International Journal of
Science and Engineering Investigations vol. 4, issue 47, December 2015
ISSN: 2251-8843

A Comparative Analysis of Natural Gas Dehydration Process Using Shell Gbaran as a Case Study

Undiandeye J.A.[1], Omobare M.O.[2], Evbuomwan B.O.[3], Onyeukwu M.C.[4]
[1,2,3,4]Department of Chemical Engineering, University of Port Harcourt, Rivers State, Nigeria
([4]maureenonyeukwu@yahoo.com)

Abstract- The presence of water in natural gas results in many problems and so dehydration is necessary to minimize these problems. This research project work examined the comparative analysis of natural gas dehydration process with a focus on solid desiccant (adsorption) and glycol dehydration system using shell Gbaran as a case study. The project also focused on the operational analysis of Shell Gbaran glycol dehydration unit to examine the efficiency and the cause of glycol loss. Cost comparism was made on both units; a general comparison was made based on different considerations. A conclusion was made on the basis of economics and merits. Modification on the design and operations were recommended for solid desiccant process.

Keywords- *Natural Gas, Gbaran, Dehydration*

I. INTRODUCTION

Natural gas is a fossil fuel formed from the remains of buried plants, gases, and animals that are exposed to intense heat and pressure over thousands of years. It is an energy source often used for heating, cooking, electricity generation and fuel for vehicles. [1]

The global demand for energy has spurred the search for alternative sources of primary energy. Moreover, natural gas remains the third most widely used energy source in the world, ranking just below coal. [2]. It contains many of impurities since it is produced from deep underground reservoir under certain temperature and pressure for example, hydrogen sulphide, nitrogen and water vapour. In order to meet gas pipe line specifications, raw natural gas should be treated to either remove or reduce these impurities for example; H2S must be reduced to less than 4ppm [3].

Today, natural gas is one of the most important fuels in our life and one of the principle sources of energy for many of our day-to-day needs and activities. It is an important factor for the development of countries that have strong economy because it is a source of energy for household, industrial and commercial use, as well as to generate electricity. Natural gas, in itself, might be considered a very uninteresting gas - it is colorless, shapeless, and odorless in its pure form, but it is one of the cleanest, safest, and most useful of all energy sources [4].

Natural gas from oil wells is comprised of hydrocarbons such as methane, ethane, propane and butane [5]. In its processing, the water in the gas can present some problems like formation of solid hydrates which can plug valves and fittings, erosion or corrosion problem [6], [4] and [7]. It becomes very important to reduce the water content in the gas stream to below or within the tolerated limit of 6- 7lb/MMSCFD. The removal of the water vapor that exists in these natural gases requires a complex treatment consisting of treatments with varying degrees of efficiency involving gas dehydration processes [8]. Glycol dehydration is the most common dehydration process used to attain pipeline sales specifications and field requirements. [9] and [10].

In order to meet the requirements for a clean, dry, wholly gaseous fuel suitable for trans-mission through pipelines and distribution for burning by end users, the gas must go through several stages of processing, including the removal of entrained liquids from the gas, followed by drying to reduce water content. In order to remove water content, dehydration process is used to treat the natural gas. The types of dehydration process used are absorption, adsorption, gas permeation and refrigeration. The most widely dehydration processes used are those which usually involve one of two processes: either absorption, or adsorption. Absorption occurs when the water vapour is taken out by a dehydrating agent. Adsorption occurs when the water vapor is condensed and collected on the surface [11].

Glycols are the most commonly used liquid desiccants in the absorption process, they are; mono-ethylene glycol (MEG), di-ethylene glycol (DEG), tri-ethylene glycol (TEG) and tetra-ethylene glycol (TREG).TEG is the most commonly used glycol for natural gas dehydration; this is because it can be regenerated to high concentration without degradation. [12]

This work is aimed at critically comparing the various gas dehydration processes involved in the dehydration of glycol using shell Gbaran as a case study and proffering possible modifications on the design of the dehydration systems.

II. MATERIALS AND METHODS

The results of the dehydration operation in a typical glycol gas dehydration unit at Shell Gbaran, a facility owned and operated by SPDC were taken in an average per month, values obtained during 2013 and 2014 tabulated for analysis.

TABLE I. LEAN TEG TEMPERATURE TO CONTACTOR

Months	Average Inlet Gas Temperature (˚F) 2013	Average Inlet Gas Temperature (˚F) 2014
January	165	165
February	160	168
March	170	167
April	168	178
May	166	200
June	166	235
July	170	169
August	168	168
September	168	171
October	165	169
November	165	167
December	165	170

TABLE II. REBOILER TEMPERATURE

Months	Average Inlet Gas Temperature (˚F) 2013	Average Inlet Gas Temperature (˚F) 2014
January	405	405
February	398	400
March	404	401
April	404	404
May	405	404
June	404	404
July	404	403
August	400	405
September	404	404
October	395	402
November	404	404
December	405	405

TABLE III. LEAN GLYCOL FLOW RATE TO CONTACTOR

Months	Average Flow rate GEM 2013	Average Flow rate (GPM) 2014
January	36	37
February	34	36
March	36	36
April	38	39
May	38	37
June	37	37
July	38	38
August	38	37
September	37	36
October	38	36
November	36	37
December	35	36

TABLE IV. GLYCOL CONSUMPTION RATE (REFILL RATE)

Months	Glycol Qty. Added (Drums) 2013	Glycol Qty. Added (Drums) 2014
January	20	21
February	18	19
March	15	16
April	18	23
May	17	27
June	21	32
July	23	22
August	20	21
September	20	20
October	19	20
November	21	21
December	21	20
TOTAL	**233**	**262**

III. RESULTS AND DISCUSSION

From the result of the dehydration unit, it is seen that the average reboiler temperature for 2013 and 2014 operational year of each month recorded has a range of 1˚F and 10˚F respectively. The reboiler temperature recorded in 2013 indicates a well-controlled process with regards to the lean TEG temperature of 2013(table 1) and this implies that the control system had no problem.

As for 2014, it can be seen that there was a constant increase in the lean TEG temperature to contactor(table 1) from April to June which affected the reboiler temperature from April to June and the glycol consumption rate (refill rate).

It can be said from the analysis that high lean TEG temperature to contactor leads to a high glycol loss by vaporization as well as thermal degradation of glycol. [13] The glycol flow rate fluctuated between 34-39 GPM during the two years.

TABLE V. DESICCANT DEHYDRATOR AND GLYCOL DEHYDRATOR COST COMPARISON

Types of Costs and Savings	Desiccant ($/yr)	Glycol ($/yr)
Implementation Costs		
Capital costs		
Desiccant (includes the initial fill)	13,000	
Glycol		20,000
Other costs (installation and Engineering	9,750	15,000
Total Implementation Costs	**22,750**	**35,000**
Annual operating and maintenance costs		
Desiccant		
Costs of desiccant refill ($1.20/lb)	2,059	
Cost of brine disposal	14	
Labour cost	1,560	
Glycol		
Cost of glycol refill ($4.50/gal)		167
Material and labour cost		4,680
Total Annual Operation & Maint. Cost	**3,633** 26,383	**4,847** 39,847

It can be said from table 5, that the operating cost for a glycol dehydrator includes topping up the glycol sump to maintain glycol levels. [14]. Maintenance and labor costs include inspecting and cleaning the mechanical systems, periodically repairing the circulation pump and pneumatic controls, and annually cleaning the fire tubes of the reboiler. Glycol costs are $4.50 per gallon. Labor costs assume operators spend hours per week maintaining and repairing the unit. Based on total operation, maintenance and labor costs glycol dehydrator system is $4,847 per year. Also it is seen that from table 5 that the solid desiccant has a lower implementation cost as compared with glycol dehydrator system which is one of the overall benefits and interests to the natural gas processing industries.

IV. CONCLUSION AND RECOMMENDATION

The agenda for natural gas dehydration process comparison is hinged on economics and industry experience. The results gotten are based on certain operating conditions, however it provides the trend of the data. It is observed in the cost estimates that solid desiccant dehydrator has a lower implementation costs and a reduced operation and maintenance costs. Hence, it is preferred to the glycol dehydrator. It can be concluded from the collected data that the inlet flow rate of glycol is determined by the TEG pump discharge.

One of the demerits of the glycol unit is the high volume of glycol loss/consumption rate. Therefore it can be concluded that the plant efficiency is achieved by sacrificing the high cost of Triethylene glycol. Hence, this unduly increases the total cost of production. This can be prevented by opting for a cheaper solid desiccant.

For efficiency in the use of solid desiccant dehydration system operated in a batch mode, a continuous mode of operation is recommended. The modification on solid desiccant dehydration system (i.e.) contaminant removal, avoidance of sudden pressure surges and anti-freeze facility should be tenaciously implemented to improve performance.

REFERENCES

[1] Zimmerman, Barry E. Zimmerman, David J. (1995): “Nature Curiosity Shop”, Lincolnwood (Chicago), IL: Contemporary books. Page 28

[2] Brian F. Towler (2014): “Future of Energy”, page 89-133

[3] Stewart .M, and Arnold .K, Gas Sweetening and Processing Field Manual. Houston: Gulf Professional Publishing, 2011, pp.51–52.

[4] Etuk P. (2007). “Total E&P Gas Dehydration Training Manual course EXP- PR-PR130”, Rev.01999.1

[5] Okorigwe London Wome, (2014): “Optimization of Natural Gas Dehydration in LNG Plant”, Institute of Petroleum Studies, University of Port Harcourt.

[6] Ikoku, C. I. (1992). “Natural Gas Production Engineering”, Reprint Edition, Krieger Publishing Company: Boca Raton, FL.

[7] Abdel-Aal.K, Petroleum and Gas Field Processing. New York: CRC Press, 2003, pp. 90–110.

[8] Katz D.L “Handbook of Natural Gas Engineering, Production and Storage”, McGraw-Hill Book Co., Inc 1990

[9] Hernandez, V., Hainvinka, M. W. and Bullin, J. A.: “Designing Glycol Units For Maximum Efficiency”. Bryan Research and Engineering, Inc. 2001.

[10] Campbell, J. M.: “Gas Conditioning and Processing” Vol 2, Campbell and Company 2001.

[11] Pimchanok .K. (2013). “Membrane Based Triethylene Glycol Separation and Recovery from Gas Separation Plant Wastewater”, Asian School of Technology, Thailand, May.

[12] Karl K, (2012): “Gas Dehydration (Engineering Design Guideline)”, KLM Technology Group, Johor Bahru.

[13] Guo, B., Ghalambork, A.: Natural gas engineering handbook, Gulf Publishing Co., 2005.

[14] U.S. Environmental Protection Agency. Lessons Learned : Replacing Gas –Assisted Glycol pumps with Electric pumps (EPA430-B-03-041, May 2003)