BURNS McDONNELL

WHITE PAPER / **DISTILLATION SYSTEMS**

DIVIDING WALL COLUMNS BRING EFFICIENCY TO THE PROCESS INDUSTRIES

BY Andrew Becker, PE

Distillation is essential to the chemical industry, yet these systems have remained unchanged for decades. Dividing wall columns (DWC) offer refineries the ability to reduce operating and capital costs by reconceptualizing the traditional distillation systems.

Distillation has been the cornerstone of the process industries since its inception. The skyline of any major facility shows the prevalence of these systems. Distillation systems utilize heating and cooling cycles, which exploits the differences in component boiling temperatures to separate multicomponent mixtures into pure components.

Despite their widespread adoption, distillation systems have been relatively unchanged for well over half a century. The developments that have occurred have impacted unit capacity and associated equipment, with very little evolution of the actual unit operation.

Separations account for 22% of in-plant energy usage in the U.S., with distillation processes accounting for 49% of the total separation energy used in the refining and chemical processing industries, as reported by the U.S. Environmental Protection Agency. It is estimated that less than 5% of all energy usage in the U.S. is spent on these distillation systems. These separations technologies are known to account for 40-70% of both the capital and operating costs in the industry, according to the American Institute of Chemical Engineers. These separations applications can significantly impact costs, energy use and waste generation. The U.S. has over 40,000 distillation columns operating in more than 200 different processes, as reported by the U.S. Department of Energy.

This high usage rate is primarily due to distillation's flexibility, low capital investment as compared to other separations technologies, and low operations risk. However, the energy efficiency of a commercial distillation column is low, with a thermodynamic efficiency of less than 10% being typical.

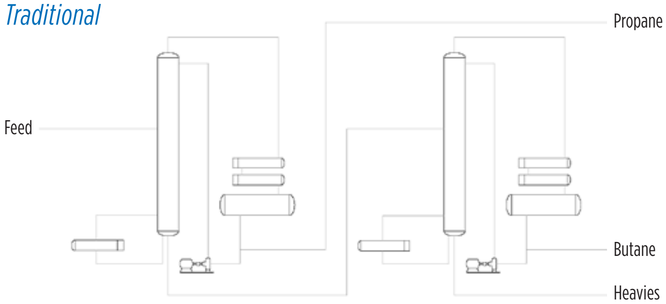
DWCs offer refineries the ability to reduce operating and capital costs by reconceptualizing the traditional distillation systems. DWCs are a type of distillation column that offers separate sections for differing compositions and independent vapor and liquid rates. The term DWCs encompasses not only the physical wall but also the varied process configurations that exploit the wall to improve thermal efficiency and reduce capital cost. These dividing sections combine the once-required multiple distillation systems into a single system with multiple products.

HOW DOES IT WORK?

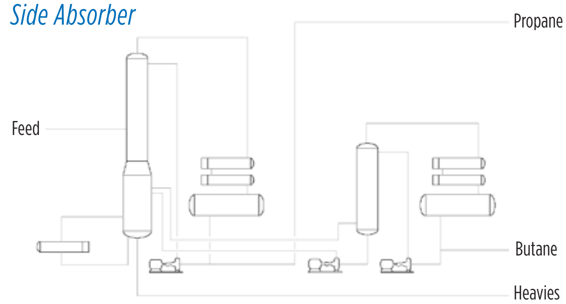
Consider a process to produce propane, butane and a heavier product. The traditional configuration would be a depropanizer and a debutanizer, comprising two distillation systems. The first step in integrating the systems would be using a single column; however, this configuration has a significant drawback — it is impossible to produce high-purity butane (the intermediate product). To maintain purity, a second, smaller column is necessary with either an independent reboiler and/or condenser using a side stripper and/or absorber. The two columns are partially thermally coupled, which results in a modest reduction in heat and capital cost requirement because of the removal of one thermal system.

To further reduce the capital costs of the system, the two columns could be integrated into either a closed top or closed bottom DWC which offers the opportunity to reduce capital costs associated with the partially coupled two column system. A final level of integration would be to remove another thermal system by opening the closed section and allowing vapors and liquids to move in and out of the bottom of the divided section. This completes the thermal integration and offers the highest opportunity for savings on operating and capital costs.

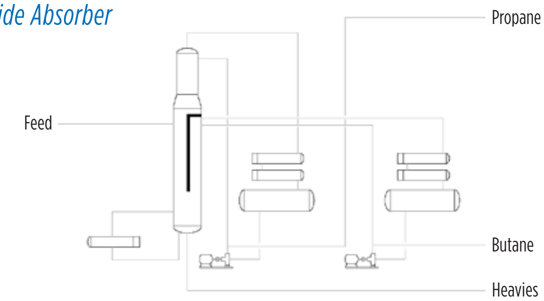
Traditional



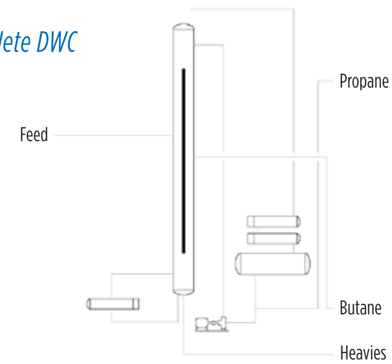
Side Absorber



DWC Side Absorber



Complete DWC



CONFIGURATION SCORECARD

	Column Systems	Thermal Systems
Traditional System	2	4
Side Absorber/Stripper	2	3
DWC Side Absorber/Stripper	1	3
Complete DWC	1	2

ADVANTAGES OF DWC

Our evaluations have indicated that some DWC systems can achieve up to 40% reduction in energy requirements, up to 40% reduction in capital and up to 50% reduction in plot requirements, when compared to a two-column traditional system.

However, depending on the chemical components, process specifications and relative product flow rates, some DWC systems use integrated side absorbers and strippers. Non-DWC systems with a simple side draw, as well as two-column configurations, may provide the optimal balance of capital expense, operating expense and flexibility. As such, any distillation system generating three or more products should be screened for the multiple DWC configurations against traditional column configurations to determine the relative benefit of the DWC system. This screening should evaluate:

- Capital cost of the system
- Constructability limitations
- Energy usage and associated operating expense
- Improvements to the operating objective of the system (i.e., better performance)
- System flexibility

If the designer is well-versed in DWC systems as well as capital cost estimation, this screening takes little time but provides assurance that the most promising configuration is implemented. This screening will highlight the unique opportunity generated by DWC systems to simultaneously reduce capital costs and operating expense.

BIOGRAPHY

ANDREW BECKER, PE, is an associate chemical engineer in the Oil, Gas & Chemical Group at Burns & McDonnell. A leader in process innovation across the industry, Andrew is responsible for sizing and specifying process equipment and instrumentation, line sizing, and hydraulic analysis and process modeling. He also employs novel simulation techniques for process optimization and controls analysis.

ABOUT BURNS & McDONNELL

Burns & McDonnell is a family of companies bringing together an unmatched team of engineers, construction professionals, architects, planners, technologists and scientists to design and build our critical infrastructure. With an integrated construction and design mindset, we offer full-service capabilities with offices, globally. Founded in 1898, Burns & McDonnell is a 100% employee-owned company and proud to be on *Fortune*'s list of 100 Best Companies to Work For. For more information, visit **burnsmcd.com**.

17876-DWC-1020