Global Journal of Researches in Engineering
Chemical Engineering
Volume 12 Issue 2 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

The Studying of Declining Reservoir Pressure on Natural Gas Sweetening Process: A Case Study and Simulation

By R.K.Abdulrahman & I.M. Sebastine
Koya University, Kurdistan region-Iraq

Abstract - Natural gas is considered as one of the most popular source of energy in recent era and future as well. However, raw natural gas usually contents several of non-hydrocarbon components for instance, hydrogen sulphide and carbon dioxide. Indeed, these impurities are undesirable compounds and cause many problems for example, corrosion and environment pollution. Moreover, amine gas sweetening process is considered the most popular technology to remove acid gases from natural gas stream. However, when the hydrocarbons reservoir pressure declines, new wells are drilled to maintain production and enhanced oil recovery methods are also applied at the end age of the reservoir. As a result, the declining of the reservoir pressure leads to decline the operation pressure for the amine contactor tower and it may lead to significant effects on gas sweetening process efficiency and performance. Therefore, this study aims to simulate gas-sweetening process for given raw natural gas stream that it contents high quantity of acid gases by using Aspen HYSYS simulator program and then examine the effects of declining reservoir pressure on the sweetening process. The case study gas stream operation pressure is about 7000 Kpa. However, the study found that when the sour gas pressure declined that will effect acid gases loading in amine solution.

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GJRE-C Classification : *FOR Code: 290602*

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Some Nomenclature

CO_2 Carbon dioxide
DEA Dimethylamine
MEA Monomethylamine
H_2S Hydrogen sulfide

I. Introduction

The demand of natural gas in recent decade has been dramatic. In fact, natural gas poses a huge rule in the recent world economy and development. However, natural gas usually contains several impurities for instance, acid gases that it need to be removed from natural gas to meet the gas pipelines specifications. Stewart and Arnold (2011) note that gas contracts restrict H_2S content about 4ppm and CO_2 about 2% in natural gas stream. Thus, several gas sweetening are develop in order to remove acid gases from raw natural gas stream for example, chemical absorption, solid bet sweetening method and physical absorption method. However, amine gas sweetening may consider the most common process among natural gas sweetening method. Indeed, amine gas sweetening process has many advantages for instance, continues process, the ability to regenerate the process solvent. However, any amine process has several operation conditions for instance amine contactor pressure and amine solution concentration. In fact, amine contactor pressure is considered one of the most important amine process operation condition. Moreover, any declining of absorber pressure may affect the whole process. Therefore, a case study for raw natural gas stream will be examined by Aspen HYSYS simulation and the operation pressure of amine absorber tower will be examined by changing the value of amine contactor pressure several time and then transfer the results to MS excel to find out the results of effect of declining reservoir pressure on amine process. Moreover, the given gas stream may consider quite sour gas because is contents a high quantities of H_2S about (5.3%) and CO_2 about (4.4%). However, amine gas sweetening process will be able to reduce acid gases contents by using a suitable amine solvent type.

II. Amine Process Description

This method is also included several processes that utilized different chemical solvents:

- MEA(MonoEthanolAmine) process
- DEA(DiEthanolAmine) process
- MDEA(MetheylDiEthanolAmine) process
- DGA(DiGlycolAmine) process
- Hot potassium carbonate process

The chemical reaction of amines with H2S and CO2 Could be summarized below:

2RNH2 + H2S = (RNH3)2S

2RNH2+ CO2 = RNHCOONH3R *R= mono,di,tri-Ethanol

Chemical solvent method may consider the most remarkable and successful method in Natural gas sweetening field. Moreover, it may consider number one in most gas plant around world. Indeed, this method is utilized an aqueous solution of a weak base to

Author α : School of chemical and petroleum engineering, Koya University, Kurdistan region-Iraq.
Author σ : School of Science & Engineering, Teesside university, UK.

chemically react with and absorb the acid gases in the natural gas stream (Stewart and Arnold, 2011). In fact, these chemical solvents possess high affinity toward acid gases. The aqueous solution could be regenerating easily and recirculate to the process. The chemical solvent method is mainly utilized either Amine or carbonate solution to achieve the sweetening process. The amine gas sweetening process is considered a continues process and figure (1) shows the general flow diagram for amine gas sweetening plant. Firstly, sour gas stream is usually enters to scrubber to remove sour gas constants. Secondly, sour gas enters to the bottom side of amine absorber tower and flow countercurrent to amine solvent and Sweet gas will leave the top of the contactor tower and need to be processed to dehydration process to remove saturated water. Moreover, Dirty or rich amine will leave bottom of contactor tower and need to be regenerate. Finally, Amine stripping tower (regenerator) is used to regenerate the dirty amine hot lean amine need to be cooled therefore it flows to amine heat exchanger and then back to contactor tower. The brief of amine process could be described as following:

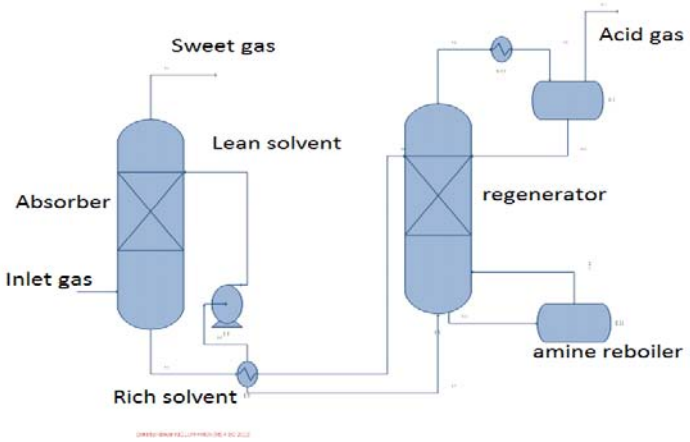

Figure 1: General flow diagram for Amine plant.

III. Case Study

The case study gas composition is shown in table (1). It seems that the gas has high content of acid gases. However, the gas analyzed on dry basis. Therefore, gas water content should be calculated.

Table 1 : Given raw natural gas compositions and operation conditions.

Case Study data		Component	Mole%
		H_2S	5.38
		CO_2	4.48
		N_2	0.11
		CH_4	63.35
		C_2H_6	13.9
Flow rate	120,000 $stdm^3/hr$	C_3H_8	6.03
NG density	0.65 Kg/m^3	$i\text{-}C_4H_{10}$	1.36
Gas SG	0.67	$n\text{-}C_4H_{10}$	2.44
Pressure	7000 K.pa	$i\text{-}C_5H_{12}$	1.03
Temperature	38 C°	$n\text{-}C_5H_{14}$	0.73
Max. Ambient temperature	38 C°	C_6H_{14}	1.19

Natural gas water content can estimate by using McKetta-Wehe Chart [3]. Therefore, water content is about 1000Kg/MMstd.m^3= 128.265 Kg/hr.

Now, the new Natural gas composition could be calculated and summarized in table (2):

Table 2 : Natural gas compositions and quantities.

Component	Mole%	RMM	Kmole/hr	Kg/hr	Mole%
H_2S	5.38	34.076	288.03426	9815.056	5.372849
CO_2	4.48	44.01	239.85009	10555.8	4.474045
N_2	0.11	28.02	5.8891764	165.0147	0.109854
CH_4	63.35	16.02	3391.6302	54333.92	63.26579
C_2H_6	13.9	30.07	744.17775	22377.42	13.88152
C_3H_8	6.03	44.09	322.83394	14233.75	6.021985
i-C_4H_{10}	1.36	58.123	72.811636	4232.031	1.358192
n-C_4H_{10}	2.44	58.123	130.63264	7592.761	2.436757
i-C_5H_{12}	1.03	72.15	55.144106	3978.647	1.028631
n-C_5H_{14}	0.73	72.15	39.082716	2819.818	0.72903
C_6H_{14}	1.19	86.177	63.710181	5490.352	1.188418
H_2O	-	18	7.1258541	128.2654	0.132922
Total	100		5360.9226	135722.8	100

a) Steady sate simulation

The amine gas sweetening plant is simulated by using the latest version of Aspen HYSY V.7. The DEA solution is used as an aqueous absorbent to absorb acid gases from sour gas stream. The first step of simulation could be done by adding the gas stream compositions and conditions which it same data of this case study. Moreover, Hysys fluid package should be carefully chosen which it should be (Amine Pkg) as shown in fig (2).

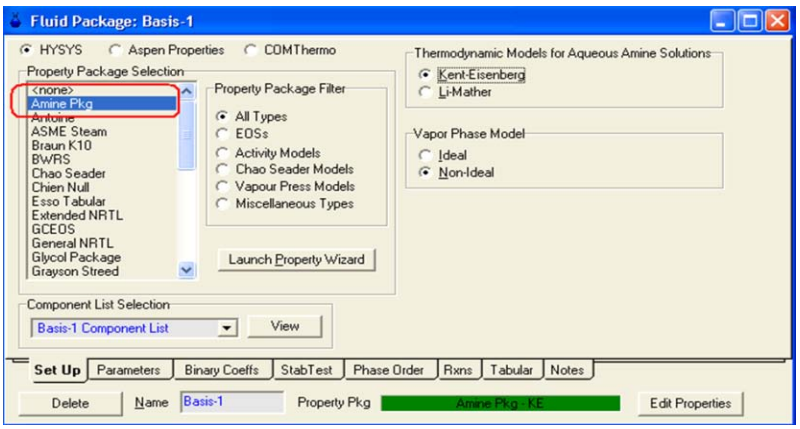

Figure 2 : Hysys fluid package menu

After achieving above, the simulation environment is entered. Moreover, simulation environment may consider the main simulation area, which it deals with the plant and shows the FPD for the process. It quite important to uses inlet gas separator to remove any undesirable impurities such as, solid particulars and liquids. Amine contactor is also important part from the plant which it also need some specifications for example, streams temperature and pressure and the amine (DEA) concentration (35% by wt. is used) and figure (3) shows amine contactor menu. After finishing above steps amine heat exchanger is also installed. Moreover, dirty amine needs to be regenerate and that could be achieved by installing the amine regenerator after amine heat exchanger and figure (4) shows amine regenerator menu.

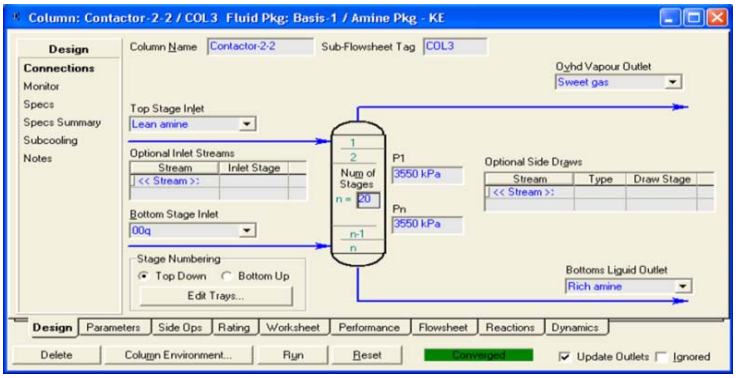

Figure 3 : Amine contactor menu

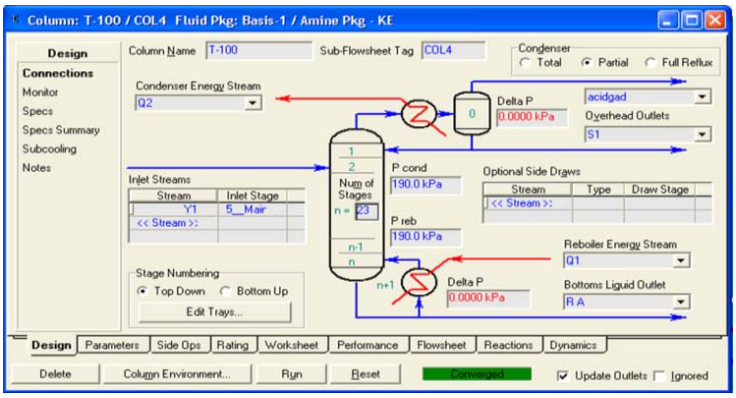

Figure 4 : Shows amine regenerator menu

The simulation process done successfully and figure (5) shows process flow diagram. As it seems from figure, (5) several processes unite are used in amine process. Infect, installing flash separator for rich amine is quite important in order to avoid any technical problems. Moreover, the ADJUST function is also important to adjust the mass flow rate of lean amine with the H2S molar friction in sweet gas stream. In addition, water make up stream should be added with a mixer to the process. In fact, amine concentration may be built up in the process because of water and amine losses with sweet gas. Therefore, water makes up stream will maintain and support the concentration of DEA at acceptable value. The simulation process done and the process achieved high acid gas removal that it will be discussed in result and discussion part.

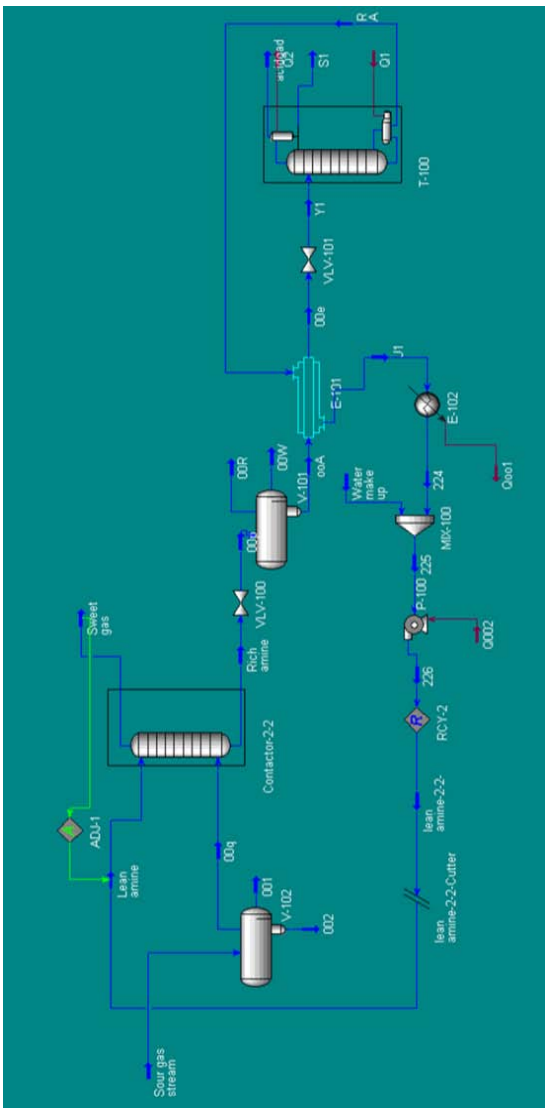

Figure 5 : Process flow diagram.

b) Effects of declining pressure on gas sweetening process

At the starting age of reservoir production, the reservoir pressure is usually sufficient to produce oil and gas as well. Moreover, it drives by natural reservoir mechanisms for example, water. Moreover, the wellhead pressure could be decreed or controlled by wellhead choke. As it showed that from given, gas stream data the reservoir peruse is high about 7000 Kpa. However, after period of reservoir production time the pressure will gradually declines. Thus, in this study part several operation pressure will be examined for example, 7000 Kpa, 6000Kpa,5000Kpa and 2000 Kpa. These values will be applied in previous HYSYS simulation program and the effects pressure change can be recognized for each case. Indeed, the declining of absorber pressure may lead to decrees the capacity of contactor unit. Figure (6) shows effect of declining operation pressure on natural gas capacity in amine sweetening unite.

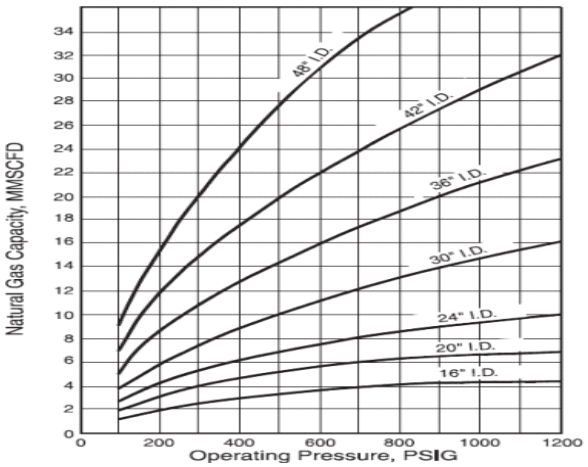

Figure 6 : Effect of declining operation pressure on natural gas capacity in amine sweetening unite (GPSA, 2004).

IV. Result And Discussion

Rich amine loading results for several assumed operation pressures are recognized and the whole results are transferred to MS excel program and the results can be showed in figure (7):

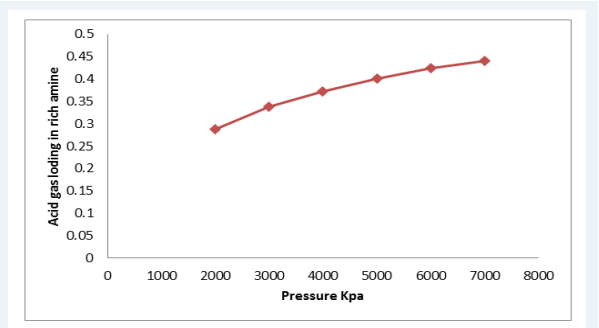

Figure 7 : Effect of declining pressure on DEA sweetening unit (20 plates in absorber).

It seems that from figure (7), the decreasing of amine contactor tower pressure due to declining of reservoir pressure has a direct effect on the rich amine lodging. As a result, the rich amine loading (moles of Acid gases/moles of amine) will be reduced and that will significantly effects the sweetening process performance. Moreover, in this case amine circulation rate should be increased in order to meet the product requirements and this will effect directly on process operation cost. Thus, drilling new wells or using EOR methods are the most economical and successful actions to overcome this problem. Thus, it can argue that if pressure of the amine contactor unite decreases due to decline in reservoir pressure then the partial pressure of Acid gases such as CO_2 will also be reduced.

V. Conclusion

In conclusion, this study is attempted to examine the effect of declining the reservoir pressure on gas sweetening process. Moreover, it is also simulated the gas sweetening process by Aspen HYSYS program. It can argue that the declining of reservoir pressure is directly affected amine gas sweetening process efficiency and performance and several technical problems for instance, it lead to increase the lean amine circulation rate, decrees rich amine acid gases lodging, increase in energy consumption by process and increase the operation cost. Moreover, it strongly recommended that incrusting the amine type or concentration in the process. However, this only could apply for short time because high amine concentration means high corrosion and cost. Therefore, the maintain of reservoir pressure by drilling additional well and using enhanced oil recovery method may consider the best solution to solve this problem.

References Références Referencias

1. Stewart, M. and Arnold, K. (2011) *Gas Sweetening and Processing Field Manual*. Waltham: Gulf professional publishing.
2. William, B. and Ghalambor, A. (2007) *Petroleum production engineering: a Computer-assisted approach*. Oxford: Gulf Professional Publishing.
3. Carroll, j. (2009) Natural Gas Hydrates: A Guide for Engineers. Oxford: Gulf Professional Publishing.
4. Maddox, R. (1982) Gas conditioning and processing: gas and liquid sweetening. Oklahoma: Campbell petroleum.
5. GPSA (2004) *Engineering data book*. Tulsa: Gas Processors Suppliers Association.

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