Recovery of Hydrogen Sulfide (H_2S) from refinery off gas with Diethanolamine(DEA)

Balakrishnan D

Coimbatore Institute of Technology, Coimbatore

Background:

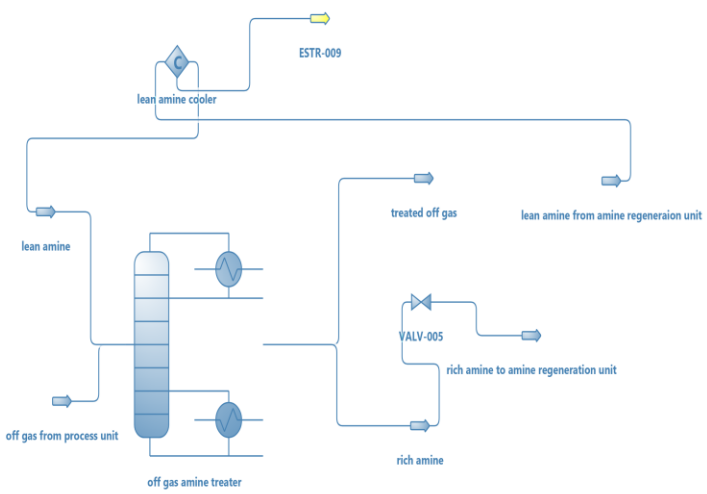
Off gas generated from various process units contains acid gases like H_2S, CO_2, etc., Among these H_2S is present in maximum proportion in off gases. These acid gases are to be removed by certain processes for further use because of its environmental concerns. H_2S when released into atmosphere combines with moisture to form sulphuric acid which can cause serious threat to personal health. These compounds can cause severe corrosion to metals and metallic objects. Hence removal of H_2S from refinery off gases is essential. There are several liquid solvents available for removal of H_2S from refinery off gas. Among them, more common are amines. These include

1. Monoethanolamine (MEA)
2. Diethanolamine (DEA)
3. Diglycol amine (DGA)

Process Description:

In this project, Diethanolamine is used to absorb the H_2S from refinery off gases. Refinery off gas containing Methane: 2 mol% , Ethane: 93 mol%, H_2S: 5 mol% at 50 deg C and 5.5 kgf/cm^{2}g is introduced into the amine treater where it comes in contact with amine solution containing water :65 mol% and DEA :35 mol% at 55 deg C and 20 kgf/cm^{2}g. The amine solution is initially cooled in a cooler from 85 deg C to 55 deg C in a lean amine cooler. Always the amine temperature is to be maintained at minimum 5 deg C above the off gas temperature to avoid the condensation of hydrocarbon in amine solution which in turn result in foaming in the amine column. Absorption of H_2S in amine solution occurs and the treated off gas from amine treater is used further and the amine leaving the amine treater also called as rich amine is further processed in amine regeneration unit for stripping off H_2S.

Flowsheet:



Results:

The properties of various streams are provided in the table below:

Master Property Table					
Object	treated off gas	rich amine	off gas from process unit	lean amine	
Temperature	335.179	329.019	323.15	328	K
Pressure	2.0594E+06	2.0594E+06	539374	2.05943E+06	Pa
Mass Flow	1.22672	8.4955	1.38889	8.33333	kg/s
Molar Flow	41.3805	176.728	46.3132	171.795	mol/s
Vapor Phase Molar Fraction	1	0.00018105	1	0	
Vapor Phase Mass Fraction	1	0.000112501	1	0	
Liquid Phase (Mixture) Molar Fraction	0	0.999819	0	1	
Liquid Phase (Mixture) Mass Fraction	0	0.999887	0	1	
Molar Fraction (Mixture) / Water	0.0124075	0.628952	0	0.65	
Mass Fraction (Mixture) / Water	0.00754006	0.235708	0	0.241405	
Molar Flow (Mixture) / Water	0.513429	111.153	0	111.667	mol/s
Mass Flow (Mixture) / Water	0.00924957	2.00246	0	2.01171	kg/s
Molar Fraction (Mixture) / Diethanolamine	9.22845E-07	0.340231	0	0.35	
Mass Fraction (Mixture) / Diethanolamine	3.27286E-06	0.744114	0	0.758595	
Molar Flow (Mixture) / Diethanolamine	3.81877E-05	60.1283	0	60.1283	mol/s
Mass Flow (Mixture) / Diethanolamine	4.01489E-06	6.32162	0	6.32162	kg/s
Molar Fraction (Mixture) / Methane	0.0219383	0.00010438	0.02	0	
Mass Fraction (Mixture) / Methane	0.0118719	3.48342E-05	0.0106989	0	
Molar Flow (Mixture) / Methane	0.907816	0.0184469	0.926263	0	mol/s
Mass Flow (Mixture) / Methane	0.0145636	0.000295934	0.0148595	0	kg/s
Molar Fraction (Mixture) / Ethane	0.95738	0.0195465	0.93	0	
Mass Fraction (Mixture) / Ethane	0.971074	0.0122266	0.932479	0	
Molar Flow (Mixture) / Ethane	39.6168	3.4544	43.0712	0	mol/s
Mass Flow (Mixture) / Ethane	1.19124	0.103871	1.29511	0	kg/s
Molar Fraction (Mixture) / Hydrogen sulfide	0.00827293	0.0111659	0.05	0	
Mass Fraction (Mixture) / Hydrogen sulfide	0.00951083	0.00791625	0.0568221	0	
Molar Flow (Mixture) / Hydrogen sulfide	0.342338	1.97332	2.31566	0	mol/s
Mass Flow (Mixture) / Hydrogen sulfide	0.0116672	0.0672525	0.0789197	0	kg/s

Conclusion:

The overall recovery of H_2S from refinery off gas using DEA solution is estimated to be 85.21%

Percentage recovery of H_2S is estimated as

= (Amount of H_2S in off gas – Amount of H_2S in off gas) / Amount of H_2S in off gas

= (0.0789197-0.0116672)/0.0789197

=85.21%

Reference:

Handbook of Petroleum Processing by David S.J. Stan Jones and Peter R. Pujado