The CONTACTOR™

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Physical Solvents – DMPEG

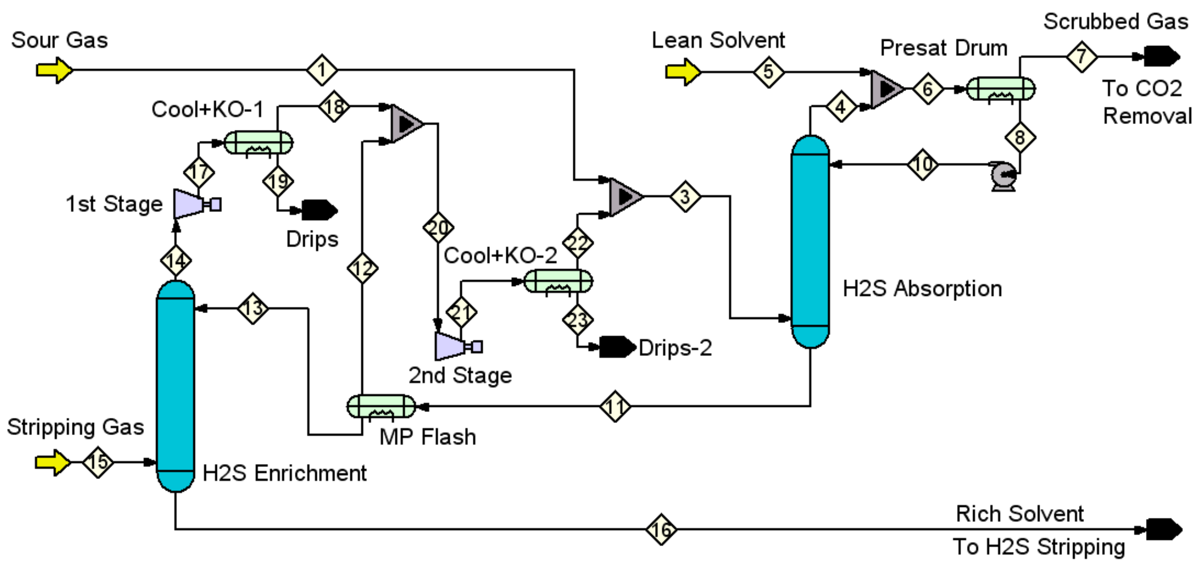

Figure 1 Example Physical Solvent Flowsheet: H_2S Removal & Enrichment Section

Introduction

Until now, Optimized Gas Treating, Inc. has focused exclusively on treating with amines. However, we recognize there other classes of solvents being used. They include physical solvents such as the alkyl ethers of poly(ethyleneglycol), (SELEXOL™, Genosorb®, Coastal AGR), methanol (Rectisol®), and *N*-formylmorpholine (Morphysorb®), as well as hybrid solvents (Sulfinol), amine-promoted HotPot (K_2CO_3), and caustic soda. We have just concluded a major effort developing the ProTreat™ simulator's framework to allow simulation of whole new ranges of solvents. This note uses the dimethyl ether of poly(ethyleneglycol) (DMPEG) to introduce our new physical-solvent simulation capability using the no-guessing, mass transfer rate-based approach.

Physical Solvents *versus* Amines

In the first step of any absorption process, the absorbing gas dissolves *physically* into the solvent. In amine systems the solvent is mostly water, and the acid gases are not very soluble in water. Amines acquire their high solubility for acid gases by reacting chemically with them. But, the chemical reactions are exothermic so there are large temperature bulges in absorbers, and regeneration energy needs are high.

In physical solvents there are no chemical reactions—the gases have a naturally high solubility in a good physical solvent—temperature bulges are smaller, and regeneration energy requirements are generally lower. What makes a good physical solvent? For acid gas and water removal, the solvent should be polar because the acid gases are polar (in terms of polarity, $H_2O > H_2S > CO_2$). Since like dissolves like, it stands to reason that DMPEG, being polar, is a good solvent for these components but a poor solvent for aliphatic (non-polar) hydrocarbons. DMPEG's high molecular weight (average molecular weight depends on brand but is about 280) gives it a high boiling point (low vapor pressure) but it also results in higher BETX solubility.

It is worth noting here that H_2S has a higher solubility in DMPEG than CO_2 does, making DMPEG somewhat selective for H_2S. However, selectivity is better achieved by clever flowsheet design. Note, too, that DMPEG's high affinity for water permits treating and dehydration in one step. And, because of its low heat of absorption and co-absorption of light-ends, DMPEG can be mostly flash regenerated. In fact, considerable temperature drop can be realized as the solvent is flashed to lower pressures permitting additional heat integration opportunities vs. amines.

The flowsheet of Figure1 is an adaptation of Johnson's and Homme's (1984) Figure 3 for the La Barge, Wyoming plant of ExxonMobil. The gas is very high CO_2 (65%) with only 4.5% H_2S, 8% N_2 and 22% methane with 0.5% helium. We assumed gas at 1,000 psig and 100°F and determined the flow to be 200 MMSCFD by sulfur balance. For simulation, we assumed the solvent was 98 wt% DMPEG with 2 wt% water. We assumed an intermediate flash pressure of 500 psig (1 compression stage at 2:1 to reach feed) and an enrichment tower at 200 psig (1 compression stage at 2.5:1 to reach intermediate feed). Columns were assumed to hold #50 IMTP random packing, and they were sized for 60% flood.

Temperature profiles are always revealing of tower operation. Figure 2 shows how circulation rate affects internal temperatures in a 50-ft H_2S absorber.

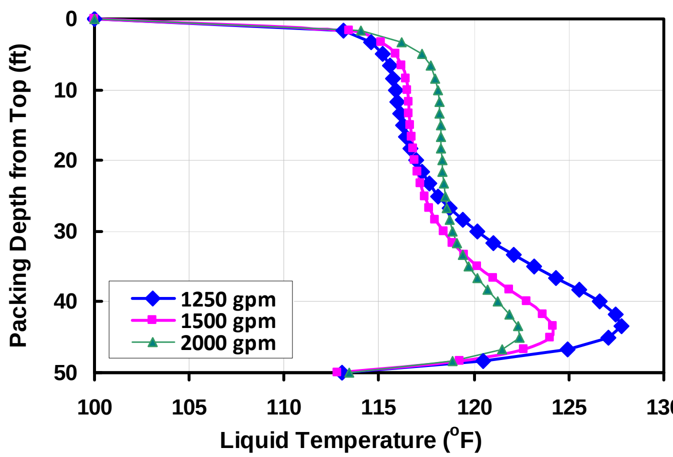

Figure 2 H_2S Absorber Temperature Profiles

Temperatures are well above the gas and solvent inlet values throughout the column, while lower solvent rates give a more pronounced temperature bulge. The reason for the bulge is H_2S removal which, as expected, is much greater near the gas inlet and, of course, low circulation generates a larger bulge.

H_2S drops exponentially with distance up the tower. Figure 3 shows the CO_2 concentration actually rises as the gas passes up the tower because H_2S is being removed.

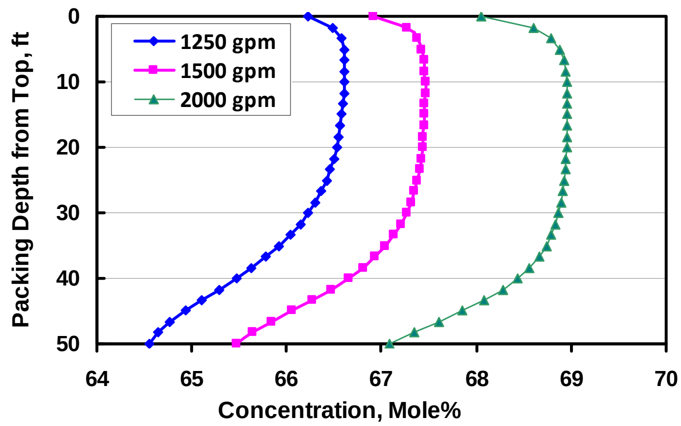

Figure 3 Absorber CO_2 Gas Composition Profile

Selectivity of DMPEG deserves mention. Figure 4 shows how solvent rate to the absorber and stripping gas rate to the enriching column affect Claus plant feed quality. Too high a solvent flow absorbs too

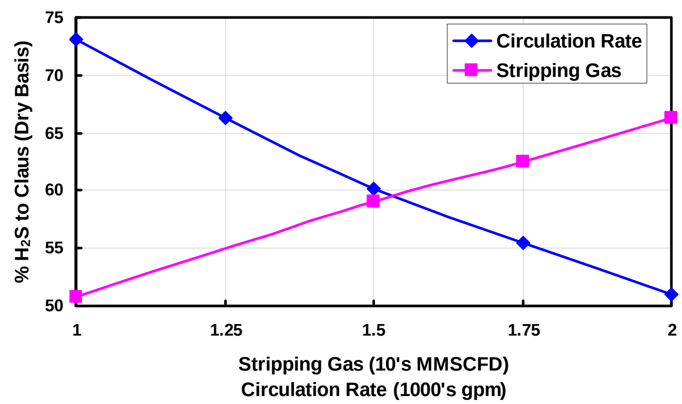

Figure 4 Flows Affecting Claus Feed Quality

much CO_2 and lowers quality, while higher stripping gas rates improve quality by rejecting more CO_2. There is no question that DMPEG can be made highly selective. In this instance we have taken a feed with 4.5% H_2S in 65% CO_2 and produced a Claus feed with at least 65% H_2S—98% of the CO_2 has been rejected