEA and remove about 45 kg per hour of heat stable salts. After the first 3 month installation of the package, the level of heat stable salt was reduced from 1% to 0.4 wt % as DEA. The plants goal is to keep the corrosion rate below 5mpy by reducing the amine heat stable salt concentration to below 0.5.wt. % as DEA. Plant observations as well as developers ion exchange technology in Sarkhoon gas retinue are discussed in this paper.

Heat stable salts (HSS) also cause corrosion problems and lead to a higher foaming tendency of the solution .Foaming in the absorber columns higher amine loses , absorber tower plug gage , heat exchanger fouling , shortened amine filter , and overall unit instability , which then cascades on to the refiners' dehydration plant , that uses Silica gel as drier , are the common problems associated with HSS accumulation. Removal of the HSS from the circulating amine will help to improve the performance of the amine unit, decrease maintenance and filter replacement costs, and improve the plant's environmental compliance.

Among the alkanolamine, DEA is kinds of amines which its boiling point is nearly close to its degradation temperature. However in gas treating application, salt contamination of DEA is quite common .So reclaiming of DEA with use of distillate technique must be performed under vacuum condition. The DEA reclined by vacuum technology was done by jack Thomason for first time at Vida plant in – 1985. with the rapidly increasing use of modern , more selective and efficient amine formulations with higher boiling points it is impossible to keep reclaiming equipment on– site , and the industry immediately noticed an accumulation of impurities the impact of contaminant accumulation is especially dramatic when a plant reduces amine losses .Periodic amine clean ups , either on – site or off- site , have proven to be a much better way of removing the impurities and are used by a number of amine plants . Ion exchange, vacuum distillation and electro dialysis have been applied to clean up amine solutions.

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However periodic reclaiming, while providing a solution for HSS accumulation, does not cure the operational and corrosion problems caused by the anions .Continuous amine reclaiming is being increasingly recognized as the most effective solution for HSS – related problems. The benefits of continuous H2S removal go beyond limiting the level of impurities in the amine loop .A continuous on–site reclaimer ensures that the contamination level is low, the corrosion rate is low and the performance of the amine system is at its maximum at all times. It also ensures that amine unit operation is reliable and provides the designed gas treating efficiency. Further more, if an upset occurs upstream of the amine unit, which is sometimes the case with tail gas amine unites, the equipment is on – site to address the problem immediately.

II. Amine recovery package of Sarkhoon gas plant

Gas treaty plant of Sarkhoon installed in 2000 which treats abut 250 MMSCFD of sour gas existing installation is operating on DEA solutions.

Because of increasing HSS in DEA solutions, amine regenerator column had faced with huge corrosion on shell side especially at places between trays is which continent of vapor most likely had had (fig 1).

Fig. 1 Corrosion on shell on vapor area

the amine solution itself started " foam " more easily due to the increase of impurities in the solution , and any rapid changes in absorber feed rates caused amine carryover , amine losses , tower instability , potentially poor H2S treat , environmental not – compliance and sulfur plant upsets . As it is evident in table 1 due to increasing Differential pressure in heat exchanger amine could not be heated well before enter into Reboiler consequently we had to increase fuel consumption in Indirect fire reboiler in order to catch temperature to favorite level.

As shown in figure 2 as HSS build , the amine filter and amine lean/rich exchanger plugged move frequently on a emergency case when lean/rich(L/R) had been clogged , we had to have an unscheduled shut down in order to maintenance it. L/R amine exchanger surfaces become fouled forcing the operator to increase the energy input to the unit's regenerator.

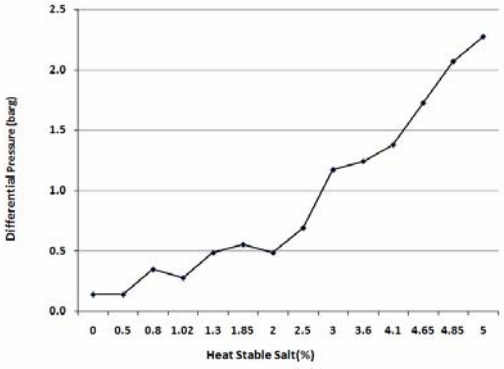

Fig. 2 Effect of HSS on Increasing DP of Lean/Rich Exchanger (E-102)n on shell on vapor area

III. Amine recovery operation

Due to visual check of regenerator during its overhaul – based on inspection on inspection department report we had about 3.4mm corrosion at different site on shell of regenerator

Once the amine solution degrades to form the HSS, the choices are to "bleed and feed" fresh amine by purging the back amine to the main system (assuming that you have the same amine in both treater) or reclaim the solution. Because both operation cost of "bleed

And feed "of fresh amine and risk of more corrosion were high. We decided to polish amine on – site.

Different strategies were studied some of them was impractical due to not being accessible like DEA reclaiming under vacuum condition .We had some negotiations with a company from Canada and their proposal for reclaiming needed to spend a huge budget .

For installation and design a amine polishing in industrial scale it needed to be checked the capacity of selected resin in

TABLE I
Effect of DP in E-102 on Fuel consumption of H-201

Date	Foaming in C-101	DP E-102 (barg)	Fuel Gas of Reboiler (MMSCMD)
23-Nov-05	7	0.8	29000
27-Nov-05	10	0.9	29300
3-Dec-05	9	0.9	30000
9-Dec-05	8	1.1	31000
21-Dec-05	6	1.2	31500
27-Dec-05	10	1.3	32000
4-Jun-06	8	1.6	33100
9-Jun-06	4	1.7	33600
19-Jun-06	4	2.0	34000

DP=Differential Pressure ,barg=Bar gage C-101 = Amine Contactor E-102=Amine Reboiler , MMSCMD=million standard cubic meter per day .

Laboratory scale .The HSS in solution were at approximately 3.5 wt% (as DEA) when laboratory test started to removal HSS form the solution .In order to reduce level of HSS to 0.5/wt% which strong ion resin studied an onions strong resin type was selected and all experimental test on it . As shown (figure4) our set up was consist of two 250 glass (decanter) which used as anionic resin column and activated carbon .That scope was removing HSS and fine Particles and color of amine(figure 5) by means of those manipulated column respectively .

Lean amine solution feed through a bubbler in to an activated column filter and the resin column. The ion exchange rosin removes the heat stable salts and the purified amine solution is collected for further analysis. Diluted caustic soda is used to regenerate the resin column.

As results is shown figure 6, it is proved that selected resin have capability of remove about 5 times of bed volume. From economical point of view amine purification by resin column is move profitable than "bleed to feed" strategy.

Fig. 3 CORROSION on Different Side of Shell(Top left to right ,Tray 9,tray 8,Bottom left to right ,Tray 10,Tray 18)

According to result of laboratory test industrial resin column designed and about 1.5 cubic meter of a strong anionic resin charged into it .After regeneration with caustic soda 4%wt lean amine from outlet of cartridge filter which installed on side stream of lean amine routes to amine column which accumulated in storage tank.

By Jan 2006, after a unit shutdown for maintenance of the amine regenerator tower , the HSS level was down to 1 wt% .A substantial decrease in the corrosion rate was observed. The ultimate goal of the plant is to keep corrosion rate and level of HSS as close zero and 0.5% wt as possible respectively. To achieve this goal it was decided to decrease the HSS concentration further .So amine treating package was run in more batches. As shown in figure 6 from august 2006 to Dec 2006 About 71.6 cubic meter amine degraded was treated. Figure 7 is the cure of the heat stable slate of solution which has declined.

Because the scope of installation of package recovery was to remove HSS form amine solution , the parameter of HSS in inlet and exit of bed was selected to operation of package .In figure 8 and table 1 are shown for Treatment of 71.6 m polluted amine with concentration 30%wt about 7 ton caustic soda , 382 m deionized water were consumed for 10 batches for a long of 3 months .

Fig. 4 Laboratory set up of (Left Resin Bed, Right Carbon Active bed)

Fig. 5 Quality of sample in inlet and outlet of resin and carbon active beds(left. 1st, polluted amine right, 2st to4rd batch of outlet bed)

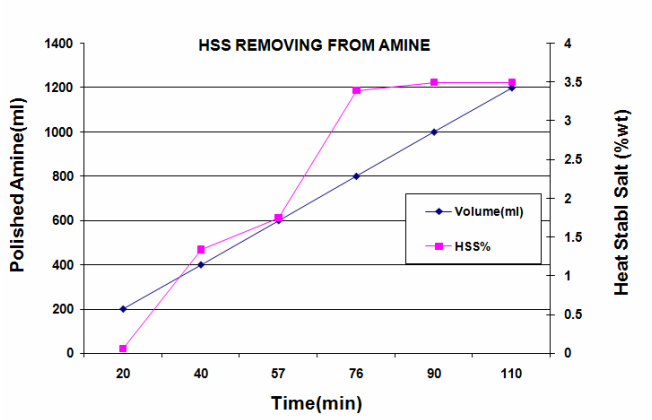

Fig. 6 Evaluation the capacity of resin bed to remove HSS)

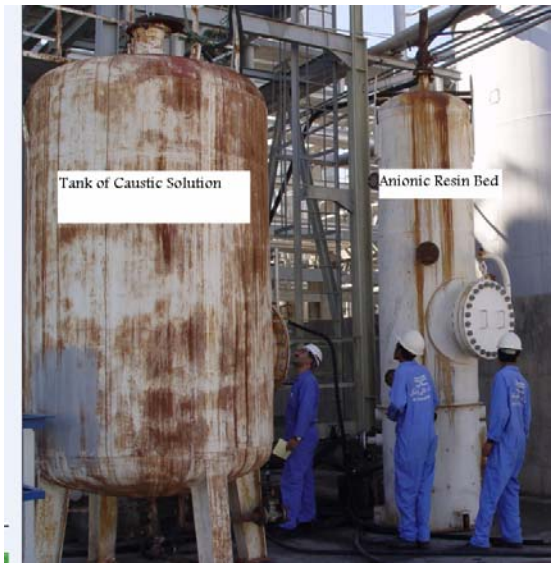

Fig.7 DEA Package recovery (left vessel Caustic Solution tank , right Anionic Resin Bed)

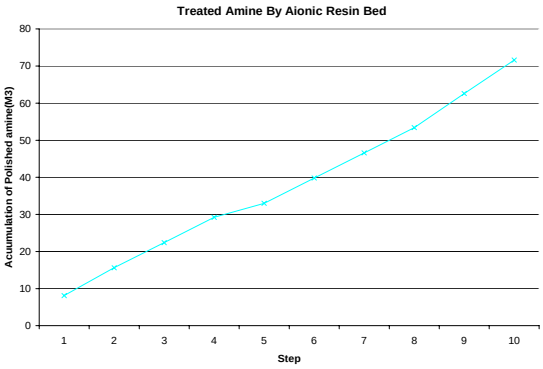

Fig.8 trend of accumulated polished amine

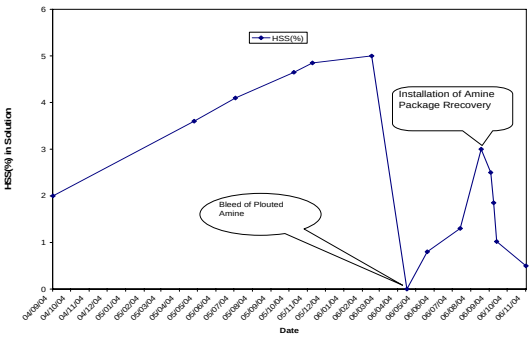

Fig. 9 trend of declining of HSS in Amine solution

IV. Conclusion

The information of heat stable salt in amine solution used in gas conditioning application has long been a problem, particularly in refinery system or when oxygen is present in feed gas to an amine unit. Total HSS level should not exceed 0.5 % of total solution. When the limit of any anion of total HSS is reached, pay more attention to symptoms of problems caused by heat stable salts. Foaming, diminished filter run time, solution color change and iron sulfide (or other solids)suspended in solution are typical warning signs of corrosion problems caused by heat stable salts. Among Alkanolamine DEA is a exception amine which should be reclaimed in vacuum condition. As Reclaiming of DEA in Sarkhoon gas Plant was un economical .Different methods are were studied for amine purification. By study of capability of Anionic resin it was appeared that it could be used for removing anions or HSS from solution. A laboratory test an industrial HSS removal developed. By on site continues removal HSS has immediate and quantifiable results: reduction of filtration cost ,elimination of periodic chemical cleaning of absorber , Lean/Rich amine heat exchanger ,improved gas treating capacity of the unit(due to increased amount of amine available for gas treating) , elimination or reduced use of antifoamers ,neutralizers and corrosion inhibitors. As results of installation and developing amine package recovery we could save $700000 beside all of equipments on amine cycle included stripping column, reboileres, etc, and corrosion occurrence of the stripping column has been vigorously decreased.

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