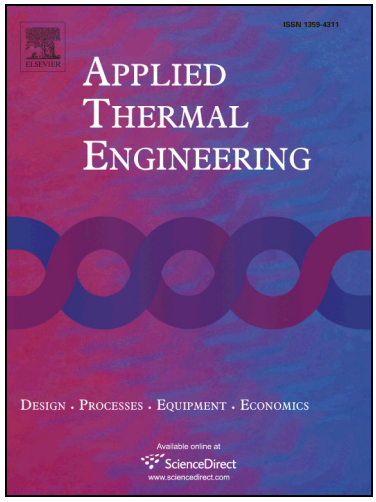

Coupling design of interunit heat integration in an industrial crude distillation plant using pinch analysis

Chengtian Cui, Jinsheng Sun

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Coupling design of interunit heat integration in an industrial crude distillation plant using pinch analysis

Chengtian Cui and Jinsheng Sun*

School of Chemical Engineering and Technology, Tianjin University, Tianjin, 300072, P. R. China

Abstract

In this study, pinch analysis was performed on three separate, efficiently-operated, preheat trains (PHTs) of industrial crude distillation units (CDUs). It was revealed that, although each individual PHT was approaching maximum energy recovery, interunit coupling could potentially be considered to make further progress. Simulative trials found that an extra 9.58% energy consumption was reduced through including innerunit optimization into interunit design. A necessary economic evaluation verified that energy cost minimization recovered the investment within a reasonable payback period. This case study illuminated a thought train for an innovative pathway—better heat sources-sinks matched with the least revamping in an extended-energy system—which might allow numerous similar refineries in China to improve their energy supply. Essentially, this study also presents a proposal for optimization of the entire heat exchanger network of three separate CDUs in a northern China bitumen enterprise.

Keywords: Crude distillation unit; Preheat train; Heat integration; Process simulation; Coupling design; Retrofit;

1. Introduction

Crude distillation units (CDUs) are well-known as energy-intensive processors, consuming 35–45% of the total energy required in a refinery [1]. Consequently, CDUs are identified as the main energy consumer in the entire refinery process. It is then reasonable to apply heat integration principles to improve their energy efficiency, reducing operating costs, and CO_2 emissions [2–7]. To be specific, crude oil feed must be heated from ambient temperature to ~360°C or higher, at which point, the oil partially vaporizes to facilitate subsequent fractionations. A large fraction of this heat (~60–70%) is recovered from product cooling and heat-removing pump-around circuits among the streams of the distillation columns using heat exchangers (HEXs) [8–9]. These HEXs are combined together as a heat exchanger network (HEN) or the preheat train (PHT) [10].

In China, it is very common for refinery owners to have several CDUs running simultaneously in their plant area. However, separate CDUs are normally considered to be less energy-efficient compared with a single, larger CDU with the same total output [11]. That is, one of the separate CDUs might have a high quality heat source, such as sideline-oil or pump-around, but has no counterpart high quality heat sinks to match with, and vice versa [12–13]. In other words, this issue leads to a waste of energy but, in view of the entire refinery, the situation was different. High quality heat sources or sinks can be matched to correspondents within a broader scope, greatly increasing the probability of successful matches through slightly rearrangement the PHT of the entire refinery or relevant units.

*Corresponding author.

E-mail address: jssun2006@vip.163.com (J. Sun).