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AN INVESTIGATION OF THE EFFECT OF NAKED GAS ON REDUCTION QUALITY OF WATER DEW POINT IN THE GAS DEHYDRATION PROCESS

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ABSTRACT

Nowadays, dehydration units done by using absorption method are used in Tri-ethylene glycol solvent (TEG) to reduce water dew point in gas. This study investigates the use of the naked gas to reduce water dew pint in gas as much as possible. To this aim, a type of wet gas was chosen and the dehydration unit was designed for it based on amount of water in it by using commercial software HYSYS, and PR equation was used for static simulation. At first dehydration unit in the form of solvent was simulated in the environment of software. Then the use of the naked gas was studied to determine its flow rate and injection place. The results of simulation revealed that if the naked gas with flow rate of 18 kg/h in a high pressure was injected to the re-boiler recovering Glycol, one would be able to reduce water dew point in gas from -14 ° C to -29 °C. This indicates how much the use of the naked gas is effective in reducing water dew point and in preventing gas being two phases in the transferring lines as a result of liquidation of water in the low temperatures. Moreover, the effect of this method in reduction of hydrate formation temperature is very obvious. The obtained graphs from the case study reveal that the produced gas hydrate temperature for dehydration process without naked gas is 11°C, and this temperature will be -25°C in case of use of the naked gas in dehydration unit. Consequently, one can say the use of the naked gas in the dehydration unit can decrease the possibility of two-phase gas and freezing gas flow in pipelines.

Keywords: Hydrate Temperature, Tri-Ethylene Glycol, Reduction in Dew-Point, Dehydration

INTRODUCTION

Dehydration is considered as the omission of steam existing in the gas. Gas industries found the necessity of dehydration in order to make sure of fluent transferring of gas in pipelines. If the existing water in the gas is not removed, the following problems will occur (Sloan, 2008; Englezos, 1993).

1- Freezing in the absorption unit system as a result of low temperature in the absorption and separation processes

2- Formation of gas hydrates as snow (crystal compounds include one share of Methane, Ethan, Propane, or Iso Bothane in addition to 6 to 7 share of water)

3- Formation of hydrates by means of existence of water in the turbulent region

There are different methods to dehydrate that some of them are as following:

1- Absorption with liquid (Di Ethylene Glycol, Tri Ethylene Glycol and ...)

2- Absorption with solid (Alumina, Silica Gel, Silica Alumina Gel and ...)

3- Dehydration with cacl₂

4- Cooling

5- Membrane penetration

6- Stripping with gas

7- Distillation

Dehydration with liquids requires a desiccant to remove the steam. There many liquids with the capability of absorption of water from gas but materials that are used in industry are the best economic case. And they must have the following properties (Masoudi *et al.*, 2005).

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- 1- High absorption efficiency
- 2- Non-formal and non corrosive
- 3- none operational problems when using high concentrations
- 4- Not act and react with gas hydrocarbons
- 5- Not mix with acid gases

Glycols, specially:

- 1- Ethylene Glycol (EG)
- 2- Di Ethylene Glycol (DEG)
- 3- Tri Ethylene Glycol (TEG)
- 4- Tetra Ethylene Glycol (T₄EG)

Are proper choices that meet these criteria with different degrees? Water and Glycol are solvable in each other completely because of Hydrogen-Oxygen bonds and its steam pressure is very low. Tri Ethylene Glycol or TEG is one of the cases is alternatively used in dehydration (Masoudi *et al.*, 2004). Glycol dehydration systems change water dew point in the output gap between the ranges 4 ° F to 58 ° F. The dehydration systems that operated in the upper ending area of dew point (drop of below dew point) use for instance from four to contact six trays and TEG concentration of 98 not 99 weight percent, and there is no need to any type of stripping gas in the boiler. These units are used in the pipelines in the warm climates and in the place low dew point of water (Masoudi *et al.*, 2004). Dehydrate systems were designed to operate in ending area of dew point (drop of above dew point), and for instance use from 10 to 12 contact trays (full structure), and require TEG concentrations more than 99.9 weight percent and stripping gas with determined concentration, or capability of making vacuum in the boiler. These units are used in the entrance of cooling systems and turbine expander units and in foul climate like northern regions of Alaska. In these units, TEG concentration is critical. For example, in order to make water dew point temperature in gas -40 ° F by means of a contact tower at 90 ° F, the minimum concentration of the required TEG solvent is 99.9 weight percent (Eichholz *et al.*, 2004).

Dehydration Process by the Method of Absorption in the Tri Ethylene Glycol Solvent

The absorption phase is formed in a tray column or a full column (figure 1). The number of trays is usually between 6 to 8 and overall performance of tray in a good design is from 25 to 40 percent that the 25 percent is used in many of functions. The distance between the trays is proposed as about 24 inches. If the diameter of the column is less, the filler is always used while for towers with bigger diameter, the bonnet trays or trays having tap are used.

The use of regulated filler in tower with very big diameter is growing. If the filler system is structured, fillers like Flexipak, GRempak, Mellapal, Montazpak are used. In tower with small diameter (low gas intensity), the use of filler is superior to tray. Temperature of absorption phase is usually limited to 38° c in order to prevent over wasting Glycol. It helps to reduce the amount of wasting and also the amount of existing water in produced gas (Afzal *et al.*, 2007). Thus, as a result of the high granary of Glycol, the temperature being about 10 ° c was determined as the low limitation. Glycol absorption is always a state temperature process. But, when the dehydration is done in pressure below 1000 (145 psi), temperature increase as a result of absorption heat is about 2 ° c (4°f). Heat vaporizes about 21 kj/kg of water absorption in addition to the amount of covered heat. The smith of thermal area for Glycol absorption tower is proposed from 50 to 140 ° F and even 31 ° F for low temperatures (Figure 1). In the absorption phase, some amount of Carbons and Hydrocarbons are usually absorbed in Glycols. In low temperature and high pressure, Glycol absorbed more amounts of light Hydrocarbons, so the solvent viscosity will decrease. The low operational pressure leads to high amount of viscosity in low temperature when the omission of Hydrocarbons increases, thus the foaming is problematic. For this condition, it is better to use absorption tower with perforated or bonnet trays. The full produced towers are also able to minimize the foaming. The saturated Glycol solvent pass from a thermal exchanger in which the heat of solvent is recovered (output of recovering tower) and heated itself before entering to recycling tower (figure 1). The boiling thermal load is related to this exchanger yield (rich/ lean exchanger) in recycling tower. The saturated Glycol flow enters exchanger from absorption tower with temperature about the temperature of

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entering gas and the recycled Glycol flow enters exchanger from recovering agent with tower boiling temperature.

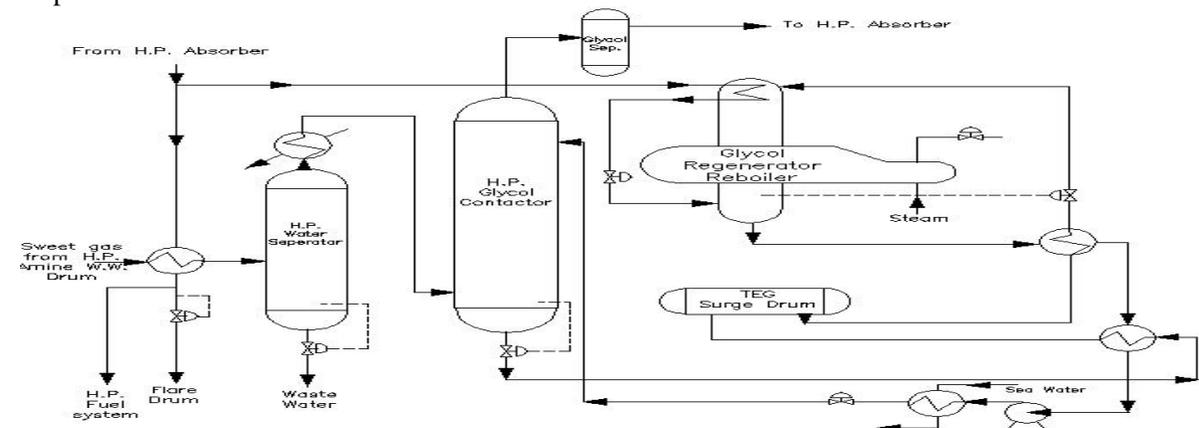


Figure 1: Processing schematic dehydration from gas in way of absorption in liquid solvent without using stripping gas (Afzal et al., 2007)

Case Study

In order to do this case study and come to result (table 2), a type of wetting gas related to gas well No. 163 of Razi Petrochemical (table 1) was chosen. Based on the overall process of dehydration units was done in the way of absorption in liquid solvent, and dehydration process for the aforementioned gas was done in environment of HYSYS software with PR thermodynamic package. The aforementioned gas contains 900 ppm mple water and it has operational condition of 26 °c 300 psig pressure and 2 MMscfd flow rate. To simulate absorption tower, the common trays (six window trays) with tower diameter 1.5 and trays distance of 24 inch were used. At first, dehydration unit was simulated without using stripping gas, and in this state, the operational condition of Glycol recovering re-boiler was determined at 400 °F temperature and 14.8 Pisa pressure (figure 2).

Table 1: Wet gas compounds

Component	Mole Frac	Component	Mole Frac
H ₂ S	0.035	IC ₄	0.0094
N ₂	0.3	NC ₄	0.0035
C ₁	0.805	IC ₅	0.0034
CO ₂	0.018	NC ₅	0.0037
C ₁	0.079	C ₆	0.0028
C ₂	0.0296	C ₇	0.0018
C ₃	0.0049	H ₂ O	0.0009

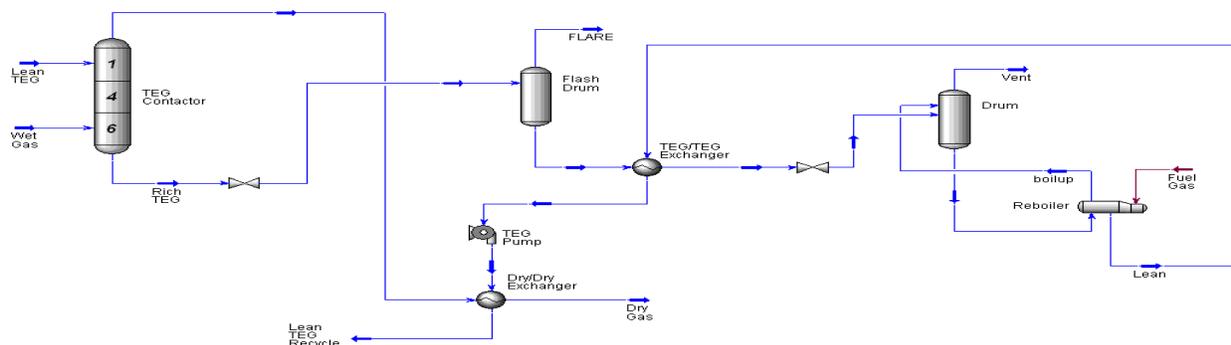


Figure 2: Simulation of dehydration unit in environment of HYSYS softwar

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effective for cool climate regions which the possibility of making two-phase gas in pipelines and making gas hydrates is high. By comparing gas hydrate – making graphs (figures 4&5) for producing gas in each two cases, we can understand the impact of stripping gas on decrease of hydrate temperature. The horizontal axis in figure 4 is near to 0 °c to some extent, but in the figure 5, this axis only contemporizes negative temperatures for making hydrates in the desired pressure for gas. Based on temperature-pressure graphs of hydrate, temperature for making hydrate in the exiting pressure from Dry/Dry Exchanger for the time that it is passing from the stripping gas in re-boiler is -25 °c and this temperature is -11 °c for the producing in case the stripping gas is not used. Consequently, we can say that the use of stripping gas and its injection into re-boiler of Glycol recovering is of a significant effect in as more decrease of hydrate temperature and water dew point in producing gas from dehydration units with liquid solvent. Furthermore, considering costs caused by Pig racing and clogging of pipelines, the use of stripping gas injection method can be regarded as a economic solution specially for cool climate regions.

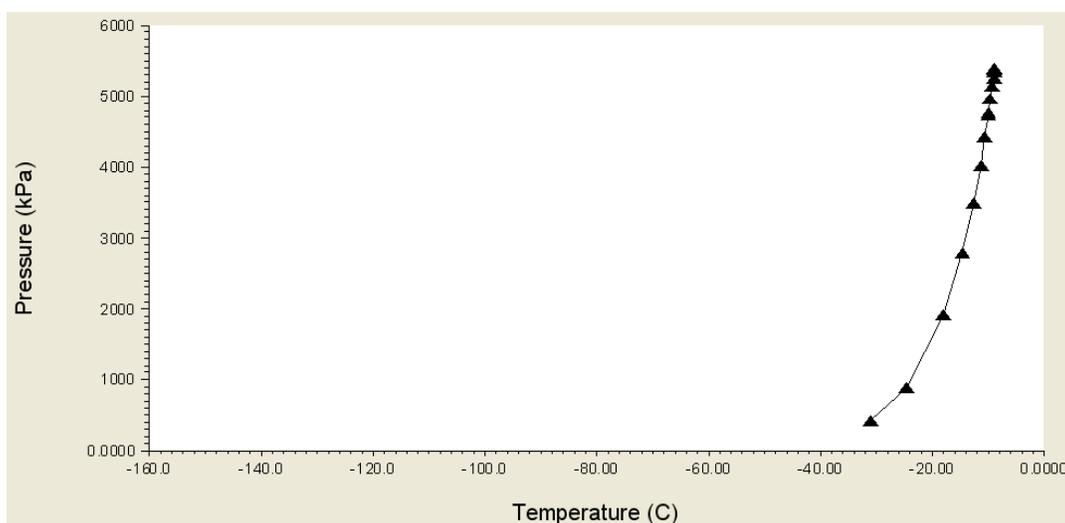


Figure 4: Temperature-pressure graph for hydrate making for producing gas (without the use of stripping gas)

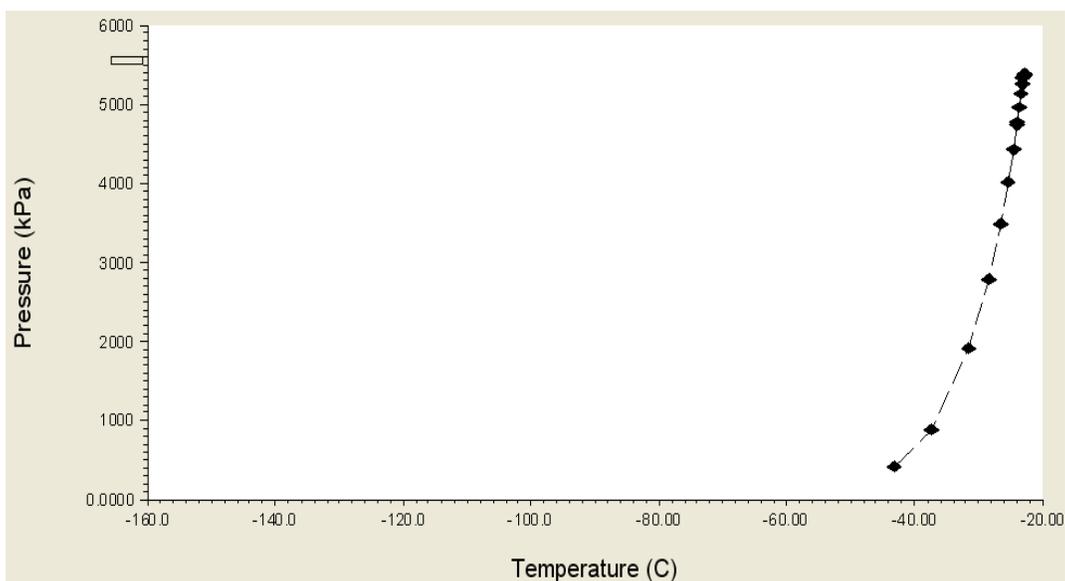


Figure 5: Temperature-pressure graph for hydrate making for producing gas (without the use of stripping gas)

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REFERENCES

- Afzal W, Mohammadi AH and Richon D (2007).** Experimental Measurements and Predictions of Dissociation Conditions for Carbon Dioxide and Methane Hydrates in the Presence of Triethylene Glycol Aqueous Solutions, *Journal of Chemical & Engineering Data* **52**(5) 2053–2055.
- Eichholz C, Majumdar A, Clarke MA, Oellrich LR and Bishnoi PR (2004).** Experimental Investigation and Calculation of Methane Hydrate Formation Conditions in the Presence of Ethylene Glycol and Sodium Chloride, *Journal of Chemical & Engineering Data* **49** 847-851.
- Englezos P (1993).** Clathrate Hydrates. *Industrial & Engineering Chemistry Research* **32** 1251-1274.
- Masoudi R, Tohidi B, Anderson R, Burgass RW and Yang J (2004).** Experimental measurement and thermodynamic modelling of clathrate hydrate equilibria and salt solubility in aqueous ethylene glycol and electrolyte solutions, *Fluid Phase Equilibria* **219** 157–163.
- Masoudi R, Tohidi B, Danesh A, Todd AC, Anderson R, Burgass RW and Yang J (2005).** Measurement and prediction of gas hydrate and hydrated salt equilibria in aqueous ethylene glycol and electrolyte solutions, Masoudi et al., *Chemical Engineering Science* **60** 4213 – 4224.
- Sloan ED (2008).** *Clathrate Hydrates of Natural Gases*, Third edition (Mrcel) New York.