Deeper Weirs Are Better, Sometimes

A poorly designed plant or one whose operations are compromised will almost always show worse than expected treating. There is an enormously long list of potential causes for low treating performance, but if we focus just on the absorber, the list gets a little more manageable. Common design issues include:

- Inadequate number of absorber trays,
- Poor tray design
  - Unbalanced liquid and vapor follow areas
  - Too few tray passes
  - Insufficient tray open area,
  - Unsealed down-comer bottoms,
  - Flooding from too close tray spacing,
- Poorly stripped lean solvent or solvent flow too low,
- Limited lean solvent cooling,

Operating issues include:

- Solvent too concentrated or too weak,
- Solvent contaminated with heat stable salts (HSSs), degradation products, foaming agents (especially liquid hydrocarbons),
- Tray damage,
- Lean/rich exchanger leak
- Foaming,
- Operating outside battery limits

A frequent suggestion with MDEA is that poor treating from marginal designs can be overcome by providing more residence time for absorption, just by raising the weir height on the trays.

We believe increasing contact area, not contact time, is the correct way of thinking about the effect of higher weirs. Increasing residence time has the implicit assumption that absorption is controlled by reaction rate so allowing longer reaction time increases absorption. However, as discussed in The Contactor™ Vol. 4, Issue 3, CO\textsubscript{2} removal is determined by mass transfer resistance in the solvent phase, not by kinetics. But whatever the reason for the weir height effect, there are situations where higher weirs help absorption, where they hurt absorption, and where they have no effect at all on overall treating.

Case 1: Deeper Weir Helps Treating

CO\textsubscript{2} is being removed in an LNG plant. The unit uses 44 wt% ADEG to treat 48 bara gas from 0.48 mol% CO\textsubscript{2} to < 50 ppmv. Figure 1 shows the effect of weir heights from 1.6 to 6 inches on the residual CO\textsubscript{2} in the gas.

![Figure 1](image)

Figure 1 Effect of Weir Height on CO\textsubscript{2} in Treated Gas Using 44 wt% DGA

At the ppm level the residual CO\textsubscript{2} content is fairly sensitive to the depth of the weir. CO\textsubscript{2} in the gas drops off exponentially from tray to tray up the tower and even with a 6-in weir it continues to drop exponentially even across the topmost tray. Column performance is mass transfer rate controlled and therefore depends on the effective interfacial area between gas and liquid on the trays. Figure 2 shows how area depends on depth of weir. Increasing the weir height from 1.6 inch to 6 inches increases the interfacial area by only a factor of two—interfacial area does not respond to weir height on a 1:1 basis; nevertheless, treating is improved by a factor of 25 times.
Case 2: Deeper Weir Has Little Effect

A fuel gas treater removes \( \text{H}_2\text{S} \) from a 200-psig gas containing 0.5 mol\% \( \text{H}_2\text{S} \) and 0.2 mol\% \( \text{CO}_2 \) with 38 wt\% generic MDEA solvent. The weirs on the 17 absorber trays are 2 inches deep. Although the treating goal is 4 ppmv \( \text{H}_2\text{S} \), the absorber is unable to get any lower than 26 ppmv (in almost perfect agreement with ProTreat® simulation). Will the suggestion to increase the weir height really allow the treating goal to be met? Figure 2 shows that even increasing weir height to 6 inches will reduce residual \( \text{H}_2\text{S} \) in the treated gas to only about 24.3 ppmv. A six-fold increase in weir height gives three times the interfacial area but the effect on residual \( \text{H}_2\text{S} \) is inconsequential.

Case 3: Deeper Weir Worsens Treating

Shale gas with 2.5 mol\% \( \text{CO}_2 \) is treated to reduce the \( \text{H}_2\text{S} \) content from 750 ppmv to 4 ppmv. The absorber has 12 trays of a 2-pass design. With a 2-inch weir height the absorber is predicted by ProTreat to produce 2.75 ppmv \( \text{H}_2\text{S} \) in the treated gas. This is felt to be too close to the design specification and it is suggested that the weir be made deeper to produce a cleaner gas. Figure 4 shows the simulated effect of weir height on \( \text{H}_2\text{S} \) treating.

Despite the fact that the interfacial area increases by a factor of 2.5, Figure 4 shows that more area results in less \( \text{H}_2\text{S} \) removal. In this case, \( \text{CO}_2 \) removal actually increases which consumes more of the solvent capacity, leaving less capacity for \( \text{H}_2\text{S} \) absorption. A higher (deeper) weir is a step in the wrong direction, although fortunately its impact on \( \text{H}_2\text{S} \) removal is very marginal. On the positive side though, going from a 1-in to a 6-in weir lowers the \( \text{CO}_2 \) in the treated gas from 2.05 to 1.9 mol\% which helps to ensure the gas meets a 2 mol\% \( \text{CO}_2 \) specification.

Higher weirs do not inevitably lead to better treating. Every case is different and ProTreat® simulation exposes the reality of each situation.

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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