The CONTACTOR™
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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_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_2 is being removed in an LNG plant. The unit uses 44 wt% ADEG to treat 48 bara gas from 0.48 mol% CO_2 to < 50 ppmv. Figure 1 shows the effect of weir heights from 1.6 to 6 inches on the residual CO_2 in the gas.

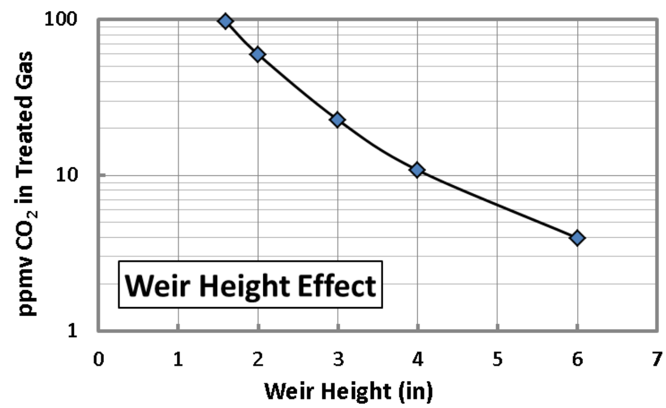

Figure 1 Effect of Weir Height on CO2 in Treated Gas Using 44 wt% DGA

At the ppm level the residual CO_2 content is fairly sensitive to the depth of the weir. CO_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.

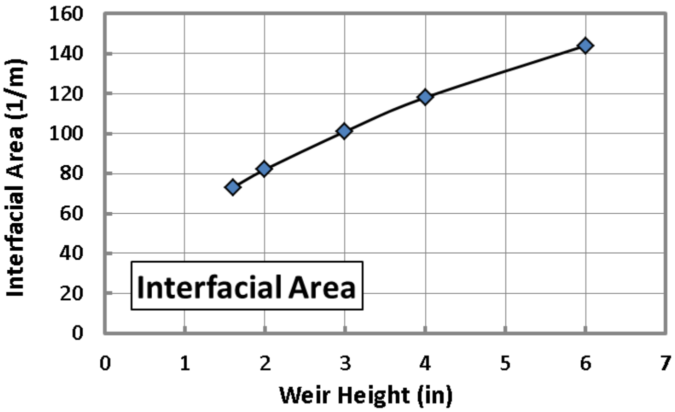

Figure 2 **Effect of Weir Height on the Interfacial Area on a Tray**

Case 2: Deeper Weir Has Little Effect

A fuel gas treater removes H_2S from a 200-psig gas containing 0.5 mol% H_2S and 0.2 mol% 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 H_2S, 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 H_2S 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 H_2S is inconsequential.

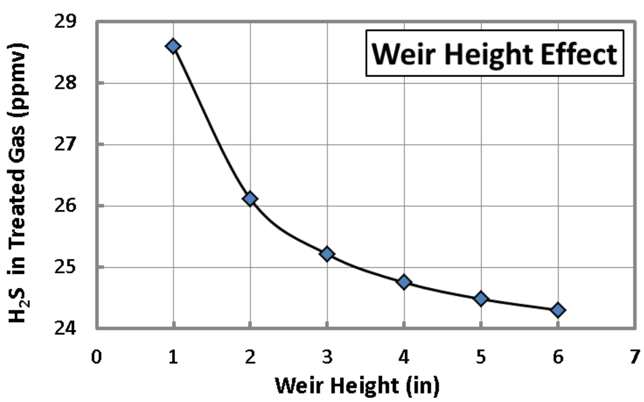

Figure 3 **Effect of Weir Height on the Performance of a Fuel Gas Treater**

It turned out that the cause of poor performance was excessive heat stable salts in the treating solvent. The solution was not deeper weirs, but solvent cleaning. However, the reason deeper weirs have so little effect in this case is that the absorber is completely lean end pinched, meaning that treating is determined by solvent lean loading, i.e., by regenerator performance.

Case 3: Deeper Weir Worsens Treating

Shale gas with 2.5 mol% CO_2 is treated to reduce the H_2S 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 H_2S 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 H_2S treating.

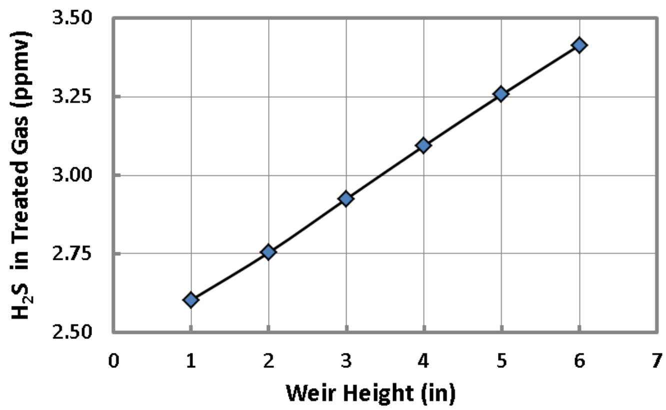

Figure 4 **Effect of Weir Height on Selective H_2S Removal in Case 3**

Despite the fact that the interfacial area increases by a factor of 2.5, Figure 4 shows that *more* area results in *less* H_2S removal. In this case, CO_2 removal actually increases which consumes more of the solvent capacity, leaving less capacity for H_2S absorption. A higher (deeper) weir is a step in the wrong direction, although fortunately its impact on H_2S removal is very marginal. On the positive side though, going from a 1-in to a 6-in weir lowers the CO_2 in the treated gas from 2.05 to 1.9 mol% which helps to ensure the gas meets a 2 mol% 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.

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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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