Converting Two Columns into One

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Dividing wall column technology can be tailor-made to meet specifications for product quality with less utility consumption and lower capital costs

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Dividing wall columns (DWC) offer a fresh perspective on traditional distillation techniques. Current-day refiners continuously face the challenge of keeping capital and energy costs low. Toward that end, DWC technology can provide a definitive edge. DWC columns, in general, have proven to save approximately 10-30% in energy and capital costs.

By providing highly customised and flexible solutions for numerous processes in the chemical and refining industry, the DWC concept can be utilised effectively for grassroots columns as well as revamping existing columns.

This article reviews a recent application where an existing conventional two-column naphtha splitter was replaced with a single naphtha splitter column using DWC technology. The first column of the original design was converted to a middle DWC. This revamped column removes a heart cut naphtha product with similar product specifications as obtained in the original design. The utility cost is lowered by approximately 25%. Additionally, the second column is removed from service and will be repurposed.

The column has now been operational since January 2017 in one of the largest refineries in South Asia.

Objective

In the original design, C8/C9 aromatics and naphthenes are obtained in the heart cut naphtha in the NS-2 column, which utilises high pressure steam for reboiling duty. The

naphtha splitter side draw and naphtha splitter bottoms.

The overhead and bottom product from NS-1 are routed to gasoline blending pools. The side draw was then routed to the second column as feed. Here a heart cut naphtha stream is removed as the top product, while heavy naphtha is the bottom product.

The two columns consumed a significant amount of utilities for reboiling duties (approximately 38 MMkcal/hr).

NS-1 was designed as a conventional side draw column with trays and a smaller diameter section at the bottom. The heating duty to the column is provided by two reboilers: a side reboiler using low temperature light cycle oil (LCO) and the bottom reboiler using higher temperature heavy cycle oil (HCO) as the heating medium. In this design, the side cut is removed from below the feed nozzle to minimise the heating duty of the lower reboiler. The column maintained the product specifications by maximising the heating duty of the side reboiler.

NS-2 is the second column in the sequence (see Figure 1). A combination of HCO and high pressure steam is used for heating duties. The overhead of this column is used to generate low pressure steam in a steam generator.

The columns possess extra hydraulic capacities in the reboilers, condensers and the larger diameter sections. However, the smaller diameter section of NS-1 acts as a constraint against increasing the vapour-liquid traffic inside the column.

Original design

The original configuration consisted of two FCC naphtha splitter columns in sequence, namely Naphtha Splitter-1 (NS-1) and Naphtha Splitter-2 (NS-2). The first column separated the feed from the depentaniser column bottoms into three streams: naphtha splitter overhead, naphtha splitter side draw and naphtha splitter bottoms.

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![Figure 1 Original design of the two column separation sequence](image-url)
utility cost of high pressure steam is quite high in Asia. The main objective of the revamp is to lower the energy consumption of the whole separation. Additionally, the refiner plans to use the second column for a different operation. Thus, another objective is to separate the heart cut naphtha in the first column, thereby freeing up the second column.

**Application of dividing wall column**

DWC technology is used to revamp NS-1 to separate a heart cut naphtha stream as the side cut product. The DWC design has been proven efficient in separating high purity products in a single column. For such applications, DWCs have less energy consumption compared to regular distillation columns.

In this particular design, the dividing wall is installed in the centre of the larger diameter section. A part of the wall also extends into the smaller diameter section at the bottom. The column is segregated into two separation zones, with each zone behaving independently. The design and layout are illustrated in Figures 3-5.

The feed enters on one side of the wall and is pre-fractionated. The lightest boiling components move up the column, while the heaviest components move to the bottom. The middle boiling components are divided between the light and heavy fractions, and then concentrate in the middle of the column on the other side of the wall. Here the light naphtha is obtained as the top product, while heavy naphtha is recovered as the bottom product. The middle boiling components are recovered as the side cut product. Due to the presence of the wall, which separates the feed from the side cut, intermixing between the two streams is avoided. Therefore the heart cut naphtha does not contain a huge spill-over of the heavier components as observed in the original design.

Additionally, since the wall is extended to the smaller bottom section of the column, the side reboiler using LCO provides most of the heating duty to this separation zone. Having two distinct zones within the column allows the utilisation of the larger diameter section for increased vapour-liquid traffic. And now an efficient fractionation is possible within the same column.

Similarly, on the other side, the main fractionation is aided by heating duty from the bottom reboiler. The heating duty is optimised by using additional HCO. The consumption of high pressure steam as the heating medium is completely eliminated.

The column uses the existing air-cooled overhead condenser. Low pressure steam is no longer generated at the top of the column as in the original design. NS-2 is completely idled along with its associated equipment.

**Results and discussions**

NS-1 is revamped using DWC technology, while NS-2 is removed from this service. NS-2, now idle, will be repurposed in a separate service.

Following the revamp, a heart cut naphtha stream is removed as the side cut from the NS-1 column. Table 1 summarises the results achieved after the revamp.

Application of the DWC concept to NS-1 provides the following benefits:

- Heating duty is reduced by approximately 25%.
- Use of high pressure steam is eliminated, improving profitability of the application despite removing...
the low pressure steam generator.
- Heart cut naphtha is obtained in the NS-1 column itself.
- Recovery of valuable C8/C9 aromatics and naphthenes in the heart cut naphtha is increased by 3.2 t/h as compared to the original design.
- NS-2 is idled and available for reuse in a different service.
- There are no equipment modifications outside the column.

Conclusion
DWC technology was tailored to meet the product specifications in the existing NS-1 column. The retrofit has provided significant benefits for the client, including:
- Better separation of heart cut naphtha in a single column as opposed to the original two-column separation sequence. This involved increased recovery of high value C8/C9 aromatics and naphthenes in the heart cut.
- Separation of heart cut naphtha in a single column allowed for the removal of the NS-2 column from this service, and it is available for use in a different service in the future.
- High pressure steam consumption was lowered by almost 30 t/h.
- Associated equipment modifications were not necessary, leading to minimal capex requirements for the retrofit.
- The revamp removed a low pressure steam generator from the original design, with minimal impact on the economics of the project.

Performance of NS-1 and NS-2 before and after revamp

<table>
<thead>
<tr>
<th>Items</th>
<th>Original configuration</th>
<th>Revamp of NS-1 to GT-DWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed rate, t/h</td>
<td>308.0</td>
<td>308.0</td>
</tr>
<tr>
<td>C8/C9 (naphthenes and aromatics), t/h</td>
<td>110.6</td>
<td>110.6</td>
</tr>
<tr>
<td>Heart cut naphtha product rate, t/h</td>
<td>165.0</td>
<td>165.0</td>
</tr>
<tr>
<td>C8/C9 (naphthenes and aromatics), wt%</td>
<td>63.9</td>
<td>66.5</td>
</tr>
<tr>
<td>% recovery C8/C9 (naphthenes and aromatics), wt%</td>
<td>95</td>
<td>98</td>
</tr>
<tr>
<td>Total heating duty, MMkcal/hr</td>
<td>38.0</td>
<td>28.0</td>
</tr>
</tbody>
</table>

Table 1

Heart cut naphtha product specifications before and after revamp

<table>
<thead>
<tr>
<th></th>
<th>Original design (NS-1 and NS-2)</th>
<th>NS-1 revamp to GT-DWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart cut naphtha flow rate, t/h</td>
<td>165.0</td>
<td>165.0</td>
</tr>
<tr>
<td>D86 IBP-FBP, °C</td>
<td>110.6-170.0</td>
<td>110.0-170.0</td>
</tr>
</tbody>
</table>

Table 2

DWC technology derives most of its basic fundamentals from conventional distillation methods. What differentiates DWC from other established concepts is the ability to be tailor-made to meet the refiner’s specifications and needs, whether for product quality, less utility consumption or lower capital costs. This flexibility in operation, combined with the generous benefits of lower opex and capex, make DWC a highly profitable method of performing distillation in a new and improved setup.

Manish Bhargava is Director of Advanced Distillation Systems at GTC Technology US, LLC, headquartered in Houston, Texas. He holds a Master’s in chemical engineering from Illinois Institute of Technology. He has over 15 years of experience in the process industry, and is a specialist in improving existing distillation sequences. He is the author of several articles on dividing wall columns and holds several patents in the field.

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For additional articles and more information on GTC Technology’s Dividing Wall Column technology (GT-DWC®) or any of GTC’s other technical offerings, please visit our web site at www.gtctech.com.