The CONTACTOR™

Published Monthly by Optimized Gas Treating, Inc.
Volume 7, Issue 6, June, 2013

Confidence in Design — When to Consider Packing

Years ago, packing developed a bad reputation in distillation at high pressures. No doubt, at least part of that reputation stemmed from poor distributor design. Today, however, both random and structured packings are finding increasing use in gas treating, in all sorts of applications.

In gas treating for LNG production, the focus is on deep CO_2 removal. MDEA alone is inadequate for reducing CO_2 to the required level in an absorber of reasonable height. Often piperazine is used as a promoter, although DGA has been used quite successfully as the solvent as well. Absorbers are often packed, either with modern random packings such as IMTP or Raschig Super-Rings, or with the FLEXIPAC and MELLAPAK types of structured packing. However, packings are harder to design for, and packing type and size can have a profound effect on performance that cannot be generalized into the usual rules of thumb. In this issue of The Contactor, we will focus on some of the advantages and disadvantages of packing over trays. In the next issue, we will look quantitatively at how packing size within a structured packing-brand series affects the treating performance.

There are two distinguishable types of performance: One is *hydraulic* and it refers to the column's ability to handle given gas and liquid rates without flooding or excessive pressure drop. The second is *mass transfer* performance. In other words, the ability of the internals selected actually to provide the separation required, to the purity required, and in equipment of reasonable size and capital cost.

Assessing the separation or mass transfer performance of hydrocarbon systems has been handled with great success for nearly a century using nominal overall tray efficiencies and HETP values. But, this approach is utterly hopeless in amine treating where efficiencies can be extra-ordinarily low (from a few percent to 50%) with values that depend on process conditions in ways that cannot be generalized into useful and reliable rules of thumb. In other words, we don't really know what efficiency value(s) to use.

There are numerous questions such as when to consider packing, in what applications, what kind of packing, what size. To come up with a first cut at some answers, it might be useful to look at the advantages and disadvantages of trays versus packing, and random packing versus structured packing. But when all is said and done, we still need to be able to simulate packed columns reliably and confidently.

In many new situations, it is simply not good enough to guestimate or to assume efficiencies and HETP values because speculating about these kinds of parameters makes the simulation not much more than a fit to performance data. The reliability of efficiencies and HETPs deteriorates rapidly as the new conditions deviate more and more from your experience base. As noted in the April, 2013 issue of The Contactor, it is no longer necessary to engage in any form of guesswork when it comes to designing towers containing one or more of a large range of packing types and sizes. The key is to simulate the column as the mass transfer device it really is.

A first pass set of guidelines for selecting internals, at least from a mass transfer point of view, depends on whether selectivity or deep CO_2 removal is the goal. Selectivity is favored by slow CO_2 reaction kinetics and by tower internals that minimize liquid agitation and maximize agitation or turbulence in the gas phase. In general, selectivity is maximized through the use of packing and a non-reactive solvent such as MDEA (although it is possible to design trays with selectivity equivalent to, or even better than, packing). The opposite is generally true for deep CO_2 removal (e.g., LNG), although for other reasons, packing is a frequent choice in treating for LNG production. But there's an important distinction: selectivity is achieved by the slowest possible reaction kinetics, making the CO2 absorption process controlled by mass transfer resistance in the solvent phase. Deep CO_2 removal is achieved by using fast reaction, and when the CO_2 reaction is fast, absorption is completely controlled by the effective interfacial area; therefore, maximizing area per unit column volume should be the objective. Trays do this well, but so does finely structured packing.

Packing has some well-known advantages over trays:

- Low pressure drop, (needed in TGTU, AGE)
- Mechanically more stable in Quench
- Tower capacity often higher than trays
- Smaller column diameters advantageous
- In FPSO and FLNG a tighter design can yield large cost advantages – minimum column diameter with right packed depth
- Foaming usually not as big a problem

But there are some attendant disadvantages, too:

- Weaker experience base in amine service
- Mass transfer performance, especially with chemical reaction, somewhat specialized
- Mass transfer performance poorly known?
- Discomfort factor because of inexperience
- Design reliability? Discomfort makes it more challenging to guarantee design
- Huge range of random & structured packings
- Packing sizes, shapes, materials, surface treatments

One of the most unsettling disadvantages in the minds of many engineers is the perception that there's a lot of uncertainty in designing columns containing packing. So does simulation really have to be that unreliable? We say, no, not at all.

Packing is just another form of tower internal. All internals perform mass transfer— what is key is the knowledge that *mass transfer rate principles are unchanged by what's in the column*. ProTreat has an extensive database of hydraulic and *mass transfer* information for packings of all types and sizes. If you use mass transfer rate-based principles, packing is just as easy to simulate as trays and with equal reliability. This statement is backed by excellent predictive comparisons with a whole raft of packed tower test data in a wide range of treating applications.

Structured packing is probably the pick of the litter in FLNG and FPSO applications. Trays are a very difficult choice for offshore work because of problems associated with periodic tray-out-of-level and liquid sloshing on the trays. Structured packing is likely to be found superior to random packing because the corrugated, vertically-oriented sheet structure of the packing makes it more difficult for significant lateral motion to develop during the period of typical waves. By the same token, structured packing may exhibit slower recovery from liquid and/or gas maldistribution. Indeed, once a maldistributed gas and liquid flow is established, it may be quite stable and resist attempts to force it back to uniformity. Of course, in any system where there is forced periodic motion and free surfaces, one always must be careful to avoid resonances between the forcing wave motion and the resulting variations of flow inside columns.

Packing is now being applied more and more widely, both onshore and offshore, and especially in FPSO and FLNG floating structures. It should always be considered for offshore applications because packing resists (but does not prevent) maldistribution from rocking motion. However, it's also important to avoid free surfaces as much as possible, especially in critical elements such as liquid distributors.

Packing, at least in small sizes, should be avoided in fouling service. Good amine hygiene is almost mandatory. Packing is naturally more resistant to foaming (although foaming can become a problem as flood is approached).

Packing often has better *vapor* handling capacity than trays do. Thus, in a revamp situation to increase a unit's capacity within an existing tower shell, packing is often specified unless high liquid load is a limiting factor. ProTreat can be used to select the right packing size or crimp to achieve the desired separation in a tower of acceptable height and diameter. This will be addressed in the July issue of The Contactor™.

~.~.~.~.~.~.~.~.~.~.~.~.~.~.~~.~.~.~.~.~.~

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

ProTreat® and ***The Contactor***™ are trademarks of Optimized Gas Treating, Inc.