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Investigation and Optimization of Gas Dehydration unit in one of the Bangestan Gas Compressor Station in Nisoc

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ABSTRACT

Natural gas production from independent sources of gas or associated gas and heavy hydrocarbons is in fact saturated with water vapor. Water vapor in the gas along pipelines and process equipment cause problems such as the formation of hydrates, corrosion and changing the flow regime (the clot) as well as lower heating value of the gas. Therefore, optimizing the energy consumption of water is allowed to bring the gas stream becomes very important. Therefore, the specification process input and output streams, process equipments and mechanical characteristics were evaluated using software package Aspen Hysys7.2 and select the appropriate equation of state (Peng Robinson) simulation was performed dehydration unit. In order to ensure the validation of the simulation process, the obtained data were compared with data in the map of PFD unit, subsequently; compare simulation data with operational information and correctness were approved equation used to predict data. The results showed that the circulating glycol (constant concentration) and the stripping gas can be achieved by maintaining the initial concentration, decreased. The stripping gas temperature does not effect in among and concentration of glycol circulation. Stripping gas used in the study station around 34 kg / h was very high, which can be reduced in the range of design about 16.36 kg / h (to achieve the same concentration). The results showed that the lean glycol circulation and the amount of stripping gas can be optimized in the unit, and the amount of stripping gas will often reduce about spec of design 16.36 kg / h).

Keywords: Dehydration, Simulation, Optimizing, Triethylenglycol

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INTRODUCTION

Raw natural gas is extracted from deep underground natural gas consumption in residential and commercial completely different. After extraction of gas as a clean fuel to be able to be used, must have a specification for the use and transfer. So the first step to removing impurities and gas treatment is required. In order to take advantage of valuable hydrocarbons from the natural gas to be recovered before they are in conversion processes is associated with high profitability, may be used.

Processed to achieve a finished product with good quality for the transmission and consumption of gas processing facilities usually consists of four main steps, which are briefly introduced in this research process we find.

1. The separation of gas from gas condensate.
2. Natural gas treatment (removal of carbon dioxide and sulfur)
3. Remove moisture from the natural gas stream.
4. The recovery of valuable hydrocarbons (natural gas liquids separation and segregation)

In addition to the four steps listed above as separator for the removal of free water from a series of well-head gas , filtered to remove sand and other large impurities , chemical injection equipment for preventive injection of corrosion inhibitor injection of gas hydrates formation is used.

Dehydration processes for natural gas include: 1. Absorption (Dehydration with liquid absorbent). 2 Adsorption (Dehydration with desiccant solid adsorbent). 3. Methods of cold and cooling. 4. The use of membrane methods. In between the first and second methods are common. [1]

Water vapor alone usually does not cause much problem, but the presence of this material in a liquid or solid operating system will cause problems. To prevent such problems should be natural gas dehydration. Among the reasons for natural gas dehydration: 1) Prevent corrosion. 2)Prevent hydrate formation in pipelines.3) Prevent reduce the volume of gas transit. 4)Prevent a decrease in heating value gas 5)Prevent water condensation of gas- two-phase flow and pressure drop in pipelines 6)Achieve a water dew point in natural gas in accordance with the contract signed sales gas (limit 4 to 7 pound of water per million standard cubic feet of gas) [2]

By absorbing moisture from natural gas liquid with absorbent, physical methods of dehydration is one in which the glycol solution is used as a liquid absorbent. In this method, most of the four types of glycol solution to the names, Mono ethylene glycol 2 (MEG), diethylene glycol 3 (DEG), triethylene glycol 4 (TEG) and tetra ethylene glycol 5 (TREG) gas is used for Dehydration operation. Today, among the glycol, Triethyleneglycol (TEG) is the worlds most widely accepted and used in many refineries of the compound [1]

The major operational equilibrium data charts TEG is water dew point of natural gas, obtained in 1966 by Mr. WORTEY have been published in book GPSA [3]. The simulation software is widely used in the design process . Applications software in this field is extensive in terms of thermo-physical properties of simple calculation currents or even pure starting materials and design factories facilities include a full- side, pipelines feedstock, of the product and transfer or Control are review1.

Since this method of manual calculations easier , faster and more accurate by repeating it in different situations can be easily and spend much less time with a complete set of predicted process performance in various states and thereby reduce the additional fees fixed investment (additional devices) and reducing operating costs (water , energy , etc.) have created more flexibility in the design process and the optimal point in terms of costs, fluency operations, safety , environment, etc. can be obtained[4]

- Description of the dehydration process in the station under study

Gas entering into a filter separator before entering into Gas dehydration system. This refined, solid particles and liquid filtration in two separate parts is responsible for gas. It driven out of the filter to the tower and the lower part of the tower. After passing through a mesh screen drops stuck to the upward flow. At the top of the tower has been built plates. On each of these plates are bubble caps. Through the direct contact with the glycol and water in the gas absorbed by the glycol.

Glycol purity 99.7 wt% entering into absorption tower and water absorbed in it, Then with a purity of about 97 %to the regeneration unit. At this stage glycol driven into the coil and 64 to 71° C pre-heated and then enter the flash drum. Lot of associated gas field in the glycol to add small amounts of light hydrocarbons are separated from the mainstream.

Glycol after the exit filter cartridge and solid particles are derived are then filtered charcoal and much of hydrocarbons separated from it then, it passes into the heat exchanger of shell and tube and temperatures up to 150 ° C increased after passing through the steel columns inside the reboiler flows through a metal ring. Boiled in a manner designed to glycol temperature up to about 200 to 204 ° C and water and other impurities up to the evaporation of the glycol through a column called stripping and through the metal rings (Pall rings) after leaving to two heat exchanger and reduce the temperature to about 114 ° C to the inlet pipe glycol pumps circulation after the departure of a cooling and reduce the temperature by 5 ° C hotter than the input gas into the tower can be dehydrating [1]

2-1-Dehydration simulation process using HYSYS- ASPEN software

In a simulation based on a mathematical model of system behavior, defined as the process of selecting or writing a mathematical model for the study is very important. Carefully designed and arranged in chemical process model simulation results will be more accurate and reliable.

Depending on the model, consider the following accomplish.
Operating conditions (temperature and pressure)
Type and category of the mixture.
Process phases (liquid and vapor) [5]

Equations of state (EOS) are widely used to process the oil, gas and petrochemical little deviation from the ideal is recommended [6 and 7]. When sulfur compounds are present in the components peng-Robinson equation or (Sour PR) can be used. However, due to the absence of the equation compatible with glycol, in simulating the process of ping-Robinson equation of state (PR) were used.

Peng-Robinson equation for many hydrocarbon compounds in a wide range of temperature and pressure conditions and the state of one, two and three-phase and polar compounds usable and suitable[8]

2.1.1- **Process simulation**
1. The choice of materials in the process
2. Choose a thermodynamic model
3. Login to the simulation
4. The definition of input and output streams
5. The definition of absorption and regeneration towers and other equipment and appliances).

Water stream doesn't exist in PFD map. Since the water content of the feed gas is a parameter affecting the water levels of out gas the absorption tower, to realize that it was used to one step flash calculate. Out gas from the top of flash drum back to absorption Tower .it quite income saturate.

The activities described above, the simulation was complete dehydration unit. Overview Figure 1 shows the simulated process based on the PFD.

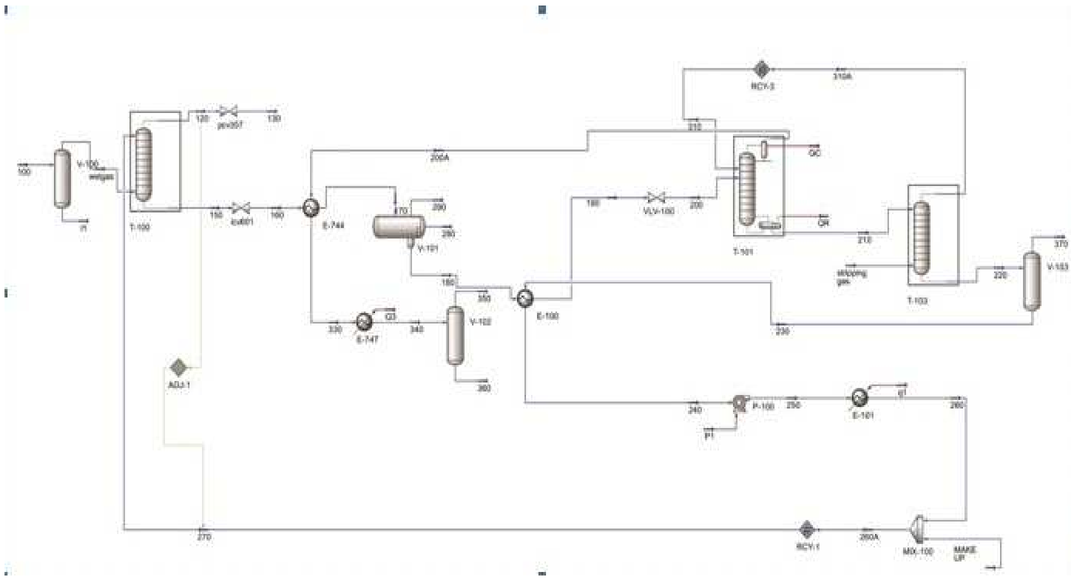


Figure 1: Simulation of Dehydration and regeneration systems Bangestan compressor station

After simulation to ensure accuracy, comparison between PFD data and data from software was done. The equation used which indicate suitable and approved (Peng Robinson), respectively. It is mentioned in this study to simulate steady Theme Unit knockdown station first, with regard to the homogeneity lack of materials and their deviation from the ideal gas (like water, H_2S, CO_2 and TEG,) version Ø-Ø is not suitable and should model γ-Ø Use that the PR equation for the gas phase and liquid phase were used for the NRTL activity model. Since the reference simulation, PFD maps relevant station equations digressions (about 0.5 %) With maps showed PFD station. In the next step Ø-Ø model and PR equation of state for both gas and liquid phases were happily processing conditions set forth in the materials and energy balance study stations with very good accuracy (less than one percent) predicted. In Table 1 the comparison is inserted. Peng-Robinson & NRTL-Peng-Robinson.

Equation state	%Glycol	%Glycol	%Glycol	Rate Glycol (kg/hr)
	210	220	230	270
Peng-Robison	0.926795	0.970984	0.971444	1496
NRTL-Peng-Robin	0.931380	0.979636	0.980311	946.3
PFD	0.926669	0.970979	0.971291	1496.71
% error P-R	0.014	0.0005	0.016	-0.047
% error NRTL-Peng-Robi	0.5	0.89	0.93	-36.77

Table1: Comparison PFD data and simulated data

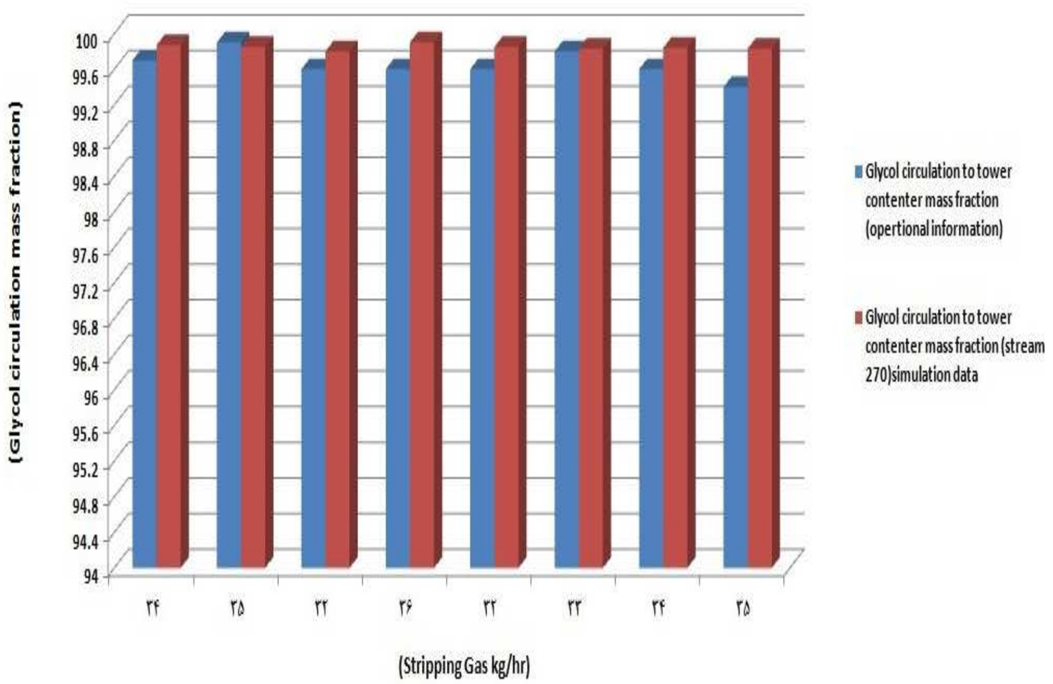


Chart 1 comparison the glycol mass fraction to Contactor tower to stripping Gas indifferent values(simulation data to operational data)

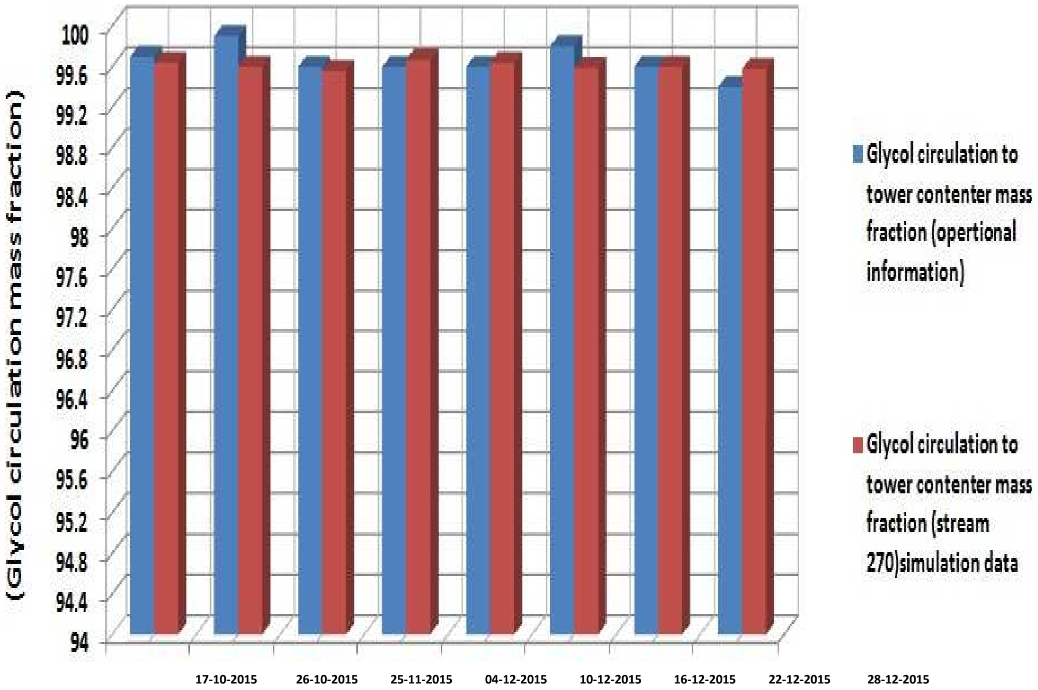


Chart 2- Comparison the glycol mass fraction to Contactor tower with stripping Gas in different &design values (simulation data to operational data)

Given the figures above it can be seen that the concentration of glycol inlet to the tower with reduce the amount of stripping gas to the design value (KG/H 16.36) also is not much change it can be used to compensate for reboiler temperature be reduced.

RESULTS

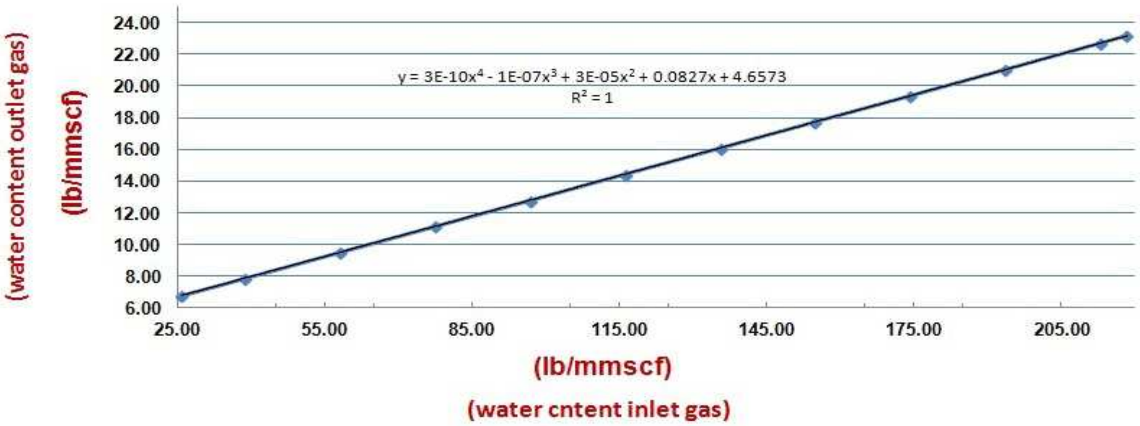
Since the goal is to minimize the amount of water in the gas is pre-determined characteristics, parameters affecting this process are of high importance. These parameters can be divided into two groups' fixture design and operational variables. Fixed design parameters such as physical dimensions Tower (length, diameter and number of trays) and type of tray used and the required operational pressure in dehydration outlet unit, determined at design time and often cannot change. Some of the operational parameter is independent of the dehydration process and system optimization is a function of their values. Including the characteristics of the feed gas (composition, pressure and temperature) can be mentioned. therefore, the purpose of the data used in this study to determine the effect of changing operating parameters and optimize their operations to achieve an acceptable level of water in the outlet due to changes in operational parameters are independent.

Optimization of parameters includes:
- Temperature boiler
- The amount of glycol in circulation
- The concentration of glycol in circulation
- Amount stripping Gas.

1. Feed gas composition change

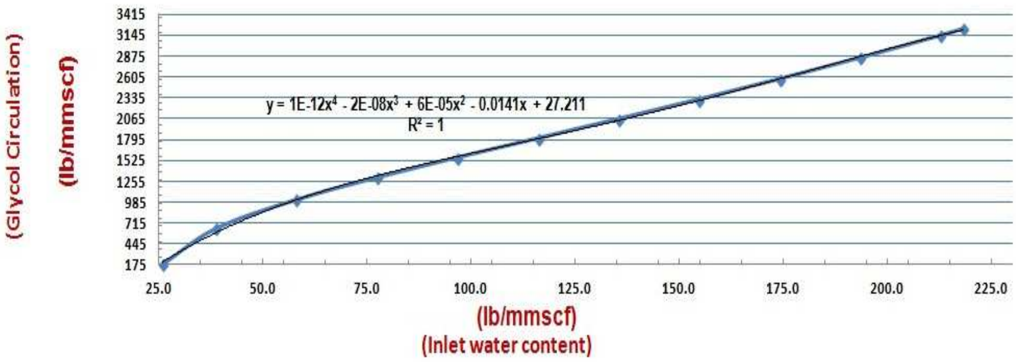
The amount gas and temperature are constant and water content of the feed gas (synthesis gas) was selected as a parameter. Given the rate of change of these parameters in design (6.5 kg mol per hour) from 1 to 6 kg mol per hour was chosen.

Assuming constant other parameters, together with increased water content of the feed gas, water with outlet gas also increases. If the reduction of water content of the feed gas, water and gas outlet will be reduced. The results are shown in Graph(1).

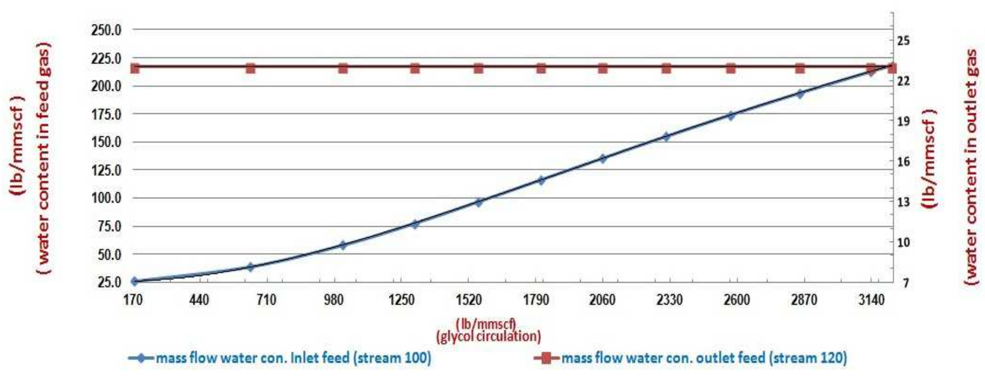


Graph (1) the amount of water content in feed with outlet gas

Since the maximum amount of water content in outlet gas must to be kg / hr10.77 (lb/h 23.69), with the level of circulating glycol (constant concentration) of glycol required to achieve the same amount of water comes out. In other words, by increasing gas amount of water content in inlet gas, in the same concentration of glycol, glycol flow rate was increased in circulation. Data gathered from Graph 2



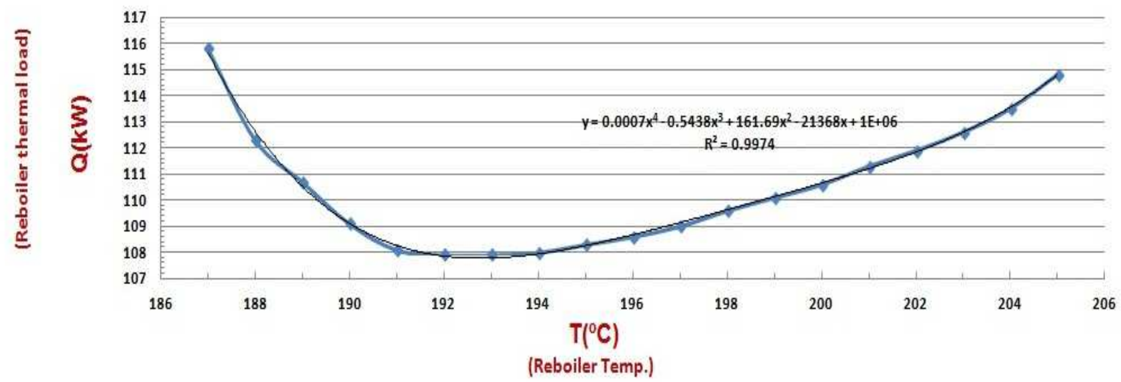
Graph- (2) -the amount of glycol in circulation to water content of the feed gas



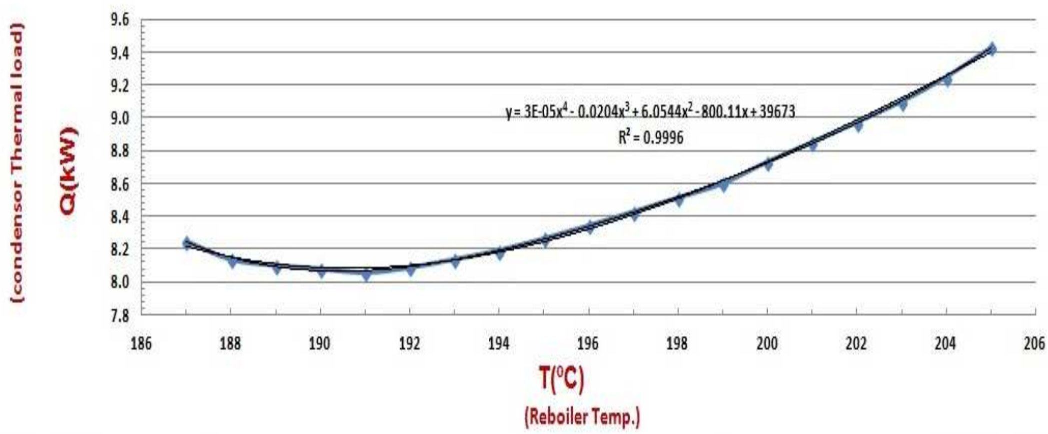
Graph- (3)- Water Content inlet and outlet gas to the glycol circulation

According to the graph (3) in the same flow circulating glycol, to achieve the necessary of spec design water in out let gas by changing the amount of water content in the inlet gas glycol concentrations should be determined.

Reboiler thermal load to temperature change:
As shown in Graph4 can be seen thermal load reboiler directly related to its temperature and with respect to the results of simulations and experiments operating at temperature 198 - 200 °C is the best period for operation of dehydrating due to the concentration of weight the glycol is in question. To learn about the practical consequences station was approved by the review. As can be seen in Graph4 in the temperature range 194-191°C,but the lowest level of thermal load reboiler- But the glycol circulating in the range of 11-20% compared to the glycol circulating the reboiler temperature 200°Cincreases and the increase glycol, glycol pump capacity, pressure and power consumption of the system and pumps the glycol is effective.



Graph (4) - the Reboiler of thermal load to reboiler temperature

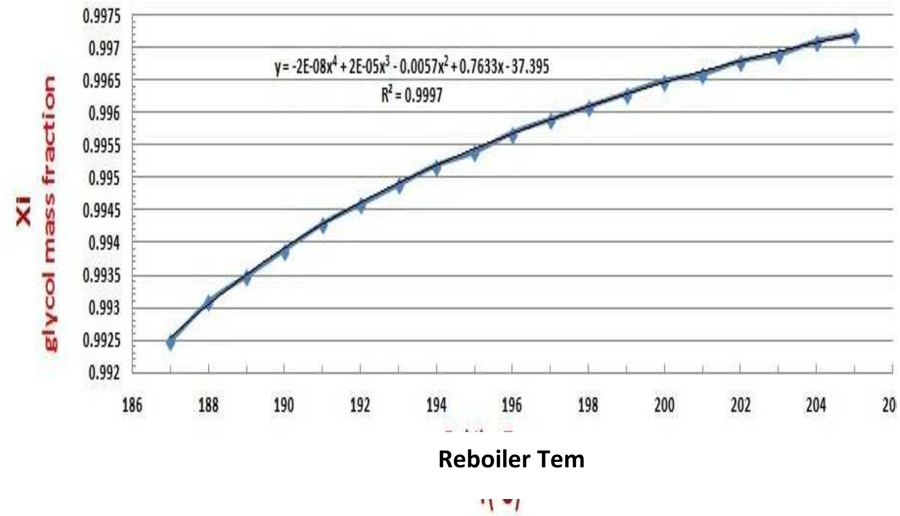


Graph (5) - the condenser of thermal load to reboiler temperature

As the shown in the Graph (5) can be seen with increasing reboiler temperature and flow rate in vapor phase increase also and condenser to condense the heat load will also increase.

The effect of temperature reboiler
In a standard Dehydration systems, reboiler heating and stripping gas flow rate are two factors in concentrations of glycol in operation. The effect of these parameters on the concentration of glycol was investigated.

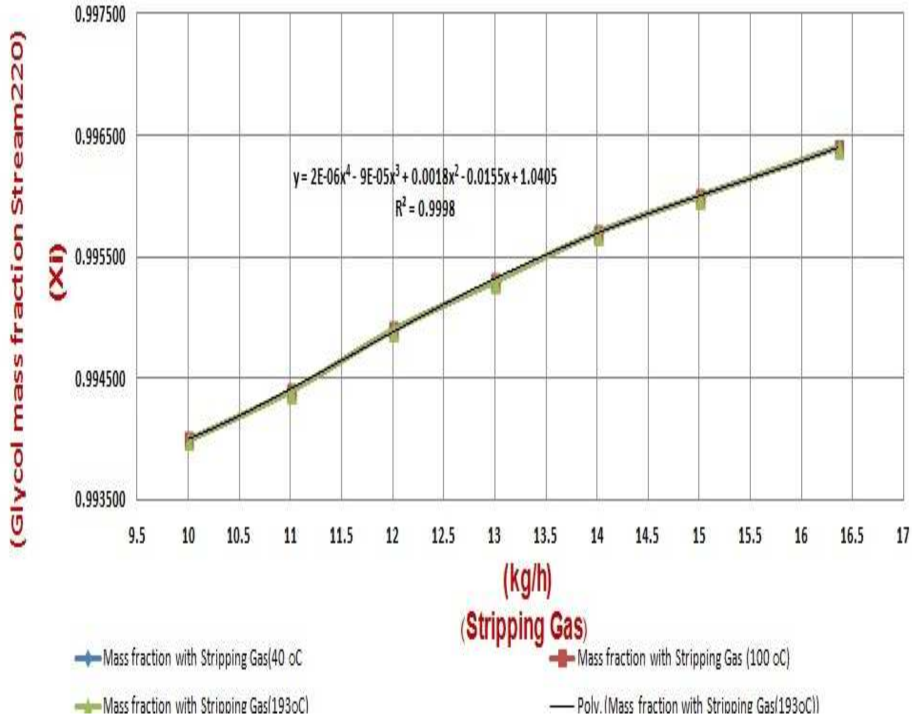
At first reboiler temperature decreases, the concentration of glycol in circulation was investigated. The resulting value in the graph (6) is given. By reducing the reboiler temperature according to graph the concentration of glycol in circulation reducing and thereby water content with outlet gas increases.



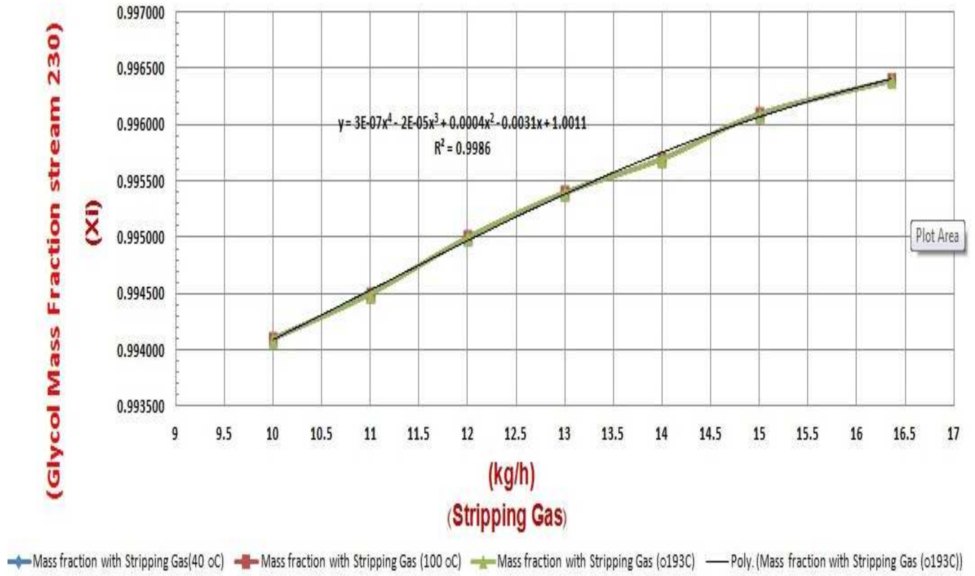
Graph (6) Glycol Mass Fraction Compared to the Heat Reboiler

Evaluate the effects of the stripping gas stream

As you know, to achieve a desired concentration of glycol and increasing the rate of evaporation of water absorbed without increasing the temperature, according to the Rauolt law should at a given temperature of the re boiler, the water in the vapor phase mole fractions and total pressure reboiler system can be reduced. In Bangestan compressor station and the dehumidification unit, it uses a gas (fuel gas made of) as a Stripping Gas is prepared to do it. The following charts at three different temperature off stripping gas (40, 100, 193°C) was drawn. The communication to changing Glycol concentration (Lean) streams (220 and 230) is shown with a stripping gas. It also determines the minimum concentration of glycol to achievable in the package, the results of which were used to maintain the temperature of the reboiler glycol in Graph (7) and (8) can be seen.

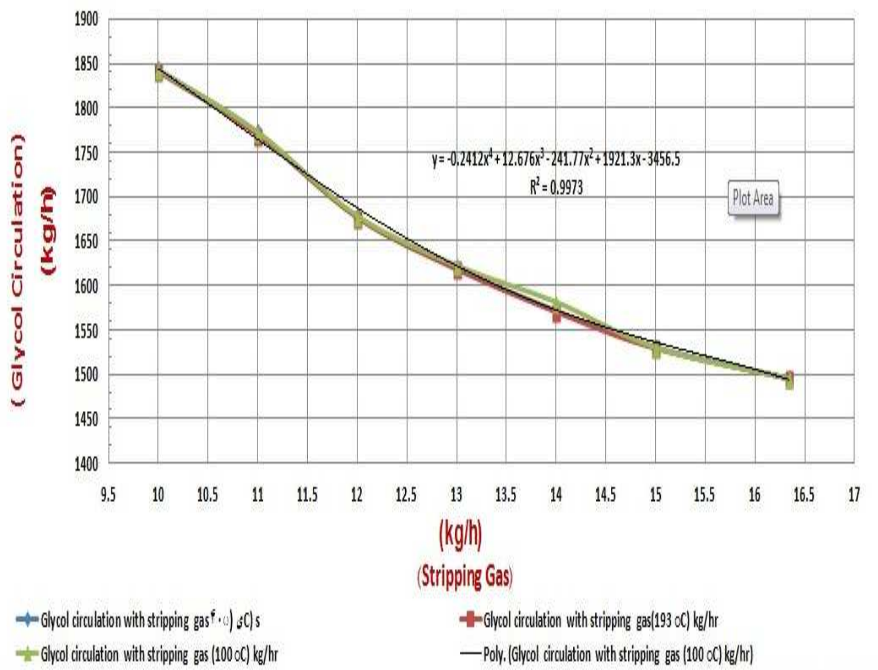


Graph (7) the concentration of glycol (stream220) with Stripping Gas with three different temperatures (40,100, 193°C)



Graph (8) the concentration of glycol (stream230) with Stripping Gas with three different temperatures (40,100, 193ºC)

According to the graphs (8) and (9) by increasing the amount of stripping gas flow the concentration of glycol in circulation increased and by decreasing the amount of stripping gas flow the concentration of glycol in circulation decreases. Previously described. The glycol concentration and temperature of the re boiler greatest impact on reducing dew point the gas outlet. Also with regard to the results of the study the increasing stripping gas temperature doesn't effect in amount and the glycol concentration. Amount of stripping gas the only factor influencing the concentration of glycol in circulation.



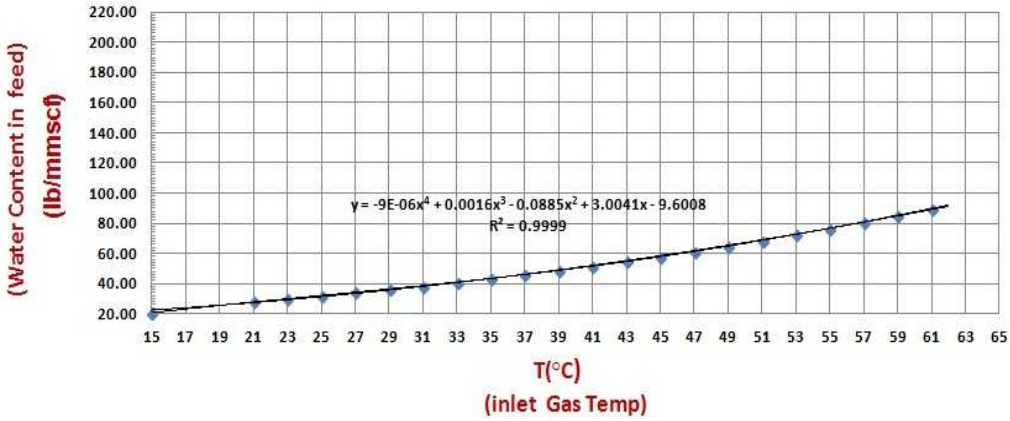
Graph (9) mass Flow Glycol Circulating Rate with stripping gas

As indicated in the diagram (9) is observed by reducing the mass flow of glycolcirculation, amount stripping gas to the increase and increasing the mass flow of glycol the amount of stripping gas should be decrease. Another means for reducing the amount Lean glycol in circulation to achieve the same concentration must increase the amount of stripping gas. Effectiveness both of them in reducing water content in outlet gas is very important menstruating. It is mentioning by reboiling temperature decreases from the optimal point of (198-200°C) also had to reach the previous levels stripping gas flow rate increased. The uptake of gas aforementioned design mode (16.36 kg/h) glycol with vapor phase will lead to more waste.

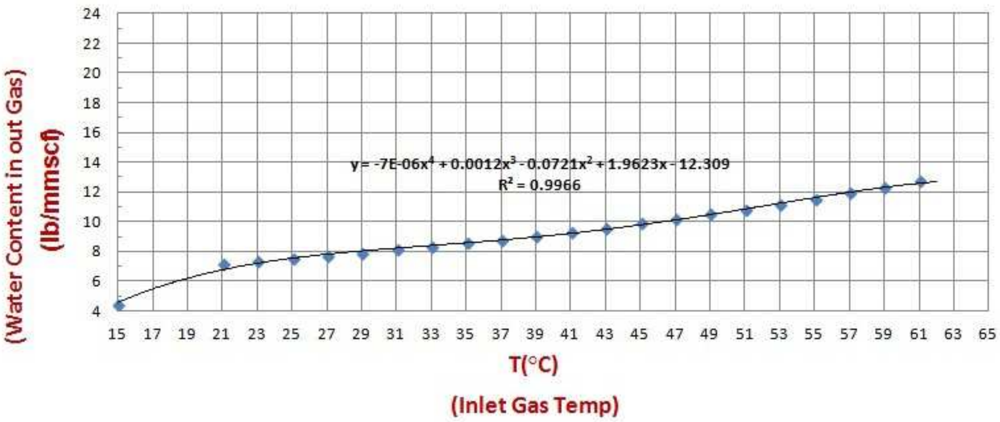
The effect of gas temperature

Since the gas temperature will change due to variations in ambient temperature, keeping constant the other parameters such as concentrations of Lean Glycol and water content of the inlet gas (synthesis gas) and the feed gas flow rate, the effect of gas temperature on the water content with outlet gas was investigated. Gas temperature in the design of PFD, in summer and in winter 45-60^{o}Cis intended. Since the maximum amount of water content with gas (gas-saturated water) dependent to gas temperature, with changes in simulation maximum water content with gas was determined. At about 60^{o}C greatest difference in water content, and gas inlet and outlet gas at its saturation point. Choose a temperature 60^{oC} as a worst case design is so designated. Dehydration systems to prevent foaming, the temperature of the glycol inlet the tower at about 5 ° C higher than the gas temperature are considered.

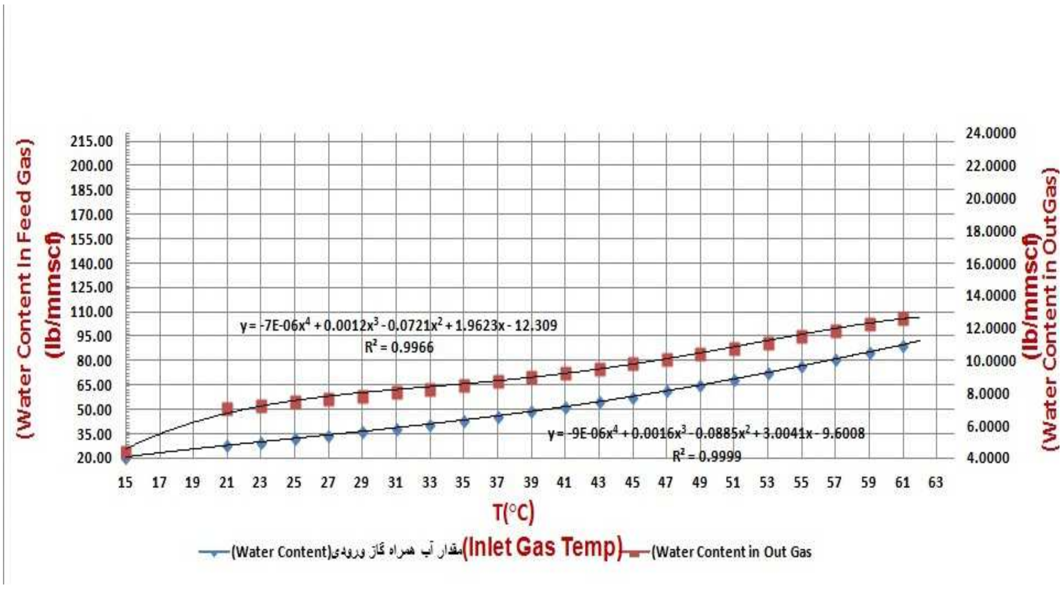
Otherwise causes the gas and glycol to contact not completely and as a result of Dehydration isn't accomplish, so in all cases 5 ° C difference between glycol and inlet wet gas was retained. The results in graphs (10), (11) and (12) are shown.



Graph (10) water content of the feed gas to the inlet gas temperature



Graph (11) water content of the outlet gas with inlet gas temperatures



Graph (12) -Water Content Of inlet and outlet Gas to the inlet gas temperature

CONCLUSION

In general, to achieve a suitable dew point, according to freeze the number of trays and Specifications of Tower, the two methods can be used. Changing The Circulation rate of glycol and increasing concentration of glycol. As we know, the first parameter to change due to adverse effects, are limited and do not have proper maneuver. The management of the effluent water, reboiler fuel gas consumption and gas stripping is required. The results suggest that to avoid saturated with liquid water to prevent the formation of hydrates in gas pipelines and, water dew point of outlet gas of the absorption tower at -5$^{\circ C}$ study stations in summer conditions and pressure is 49.13 bar .the purity of glycol is entering the absorption tower,. Gas water dew point will be lower output. In this regard, the simulation dehydration unit was done. The effect of process variables (such as reboiler temperature of glycol, regeneration unit, the stripping gas and temperature top of the glycol concentration towers, etc.) and the following results were obtained.

1-To achieve the desired concentration of glycol regeneration tower reboiler temperature of 200 degrees should be kept first and then injects stripping gas.
2. To prevent destruction TEG of regeneration tower with vapor output temperature must be kept at about 100 ° C.
3. If the reboiler temperature less than 200 degrees to achieve the desired concentration should be monitored for the amount of gas stripping to be increase, because it makes more destruction will be glycol.
4. dehydrating effect of gas temperature on the system, and changes in water level of input and output, indicates that the maximum difference in temperature 60^{oC} gas inlet and outlet of water in there.
5. glycol concentration affects is dew point, as a result of the reboiler heating and flow rate ofstripping gas are two important factor for glycol concentrations, with reboiler heating and amount of gas stripping , glycol concentration increased, thereby reducing the amount of glycol in Circulation. .
6 stripping gas temperatures doesn’t effect in amount and the glycol concentration. Mass flow of stripping gas the only factor influencing the concentration of glycol in circulation.
7. With regard to the results of this study showed that the stripping gas used in the study stations around 34 kg / h very high and can be reduced in its design range kg / h) 16.36 (the same concentration acquired.
8. In the temperature range 191- 194^{o}C, the lowest level of reboiler thermal load but circulating glycol in the range of 11-20% compared to the glycol circulating the reboiler temperature 200^{o}C increases, which in turn increased the capacity glycol, glycol pumps can influence pressure drop and power consumption.

(Table 2, 3: Comparison of Data from Simulation Software and Operational Information in design & different stripping gas values

Data from operation						Data from simulation						
Gas inlet	Reboiler Temp.	Stripping gas mass flow	Glycol circulation Mass flow	Rich Glycol from tower	Lean Glycol to tower	Gas inlet	Reboiler Temp.	Stippling gas mass flow	Glycol circulation Mass flow	Rich Glycol (stream150)from Glycol Contactor Tower	Lean Glycol (stream230) to Glycol Contactor Tower	Date
mmscfd	T(°C)	Kg/h	Kg/h	Mass percent	Mass percent	Mmscfd	T(°C)	Kg/h	Kg/h	Mass percent	Mass percent	
12.1	197	34	1467	97.7	99.7	12.1	197	16.36	1467	95.34	99.64	1394/07/25
13.9	197	35	1628	97.5	99.9	13.9	197	16.36	1628	95.22	99.60	1394/08/04
15.6	195	32	1635	97.3	99.6	15.6	195	16.36	1635	94.86	99.56	1394/09/04
15.1	198	36	1348	97.7	99.6	15.1	198	16.36	1348	94.4	99.67	1394/09/13
15.4	197	32	1432	97.2	99.6	15.4	197	16.36	1432	94.53	99.64	1394/09/19
20.8	195	33	1469	9608	99.8	20.8	195	16.36	1469	93.45	99.59	1394/09/25
21.7	196	34	1471	97.4	99.6	21.7	196	16.36	1471	93.28	99.60	1394/10/01
24.5	197	35	1625	98	99.4	24.5	197	16.36	1625	93.17	99.58	1394/10/07

Data from operation						Data from simulation						
Gas inlet	Reboiler Temp.	Stripping gas mass flow	Glycol circulation Mass flow	Rich Glycol from tower	Lean Glycol to tower	Gas inlet	Reboiler Temp.	Stripping gas mass flow	Glycol circulation Mass flow	Rich Glycol (stream150)from Glycol Contactor Tower	Lean Glycol (stream230) to Glycol Contactor Tower	Date
mmscfd	T(°C)	Kg/h	Kg/h	Mass percent	Mass percent	mmscfd	T(°C)	Kg/h	Kg/h	Mass percent	Mass percent	
12.1	197	34	1467	97.7	99.7	12.1	197	34	1467	95.50	99.87	1394/07/25
13.9	197	35	1628	97.5	99.9	13.9	197	35	1628	95.39	99.85	1394/08/04
15.6	195	32	1635	97.3	99.6	15.6	195	32	1635	95.03	99.80	1394/09/04
15.1	198	36	1348	97.7	99.6	15.1	198	36	1348	94.56	99.90	1394/09/13
15.4	197	32	1432	97.2	99.6	15.4	197	32	1432	94.67	99.85	1394/09/19
20.8	195	33	1469	96.8	99.8	20.8	195	33	1469	93.59	99.83	1394/09/25
21.7	196	34	1471	97.4	99.6	21.7	196	34	1471	93.42	99.84	1394/10/01
24.5	197	35	1625	98	99.4	24.5	197	35	1625	93.32	99.83	1394/10/07

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