

The CONTACTOR™

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The H₂S Stripper in Two-Stage Sour Water Stripping

The most common configuration for a sour water stripper (SWS) is a single column in which both hydrogen sulfide and ammonia are removed from the sour water and discharged overhead to a sulfur plant. The stripping medium is generally steam, either generated in a reboiler or injected live into the base of the column.

It is sometimes advantageous to separate the hydrogen sulfide from the ammonia as two relatively pure streams; the H₂S comes from the first column (the H₂S stripper), and ammonia comes from the second column. This issue of The Contactor™ looks only at the H₂S stripper with a view to elucidating the effect of process configuration and operating conditions on performance.

Figure 1 shows a simple flow scheme for the H₂S stripper in which the Sour Water is preheated via cross exchange against hot bottoms from the ammonia stripper (not shown). The entire sour water stream is fed to the top of the stripping section of the tower. A small slip stream is taken from the fully stripped water and is fed to the top of what might be termed a wash section at the top of the tower. Here the clean water is used to remove ammonia coming from the stripping section in order

to purify the predominantly H₂S stream. The flow rate of wash water (10) is only a few percent of the sour water flow (2) although the vapor flows are similar in the two sections of the tower. The low liquid flow rate in the wash section suggests that this part of the tower will be of small diameter so it should probably be packed, while the much higher L/G ratio in the stripping section can be better accommodated by trays.

At the conditions used for the ProTreat® simulation of the scheme in Figure 1, the H₂S Product stream was nearly 19% water vapor with 77% H₂S and 4% NH₃. On a dry basis, this is 95% H₂S and 5% ammonia.

There is a simple way to improve on the hydrogen sulfide purity. A small part of the sour water can be fed at ambient temperature to a short packed section immediately above the stripping section. Thus, the sour water can be used as wash water in that part of the tower where the H₂S and ammonia concentrations are already high in the vapor phase as the result of stripping. Figure 2 shows this modification.

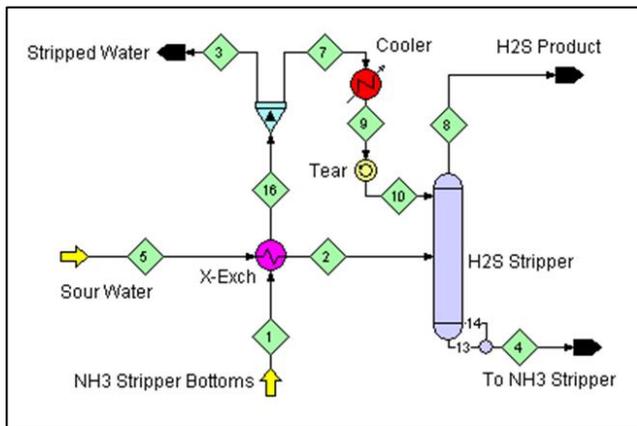


Figure 1 Simple H₂S Stripper

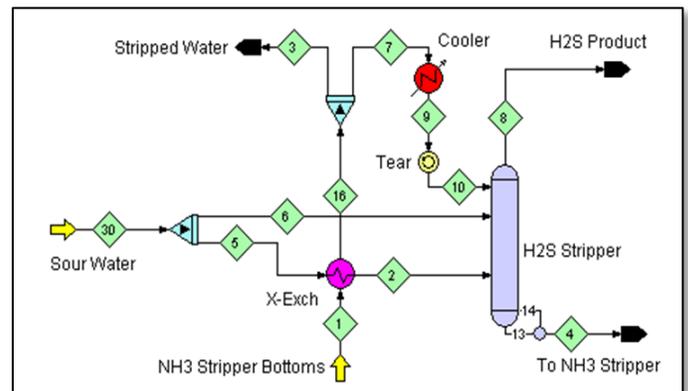


Figure 2 Improved Arrangement

ProTreat simulation showed that when only 10% or so of the sour water feed is diverted to a

short wash section just before joining the main flow onto the top of the stripping section:

- The H₂S Product stream is much cooler,
- Its water content is lower,
- Ammonia contamination is < 200 ppmv.

On a dry basis, the product stream is 99.8+ percent H₂S. Using cold sour water as wash water has removed a considerable amount of additional ammonia from the vapor leaving the stripping section and this has allowed the very small original wash water flow to cool the vapor further and finish the task of washing residual ammonia from the vapor.

Figure 3 shows the vapor temperature profiles for these two cases. With fully preheated sour water feed at full flow to the stripping section (blue line) the vapor experiences a limited temperature drop as it rises through the relatively warm feed tray. However, it then reheats as it meets oncoming hot liquid. It experiences no further cooling effect until it meets the very low wash water flow just as it leaves the column.

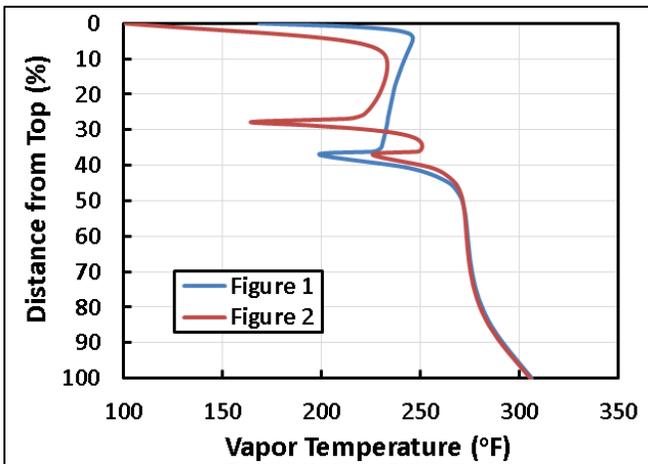


Figure 3 Vapor Temperature Profiles

Under the scheme of Figure 2 (red line) the vapor again passes through a warm feed tray with a smaller liquid flow so it experiences a somewhat lower temperature drop, but its temperature rises again when it meets relatively hotter liquid. However, when it meets the cold sour water flowing into the top of the short wash section, its temperature falls dramatically. Of course it heats up again as it meets the down flow of hot wash water, but it never reaches the temperature of the wash water in the original case.

The effect on the ammonia content of secondary washing with sour water is most easily seen from Figure 4. Without secondary washing,

the flow of fully stripped wash water to the top of the column is too low to wash out enough ammonia from the rising vapor to get the best H₂S purity. But with secondary washing the uppermost part of the wash section is presented with an already low ammonia concentration — one it is capable of removing. An additional, favorable factor is the lower temperature itself in this upper section.

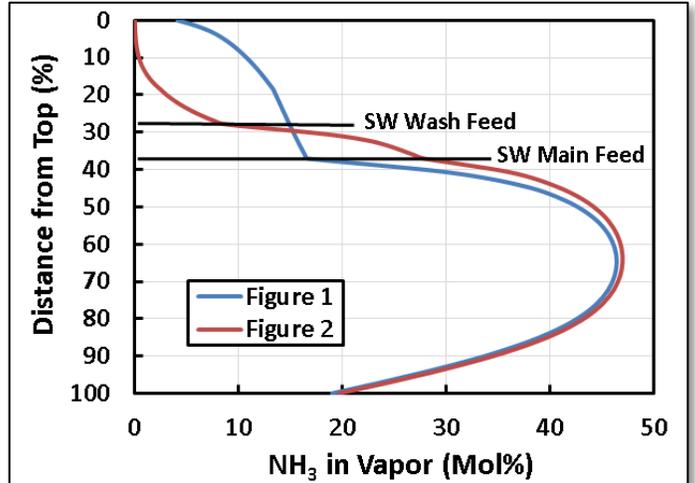


Figure 4 Ammonia Profiles

It may be of interest to note the very large bulge in ammonia concentration throughout much of the column's stripping section. Although hydrogen sulfide and ammonia, being acidic and basic, respectively, tend to trap each other in solution so that H₂S carries ammonia down the column in the water phase, this cannot explain the bulge. This column differs from conventional SWSs. In the two-stage stripping process, the H₂S stripper operates at relatively high pressure in order to force H₂S out of solution by the higher temperature while keeping ammonia in solution through the elevated pressure. Pressure markedly changes phase behavior.

The ProTreat® sour water stripper model is completely and genuinely mass transfer rate based which enables it to predict the performance of simple stripping units as well as more complex processes such as WWT with packings and trays in the same tower. And if your sour water is phenolic, ProTreat can accurately simulate that, too.

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

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