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Optimize Distillation Columns

Application of mass-transfer and pressure-drop fundamentals can lead to improved designs for both trayed and packed columns.

Distillation is the dominant process for separating large multicomponent streams into high purity products. So, the chemical process industries' ongoing quest to improve energy utilization, reduce capital costs, and boost operating flexibility is spurring increasing attention to distillation column optimization during design. Designers often approach column optimization in an iterative manner, heavily relying on vendor experience and information. A good understanding of mass-transfer and pressure-drop fundamentals, as they relate to optimization, will enable the column designer to independently judge vendor offerings and effectively determine the optimal equipment design.

This article will address the following optimization goals: (1) maximizing theoretical stages per height of section or column, (2) minimizing pressure drop per theoretical stage, and (3) maximizing the operational range, turn-down, or turn-up.

A distillation column can use either trays or packings. Their mechanisms of mass transfer differ, but the key for both is a good approach to equilibrium through the generation of large amounts of interfacial area. This interfacial area results from the passage of vapor through the perforations of trays, or the spreading of liquid on the surface of packings.

First, we will discuss the underlying phenomena for trayed columns and the design approaches that can be used to meet the three optimization goals. Then, we will address the mechanisms and approaches for packed columns. Finally, we will consider the selection of trays vs. packing.