

The CONTACTOR™

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An Amine Unit Direct Contact Condenser†

Before sending amine acid gas (AAG) to a sulfur recovery unit (SRU), its water content is usually reduced to as low a level as the coolant temperature will permit. This is conventionally done using an aerial overhead condenser and reflux drum arrangement (called a mechanical condenser here). However, in the unusual situation being considered here, there were concerns about freezing up the amine regenerator reflux condenser during frigid Northern winters. It was felt that a pumparound system might allow better utilization of larger air cooler temperature differences and the higher liquid (condensed water) flow velocities. This would provide a more freeze-resistant condensing system.

Case Study Background

This was a gas processing unit treating about 125 MMscfd in each of two parallel trains using 18 wt% aqueous DEA in a split-flow configuration. The sour gas was 13% H₂S and 4.6% CO₂, and quite high DEA loadings were used. The flowsheet with pumparound condenser loop circled is shown in Figure 1.

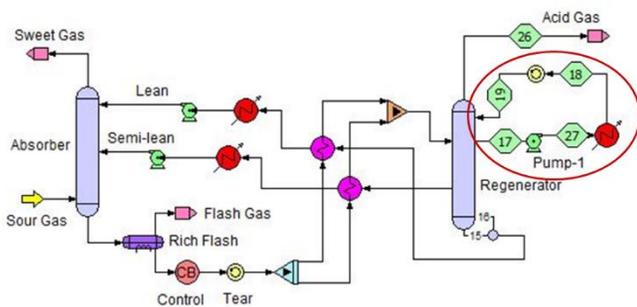


Figure 1 Split Flow DEA Unit with Pumparound Condenser (Circled in Red)

In this study, we evaluate the impact of pumparound water flow rate on acid gas temperature and water content of the SRU feed. Each train treats 125 MMscfd of a fairly sour gas (13% H₂S). The acid gas from the combined units represents about 1,325 LTPD of sulfur production — quite a large unit by any measure. The water content of the SRU feed can account for a significant proportion of the total feed to the unit. Thus any

reduction in water content of the AAG would be a worthwhile goal. The rich solvent (5,000 USgpm) is heavily loaded with acid gas (the H₂S and CO₂ loadings are 0.411 and 0.205 mol/mol, respectively). The semi-lean flow is 65% of the total solvent and it is taken from the 8th tray below the feed tray. The pumparound section contains six trays between the top of the column and the rich amine feed tray.

Simulations

ProTreat® simulations were run at several pumparound flowrates and a range of pumparound return temperatures. Regardless of the values of these two parameters in the range studied (reflux flows from 1,000 to 2,000 USgpm and reflux temperatures from 60°F to 120°F), absorber performance remained virtually unaffected. However, these parameters had a profound effect on the temperature of the acid gas, and therefore on its water content, as well as on the sulphur processing capacity of the SRU.

Figure 2 shows how the temperature of the acid gas responds to changing pumparound flow rate. Figure 3 shows the corresponding response of the AAG water content.

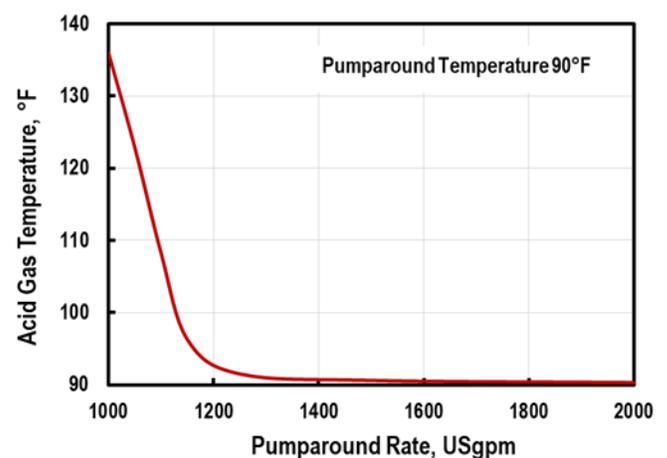


Figure 2 Response of Acid Gas Temperature to Pumparound Flow Rate

† With thanks D. John Morgan (Petroskills, formerly John M. Campbell) for suggesting this topic. John relates that the calculations were all

done by hand in the 1980s without knowledge of SWS pumparound condensers.

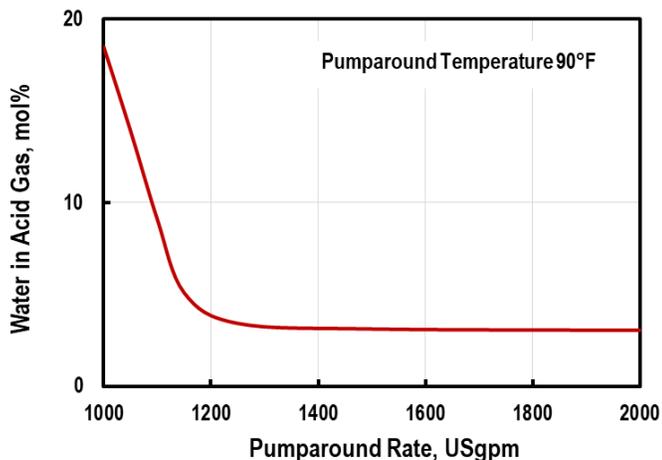


Figure 3 Response of Acid Gas Water Content to Pumparound Flow Rate

As a point of reference, one would normally operate the overhead condenser in an amine system at about 120°F. Under these conditions, the acid gas water content would be about 7.07 mol%. Under extremely cold conditions, the heat transfer medium (ambient air) might be well below zero Fahrenheit and it might be extremely difficult to ensure that the reflux flow (essentially water at 130 USgpm) does not freeze anywhere in the overhead condenser system, including the reflux drum and the piping.

It would probably be imprudent to try to take advantage of such a cold heat transfer fluid by running a mechanical condenser at, say, 60°F. However, at a pumparound flow of, say, 1,400 USgpm one could easily take the gas to 60°F or even a little lower with minimal risk of the high velocity flows freezing. Table 1 shows how water content is related to pumparound temperature at 1,400 USgpm flow rate. Note that the acid gas temperature is slightly higher than the pumparound return temperature but that the mechanical condenser is assumed to produce acid gas at precisely the condenser temperature. Thus, the mechanical condenser produces slightly cooler gas than the pumparound at the same nominal temperature.

Table 1 Water Content vs. Pumparound Temperature

Temperature (°F)	Mol% Water
60	1.33
75	1.88
90	3.04
120	7.42
Mechanical @ 120°F	7.07

If one is able to operate the pumparound condenser at 60°F (vs. 120°F for a mechanical condenser), the acid gas will contain only 1/5th the water. This is the second advantage of the pumparound system in this application. Not only is the possibility of a freeze-up of the mechanical system minimized, but

a much drier acid gas can be presented to the SRU and the 5% water that has been removed can be replaced with 5% more sulphur processing capacity.

Not discussed here is the provision of hydrocarbon liquid skimming required on the regenerator trap-out tray for stream 17 in Figure 1. This is akin to provision of hydrocarbon skimming in a conventional reflux drum.

This flowsheet is not a particularly complicated one for any modern process simulator, but one can only shudder to imagine the effort required to solve it manually, even once. The ProTreat® mass transfer rate-based simulator solved this problem in isolation in 24 seconds. As one in a series of case studies, each instance solved in just 3 seconds. How the rigors of process calculations have changed in the span of 35 years!

To learn more about this and other aspects of gas treating, plan to attend one of our training seminars. Visit www.pro-treat.com/seminars for details.

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