IBP1045_06

COST EFFECTIVE ALTERNATIVES FOR TRADITIONAL OFFSHORE TEG DEHYDRATION UNITS

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Abstract

Gas dehydration with TEG – triethylenglycol - in offshore units is a frequent choice in the Brazilian gas production and exploration market. Either for transport or re-injection, water must be removed from gas to avoid corrosion and hydrate formation. Offshore units restrictive layout outline process difficulties which must be solved during the engineering and construction phases. Offshore units tend to have vertical orientated layouts while onshore units are spread out horizontally. In floating units equipment location and orientation as well as proper instrumentation selection is crucial due to ocean wave motion. Options such as cooling with sea water are usually an advantage in offshore units, energy recovery and optimization in offshore units is an important factor that must be taken into account. This paper is aimed to share cost effective alternatives for traditional off shore TEG dehydration units.

1. Introduction

Gas dehydration may be accomplished using different technologies, the most common ones being solid desiccants and TEG units. Even though both processes are suitable for gas dehydration, each one has found its own niche in the oil and gas facilities. The main differences between them are their potential to remove water and their CAPEX. Since solid desiccants can achieve water dew points below -100 ºC they have conquered the LPG treatment processes where these very strict specifications are required. For other applications where water dew point restrictions are not as demanding, TEG units have clearly succeeded due to lower CAPEX.

Offshore and principally FPSO's dew point requirements in the Brazilian market are not particularly strict due to the fact that gas is mainly used to artificially lift oil from wells, commonly known as gas lift. On the other hand, oil and gas processing on FPSO's and other offshore installations poses a significant challenge when it comes to space limitations, layout restrictions and weight on the offshore production unit.

Taking into account these restrictions and budget limitations, any possible optimization to a traditional TEG unit regarding equipment dimensions, quantity and weight, provides a significant competitive advantage.

2. Traditional TEG Units

2.1. Dehydration Section

Wet gas enters the plant through the gas inlet separator where liquids in the feed gas are separated. Gas then flows to the TEG contactor, rises through the absorber column where it contacts lean TEG that is injected at the top. Dry gas leaves the contactor through the top; a mist eliminator removes any entrained droplets and minimizes TEG losses. Before leaving the unit gas interchanges heat in the Gas x TEG heat exchanger with the lean TEG that flows to the contactor. This heat exchanger is usually designed to cool lean TEG down to approximately 5ºC above inlet gas

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temperature. Higher temperatures would increase TEG losses due to vaporization. A lower temperature might cause heavier components in the gas to condensate, which may cause foaming in the contactor.

2.2 Regeneration Section

In the “Regeneration Section” rich TEG flows from the contactor to the cold TEG x TEG heat exchanger before it enters the TEG flash separator where entrained gas and liquid hydrocarbons are removed.

Rich TEG then flows through the filtration train: primary TEG cartridge filter, TEG charcoal filter and secondary TEG cartridge filter. The cartridge filters remove solids and carbon particles that may have slipped from the activated charcoal filter and the charcoal filter removes dissolved hydrocarbons and degradation products.

Rich TEG is then preheated in the hot TEG x TEG heat exchanger before it enters the regenerator column. At the regenerator, heat is provided to evaporate water and volatile components and to strip off any left over dissolved gas.

Lean TEG then flows through the hot TEG x TEG heat exchanger as it leaves the TEG regenerator through the TEG surge vessel. Cold TEG x TEG heat exchanger is designed to limit pumping temperature to typically 90ºC and optimize heat recovery.

Lean TEG enters the TEG circulation pumps and flows through the Gas x TEG heat exchanger before it enters the contactor.

Figure 1 shows a traditional TEG unit process blocks diagram and Table 1 shows some of the traditional operating values.

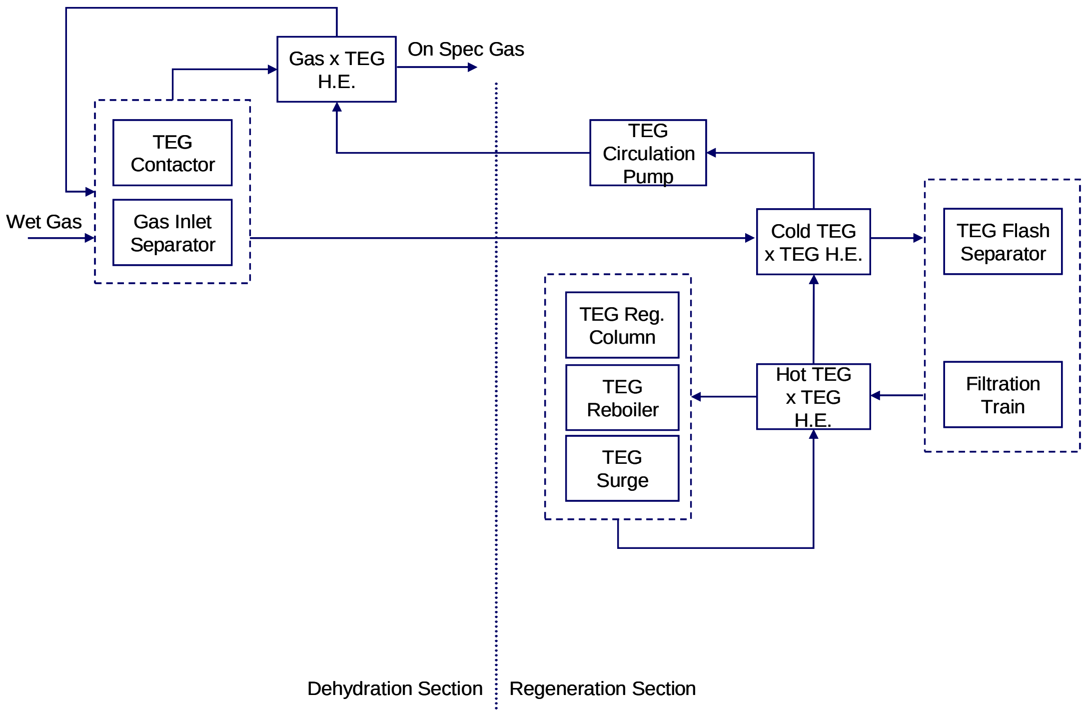

Figure 1 – Traditional TEG Unit process block diagram.

Table 1 – Traditional TEG Unit operating values.

TEG Contactor Pressure, barg	70 - 150
TEG Contactor Temperature, °C	30 - 50
TEG Flash Drum Pressure, barg	3 - 8
TEG Flash Drum Temperature, °C	70 - 90
TEG Regeneration Temperature, °C	204
Lean TEG Concentration, % mass	98.7

3. Cost Effective Alternatives

Subtle differences can significantly reduce capital cost in a TEG unit. In view of the restrictions mentioned above in this paper, the following paragraphs show some cost effective alternatives to traditional TEG units. Alternative

"A" shows how a good knowledge of the inlet gas composition can reduce CAPEX in heat exchangers. Alternative "B" shows how a higher TEG concentration can be achieved using stripping gas within the regenerator.

3.1 Alternative A

On traditional FPSOs TEG flash separators operate at temperatures in the range of 70-90 ºC. Since TEG contactor normally operates at temperatures below 60ºC, rich TEG flowing to the flash separator needs preheating. This is usually achieved by means of the cold TEG x TEG heat exchanger where rich TEG flows from the contactor to the flash separator and lean TEG flows from the TEG surge vessel to TEG circulation pumps. One of the reasons for this high operating temperature is that the two liquid phases are more easily separated. Another reason is that at higher temperatures BTX and VOC are more easily released in the flash separator. These contaminants may be either discharged to flare or used as fuel gas instead of venting them directly to the atmosphere at the TEG regenerator column.

However a good knowledge of inlet gas composition may allow the flash separator to operate at a lower temperature. If BTX and VOC are not significantly present in the inlet gas, a higher temperature at the flash separator is not essential. This enables the flash separator to operate at, around 60ºC and hence the cold TEG x TEG heat exchanger can be eliminated.

Heat must be removed from the top of the regenerator column to generate a reflux. Since the TEG contactor column operating temperature is below 60ºC some heat may be recovered by sending rich TEG through a coil at the top of the regenerator column. The coil, acting as a condenser, generates this required reflux that may be easily controlled with a manual by-pass on the rich TEG line. The recovered heat increases the rich TEG temperature several degrees centigrade with little capital cost.

To help separating the two liquid phases, a coalescer is included in the flash separator. The coalescer makes up for the lower temperature in terms of hydrocarbon recovery and liquid phases separation. Since glycol circulation is low, extra retention time also enhances separation without adding extra cost by slightly increasing the size of the flash separator.

Figure 2 and Table 2 show a process block diagram and some operating values of this alternative.

Table 2 – Alternative A operating values.

TEG Contactor Pressure, barg	70 - 150
TEG Contactor Temperature, °C	30 - 50
TEG Flash Drum Pressure, barg	3 - 8
TEG Flash Drum Temperature, °C	**50 - 75**
TEG Regeneration Temperature, °C	204
Lean TEG Concentration, % mass	98.7

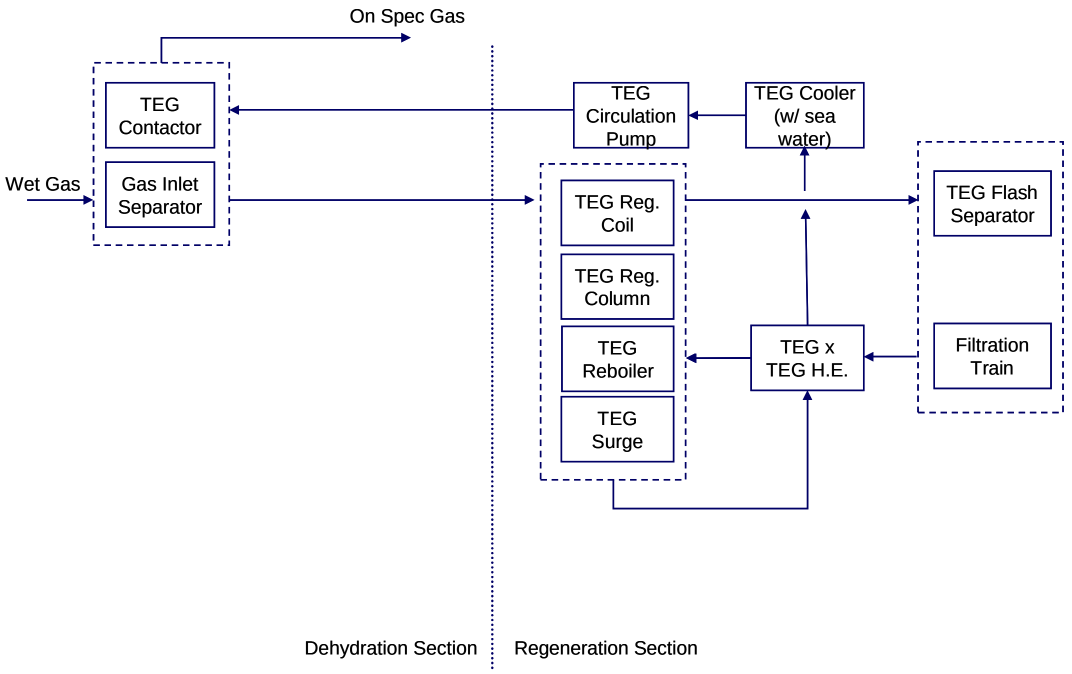

Figure 2 – Alternative A process block diagram.

3.2 Alternative B

The simplest TEG regeneration process achieves concentrations of 98.75 % (w/w). To achieve higher concentrations of TEG and remove higher amounts of water, alternatives such as gas stripping must be considered. Stripping gas may be taken from the TEG flash separator or from another gas source. Higher TEG concentration and other operating values for this alternative are shown on Table 3.

Table 3 – Alternative B operating values.

TEG Contactor Pressure, barg	70 - 150
TEG Contactor Temperature, °C	30 - 50
TEG Flash Drum Pressure, barg	3 - 8
TEG Flash Drum Temperature, °C	50 - 75
TEG Regeneration Temperature, °C	204
Lean TEG Concentration, % mass	**99.2 – 99.9**

Traditionally stripping gas is injected at the reboiler. In order to obtain higher TEG concentration a separate stripping column may be used. This implies a significant extra cost, attributed not only to the separate stripping column but also to the associated piping and pumps, if required.

However, by injecting stripping gas at the surge drum and adding an equilibrium stage between the surge drum and the reboiler (Stahl´s column), TEG concentration is greatly increased at a very low extra cost. Further more; the separate stripping column may be eliminated. Figure 3 shows alternative B process blocks diagram.

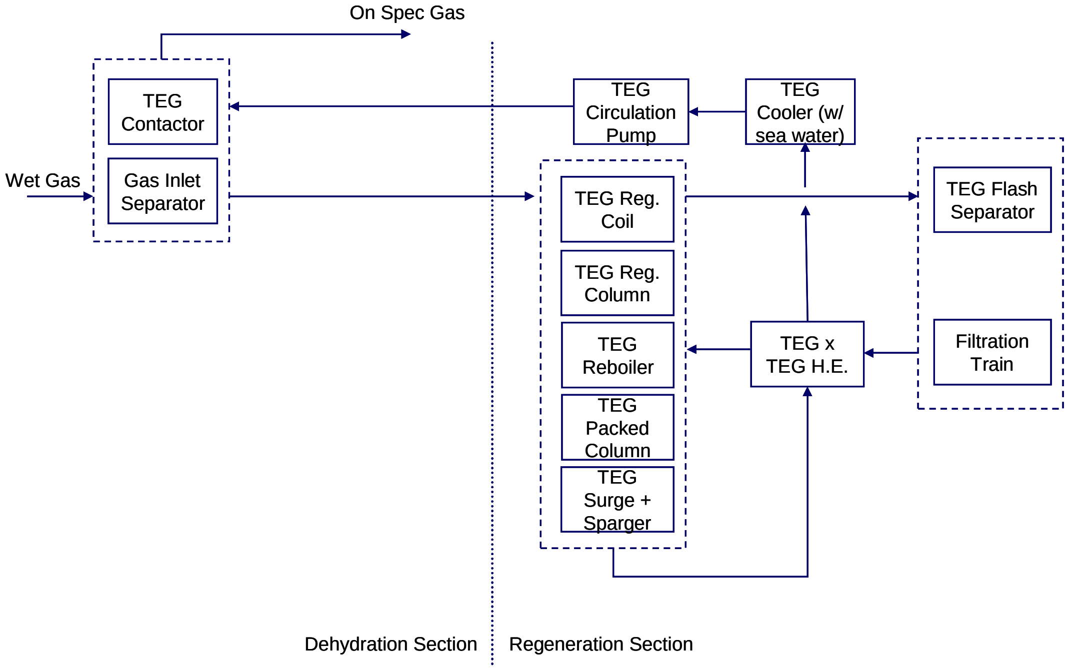

Figure 3 - Alternative B process block diagram.

Given the water content of the inlet gas and the dew point requirement, a higher TEG concentration allows reducing circulation and hence reducing line size, equipment size and pumping costs. Although sometimes a high TEG concentration is simply a client's specification.

4. Other Possible Alternatives

4.1 Sea Water and Layout

In many offshore installations, cooling sea water is available as a service. TEG temperature may be adjusted using a sea water x lean TEG heat exchanger instead of a gas x lean TEG heat exchanger. Since the sea water x lean

TEG heat exchanger can be located upstream of the TEG injection pumps and downstream of the regenerator, the heat exchanger can be designed both, shell and tube sides, at low pressure. This alternative has a lower pumping temperature which is technically more convenient and a lower capital cost due to lower design pressure (rating reduced from 600# / 1500# to 150#). The relocation of the heat exchanger implies that the net positive suction head available for the TEG circulation pumps must be verified.

Offshore installations may have a reduced or restricted footprint, but tend to have less vertical limitations. Modules can be stacked one on top of the other giving the TEG unit a vertical orientation. Taking into account the net positive suction head required by the TEG circulation pumps, they should be located on the bottom floor. The atmospheric regenerator should be located on a higher level and the suction heat exchangers should be designed in such a way that the pressure drop is low enough to have the adequate positive suction pressure. Figure 4 shows an example of this equipment distribution: TEG circulation pumps are on bottom floor and TEG regenerator is located on the second floor.

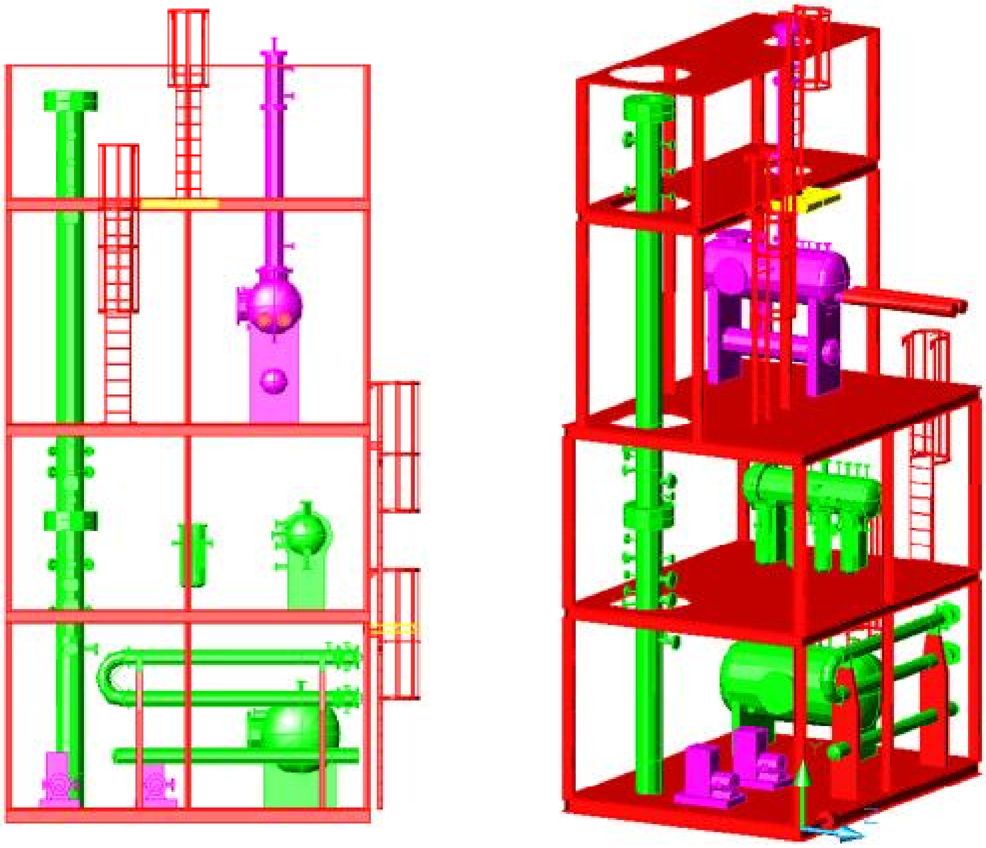

Figure 4 – TEG Unit layout.

On FPSOs, another issue to have in mind when defining the layout is the equipment location relative to ship center line. Vessels and ship longitudinal axes should be parallel so that ocean wave motion effect is minimized.

4.2 Level Instruments

Instrument selection is crucial in order to achieve, during operation, design requirements. Particularly, on floating offshore installations or FPSOs, level instruments are critical since they have to deal with pitch and roll effects. They should be mounted on external chambers or "stand pipes" so as to minimize the turbulence inside them. It is also very important to locate level transmitters near the centre of the vessel and to dampen level signals to avoid level alarms activation due to ocean wave motion.

5. Conclusions

In projects where well known technologies are used, cost effective alternatives are hard to come by. When facing this kind of projects, subtle adaptations to the traditional technologies will make the final design a cost effective one. There are many solutions to a given problem so projects should be looked at as a whole in order to find the economically viable modifications that will make the difference.

6. References

CAMPBELL, JOHN M., Gas conditioning and processing, Vols. I & II, 8th Edition.
GAS PROCESSORS ASSOCIATION, Engineering Data Book, Section 20.
MANNING, WILLIAM, WOOD, HAROLD, Guidelines for glycol dehydrator design, Part I.
KOHL ARTHUR, NIELSEN RICHARD, Gas Purification, 5th Edition.
GHOSBAL, P. C., MUKHOPADHYAY SUMIT, Improve glycol dehydration unit efficiency.