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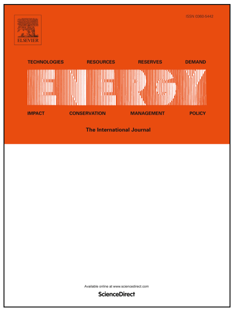

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Benchmarking of Olefin Plant Cold-end for Shaft Work Consumption, Using Process Integration Concepts

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Abstract:

The olefin plant cold-end is aimed at separating cracked gas into ethylene, propylene and other heavier by-products using low-temperature gas separation processes. This process is energy-intensive and hence retrofitting for energy saving would be desirable. However, a full retrofit study requires a lot of time and costly engineering work. So, a novel method is introduced in this paper for benchmarking of shaft work consumption in olefin cold-end, which is based on process integration concepts. In developing this method, the amount of shaft work required in refrigeration cycles was first targeted via application of pinch analysis to six different olefin plants followed by the calculation of feasible and achievable energy saving potential. When doing so, the effect of predominant factors such as plant capacity, feedstock (naphtha or natural gas), products specification and type of technology being used was investigated as well. Finally, a mathematical model was developed for rapid estimation of energy saving potential using the above key factors. This model was verified through case studies and was proved to be accurate enough for shortcut calculations.

Keywords: Olefin Cold-end, Pinch Technology, Energy Consumption Model, Energy Benchmarking, CO_2 Reduction

1. Introduction:

Olefin plant is one of the most energy-intensive industries through petrochemical complexes. Fig. 1 shows energy input in production of different chemical products [1].

Ren et al. [2] reviewed energy efficiency in conventional steam cracking and innovative olefin technologies and reported up to 20% savings in the pyrolysis section of naphtha cracking and up to 15% savings in the compression and separation parts in total. A low-temperature separation system such as the cold-end of olefin plant usually consists of three main systems: separation systems (usually distillation column), heat exchange system (multi-stream plate fin heat exchanger or other exchangers) and refrigeration system. Design of the low-temperature separation system is so complicated because an interaction exists among the design of distillation columns, heat exchanger network and refrigeration cycles [3].

In spite of low thermodynamic efficiency and high operational costs, distillation is still very popular for separation systems. Distillation columns demand high quality energy via reboiler and then reject lower-quality energy via condenser [4]. Numerous studies have been reported on improving the efficiency of distillation columns. There are many factors such as different reflux ratios, working pressure, side condensing/reboiling and feed preheating/cooling that affect the column efficiency. Dhole and Linnhoff [5] developed a methodology based on a combination of thermodynamics and practical aspects of column modifications to give the engineer pre-design targets. Pejpichestakul and Siemanond [6] performed column grand composite curve for three columns in ethanol production by ethylene hydration and reduced energy consumption up to 28%. Working pressure of the column changes the column duty and temperature, depending on the trade-off between the power required for refrigeration and feed compression [7]. Distributing the reboiler and condenser duties over the length of the column increases the separation efficiency [8]. Kiss et al. [4] have investigated energy saving options for distillation column with a focus on heat pumps and reported energy reduction potential about 20-50%. Alcántara

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