The CONTACTOR™

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Stahl Columns — An Alternative to Mol Sieves

The achievable moisture content of a gas being dehydrated using glycol is almost entirely controlled by the *dryness of the lean solvent* (glycol) and the *temperature of the wet inlet gas*. On the solvent side, dried lean solvent is obtained by regeneration of the wet glycol. Concerning the controlling temperature, only a small solvent flow is needed to treat a large gas flow so the L/V ratio in a dehydration column is usually quite small. The thermal mass of the solvent flow relative to the gas is therefore too small to greatly affect the gas temperature in most of the absorber. Thus, contrary to popular belief, most of the dehydration column is usually close to the temperature of the entering gas†, not to the temperature of the lean solvent (except at the very top of the column where the gas rapidly cools or heats the glycol).

From a process standpoint, the conventional reboiled regenerator has a serious, inherent weakness. The dehydrating agent is saturated steam, but water is the very component one is trying to remove from the solvent. There is no carrier or diluent for the removed water; in other words, there's no place for the stripped water to go except into the already saturated steam. The driving force for stripping out the water is the difference between the equilibrium and actual water content of the vapor. No matter what one does, these quantities are very nearly equal throughout most of the column; there is just little or no driving force for stripping water from the solvent when the vapor is already almost all water anyway. This is the flaw in the solvent regeneration side of the process, but it can be overcome by providing a diluent gas to envelop the water vapor.

To a very limited extent, this diluent is already provided by the gases that dissolved into the glycol in the dehydration column (usually at high operating pressure). But they are released near the top of the column where they are immediately swept out, and so do the least good because they have such a small volume of the column in which to operate. In any case, their concentrations are usually far too low to have a significant dilution effect; they may contain some of the very components having significant sales-gas value so we want to keep them with the sales gas; or they may be components with serious environmental concerns if released into the atmosphere with the stripped water vapor. Incidentally, most glycol regenerators are refluxed. This provides no benefit to dehydration because putting some of the already stripped water back into the column is counterproductive. Condensate is recycled *to recapture glycol* from the vapor via a water wash, not to enhance dehydration.

The boiling of solvent in the reboiler is what is chiefly responsible for stripping water from the wet glycol. The column itself contributes very, very little. What small benefit it has is to a considerable extent destroyed by returning reflux water to the top of the regenerator to recover glycol vapor before it escapes from the system with the removed water. At best, the reboiler is a single ideal stage of contact and the rest of the regeneration system, mostly the column, is functionally dormant as far as water removal is concerned. To activate the column itself requires use of a stripping gas to dilute the stripped water vapor and encourage further evaporation. This is the principle behind the Stahl column.

Case Study

Our focus here is on whether it is possible in principle to regenerate triethylene glycol (TEG) to a moisture level capable of drying methane to below 0.1 ppmv H_2O, the generally accepted maximum moisture level recommended for gas entering the liquefaction section of an LNG train. It goes without saying that this is not possible using only a reboiled regenerator. Conventionally, molecular sieves are used to reach such a low moisture content. Our contention, substantiated via simulation, is that a Stahl column can easily enable reaching the same low water content while keeping temperatures below TEG's decomposition limit.

For the sake of being specific, the gas being dried is assumed to be primarily wet methane with small amounts of other hydrocarbons at 35C and 105.9 barg (1,535 psig). Figure 1 shows a schematic of the process flowsheet. The callouts display OGT | ProTreat® simulated results for key streams.

A **Stahl column** has been added to the regeneration section immediately below the reboiler of the conventional regenerator. A small slipstream (0.025% of the fully dehydrated

† Michael H. Sheilan & Ralph H. Weiland, *Evaluate the Cause of Reduced Capacity in a TEG Dehydration System*, Gas Processing, January/February, 2017.

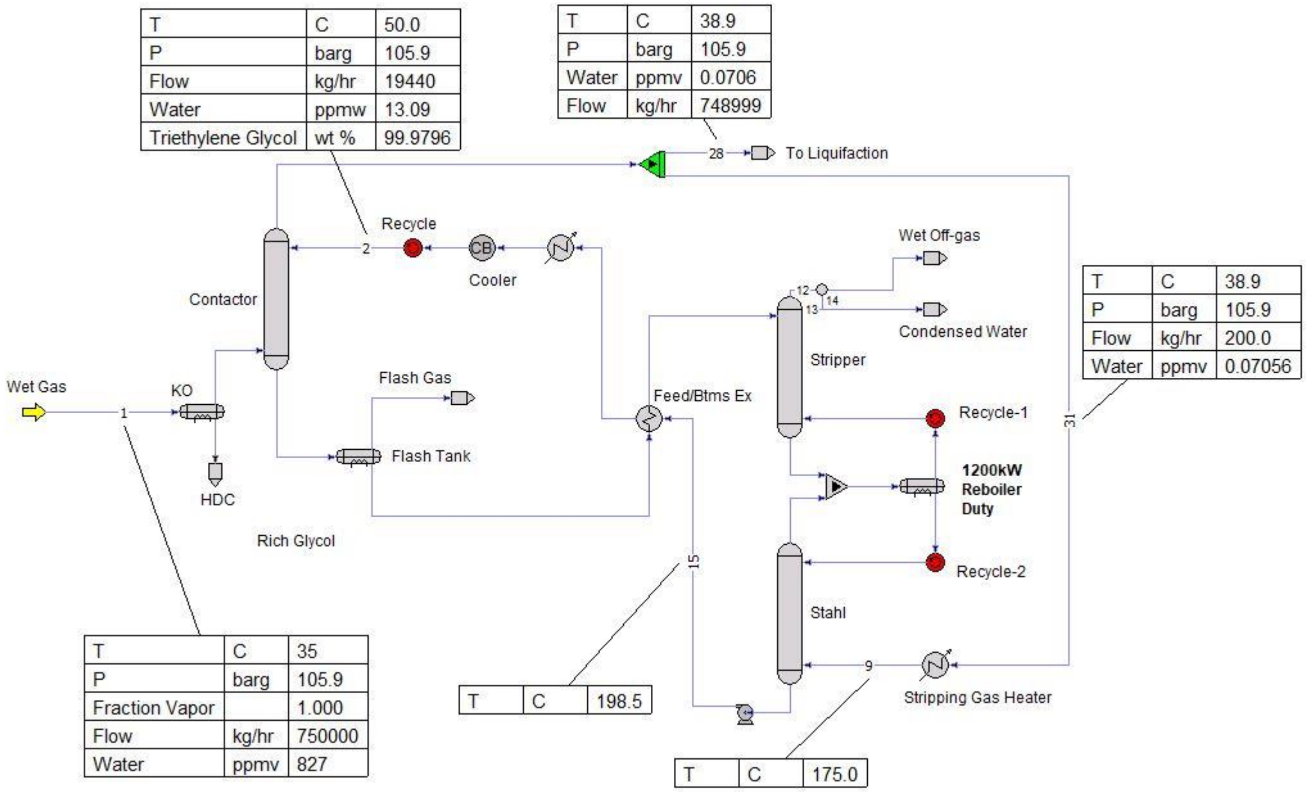

Figure 1 **Flowsheet for Gas Dehydration Using TEG and a Stahl Column**

gas) flows to the bottom of the Stahl column where it will act as very dry stripping gas. The Contactor, Stripper, and Stahl columns contain 10-m of MellapakPlus M452.Y of structured packing, respectively. None of these columns is particularly tall and all are well within reasonable flooding levels from 25% for the Stahl column to 71% of capacity for the Contactor. The L/G ratios are typical for glycol dehydration units so an unusual hydraulic situation in any of the columns is not expected.

The TEG coming from regeneration is only 0.00130 wt% water (99.9796 wt% TEG) which at 50C can produce 0.07 ppmv water in the dry gas. The tiny stripping gas stream (only 200 kg/h or 0.025% of the dry gas flow) enables the Stahl column to produce extremely dry solvent.

Conventional dehydration of the gas feeding the compression section of an LNG facility uses TEG for bulk water removal followed by molecular sieves to lower the moisture content to a suitable level. Recently, Carmody‡ presented an interesting paper in which he suggested using the approach being described here. Without access to a mass transfer rate-based simulator, however, his analysis could not connect ideal stages to actual towers with real internals. Here we've shown that a TEG system alone can achieve dehydration very satisfactory for gas liquefaction in an LNG plant _without using molecular sieves at all_.

Figure 2 shows that the residual moisture content in the treated gas is readily controlled by the stripping gas flow to the Stahl column and that in all cases this flow is only a tiny part of the treated gas (0.0067% to 0.05%). The powerful rate basis of OGT | ProTreat reveals the potentially great utility of the Stahl column. The potential savings offered by eliminating mol sieves from the process can be quite substantial.

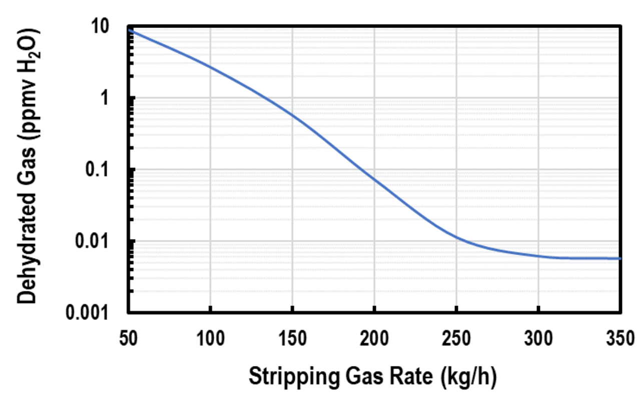

Figure 2 **Stripping Gas Flow Easily Controls Dryness**

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‡ Paul A. Carmody, Designing Glycol Dehydration Units that Utilize Stahl Columns with Stripping Gas, Laurence Reid Gas Conditioning Conference, Norman, OK, Feb 24–27, 2020.