Integrated Approach to Retrofit & Debottleneck Ethylene Plant cold section

Dhanasekar Periyasamy

Aspen Technology MENA

Dhanasekar.Periyasamy@aspentech.com

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Objectives

The separation and purification of Ethylene from other hydrocarbons in the Cracker effluent stream through the chill down train and the subsequent Low-temperature fractionation (Cold section) is an energy intensive process. There is a complex interaction between core processes (separation columns), associated heat exchanger network and refrigeration cycles in sub ambient processes. The conventional process of debottlenecking the cold section is usually a scale-up approach and involves major modifications with negligible change in the overall energy efficiency of the process. This paper presents a case study that demonstrate the workflow to perform a thermodynamic optimization of the low temperature distillation process, refrigeration cycles and the heat exchanger network using the concepts of Pinch Technology to exploit the process interactions and inherent potential to improve the overall energy efficiency of the Ethylene plant.

WORKFLOW & DISCUSSION

There are a number of options to debottleneck ethylene plant cold section like replacing the column trays with high performance trays/packings, modifying the major equipment to higher capacity and even adding parallel equipment. The conventional methods of debottlenecking of the Ethylene plant cold sections eliminate the bottlenecks one by one and as a result the capacity increase is achieved by scale-up of the equipment/unit operations. Scale-up approach usually are as expensive as the new designs and they hardly make any change to the specific energy consumption in the separation process. The new approach to debottleneck the C2 splitter, the C3R refrigeration compressor and compressor driver by exploiting the inherent design interaction was studied through Pinch Analysis using simulation tools.

Simulation models for the Ethylene plant cold section was built with the thermal analysis and hydraulic analysis options enabled. The temperature enthalpy curve generated in the thermal analysis of the converged C2 Splitter column also called Column Grand Composite Curve (CGCC) was used to optimize C2 splitter feed tray location for a given light key and heavy key components in the bottom and top product respectively. The shift in feed tray location gave room for reducing the reflux ratio of the C2 splitter. Then the hydraulic bottleneck in the stripping section of the C2 splitter was eliminated by targeting feed preheating and side reboiler with the use of thermal and hydraulic analysis results.

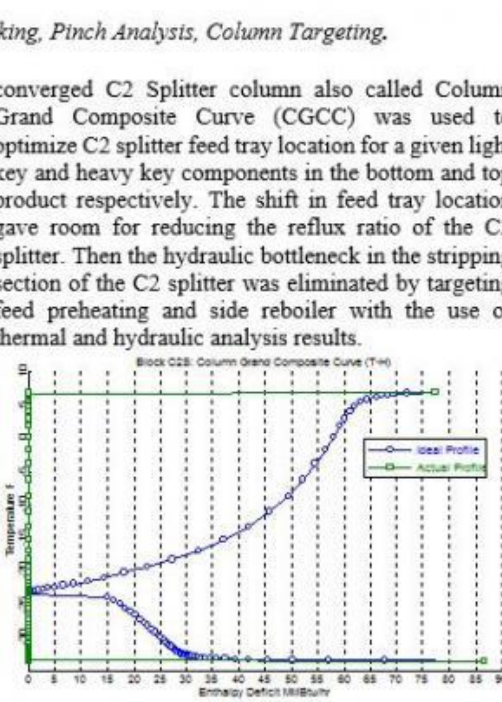

Fig.1. – Column Grand Composite Curves (CGCC) in Thermal Analysis

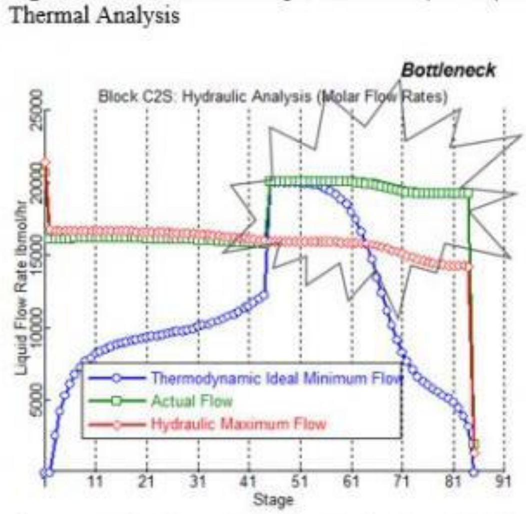

Fig.1. – Hydraulic Analysis showing bottleneck in the C2 Splitter stripping section