The CONTACTOR™

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Dehydration Using TEG

Gas from offshore platforms is usually transferred onshore for processing via a pipeline laid on the ocean floor. The combination of low temperature and wet gas can result in gas hydrates completely plugging the pipeline. This can be prevented by either removing the water using on-platform dehydration or by using small amounts of an inhibitor such as methanol or a glycol. This issue of The Contactor presents part of a previously published† case study showing how the capacity of a severely constrained TEG train in an offshore facility was increased.

Case Study

This was a fairly conventional TEG unit for taking a high pressure well-head gas to a –5°C dew point (about 50 ppmv at the operating pressure) for transfer via pipeline to an onshore LNG production facility. Additional stripping of the lean solvent was done by sparging dry stripping gas (98.5% methane, balance water) directly into the regenerator's reboiler (Figure 1).

One of the issues with the unit was traced to a capacity limitation of the lean glycol charge pump that happened to be operating in a poor region of the pump curve, and unfortunately, its performance could not be improved. Inadequate pumping ability made the liquid level in the accumulator rise periodically and trip on high level. The bottleneck to pump capacity in this case was the very high viscosity of the stripped solvent at the then-current operating temperature of 42°C. Table 1 shows the temperature dependence of lean-solvent viscosity at the point of entry into the dehydration column.

The only way to allow the second pump to handle the required flow was to lower the viscosity of the glycol. The lean glycol would have to be run at 50°C, hotter than desired. However, running the glycol hotter appears on the surface to be completely divergent to meeting the water dew point specification, at least according to the dew point charts.

Table 1 Temperature Dependence of TEG Viscosity

Temperature (°C)	TEG Viscosity (cP)
30	40.0
42	24.5
50	17.6
60	12.1

The lean TEG water content is generally 0.8–0.9 wt% (TEG strength of 99.1–99.2 wt%). The rich glycol was 3.5–4.0 wt% water. With no stripping gas to the reboiler, the expected lean water content of TEG is about 1.2 wt% (98.8 wt% TEG). Referring to the GPSA Data Book‡, Figure 60–28 shows that 98.8 wt% TEG won't meet the –5°C dew point specification; 99.2 wt% TEG at 42°C could produce a dew point of –12°C, but the same solvent at the temperature of 50°C needed to debottleneck the charge pump would be marginally unable to produce on-specification gas. The dew point would be only –4°C. From the charts it is evident that as the lean glycol temperature increases (no matter the TEG strength), the treated gas water dew point will also rise.

It's important to note that this analysis assumes the temperature of the lean solvent feed to the tower determines the moisture content of the dried gas. Using this

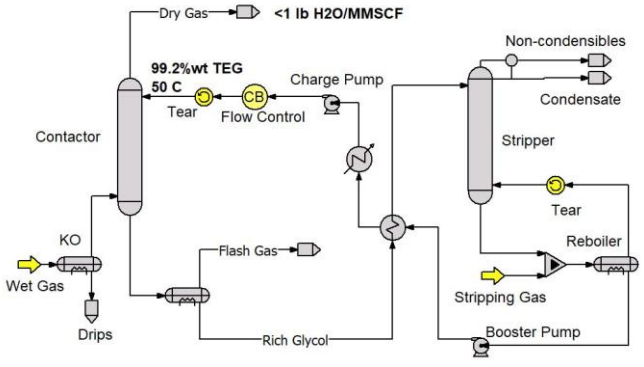

Figure 1 TEG Unit for Simulation

† M.H.Sheilan & R.H.Weiland, *Evaluate the Cause of Reduced Capacity in a TEG Dehydration System,* Hydrocarbon Processing, January–February, 2017

‡ *GPSA Engineering Data Book*, 12th Edition, Electronic, Figure 20–68, Page 20–34, Gas Processors Association, Tulsa, Oklahoma, 2004.

temperature has the implicit assumption that the temperature in the tower is the entering temperature of the lean TEG. How valid is this assumption, and what does a mass transfer rate-based simulation tell us? The ProTreat® simulator used for this study has a mass and heat transfer rate-based glycol dehydration module and, as will become apparent, it is an excellent tool to answer this question.

The Contactor contained 3.4 meters of a fine-crimp structured packing; the stripper had random packing. The absorber pressure was 106 bara (10.6 MPa). Wet gas was mostly C_1 with a small amount of CO_2 and C_{+2}.

At the initial 42°C lean TEG temperature, simulation predicted the lean solvent would be 99.21 wt% TEG, in perfect agreement with the measured value of 99.1 to 99.2 wt%. The dehydrated gas was predicted to contain 1.907 lb of water per MMscf. At the operating pressure of 106 bara, this corresponds to a dew point of –15°C (+5°F), quite a bit in excess of requirements.

The simulation was rerun with a 50°C lean TEG temperature. The results were nearly identical to the 42°C case. Increasing the lean solvent temperature by 8°C caused virtually no change in the dry case water content! This was quite a surprise! The simulator then was used to experiment further over the solvent temperature range 30–60°C. The results were much the same— the dried gas moisture level was unresponsive to lean TEG temperature. What is the reason for this surprising result?

The actual temperature of the inlet gas was 38°C. Simulations were run in 5°C steps. The results are summarized in Figure 2. The wt% TEG shown with each line correlates with the temperature of the wet feed gas color coded in the legend. The astonishing observations are that:

- The moisture content of the dried gas ***depends on the wet gas temperature***.
- For each wet gas temperature, it is nearly completely ***independent from the lean TEG temperature***.

This runs counter to conventional wisdom and it suggests that, at least in this case (and in most dehydration units), estimating the likely dry gas moisture content on the basis of lean glycol temperature is quite erroneous. If one inlet stream or the other must be used, the estimate can be made best using the *lean glycol* water content and the wet *feed gas temperature*. To understand why this is so, consider the mass flow rates of glycol versus gas. In the present case, the gas-to-glycol (G/L) mass flow rate ratio was 40 to 1. The gas phase dominates thermally.

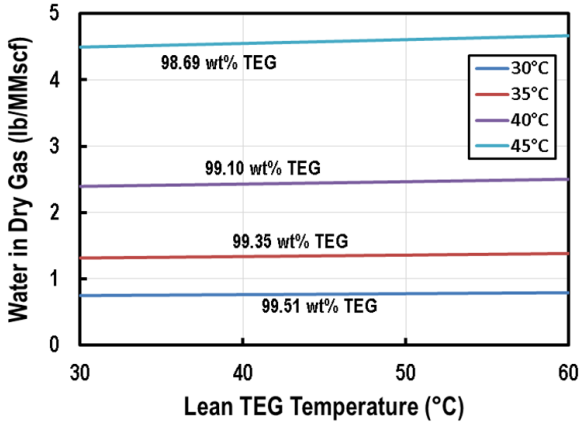

Figure 2 **Dependence of Dried Gas Moisture Content on *Lean TEG Temperature*.**

Figure 3 shows that temperature throughout the column, including the glycol phase, is set by the inlet gas temperature, moderated by the small glycol flow slightly heating the gas. By the time the gas has almost reached the top of the absorber it's already dry, but at the gas temperature—the lean glycol temperature is almost irrelevant.

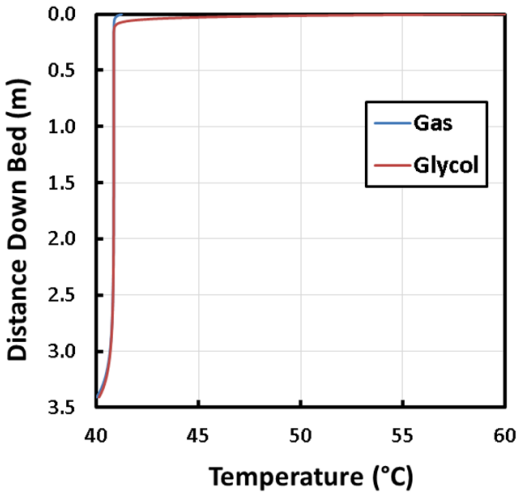

Figure 2 **How Temperatures Change in the Absorber with 60°C Glycol and 38°C Gas**

The key to discovering this surprising process insight into glycol dehydration is the picture provided by the temperature profiles available from ProTreat's unique mass and heat transfer rate-based tower model.

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