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Improved area—energy targeting for fired heater integrated heat exchanger networks

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ABSTRACT

Effective integration of various subsystems into the overall process, results in an energy efficient and economic plant design. In this paper, issues related to the area-energy targeting for fired heater integrated heat exchanger networks are studied. Performance of a fired heater is affected by the variables such as fuel fired and air-preheat temperature. These variables along with the minimum approach temperature difference for the heat recovery of the background process, affect the performance of the overall system. A methodology is proposed for the area-energy targeting for fired heater integrated processes. In the proposed methodology, the fired heater heat duty split between the radiation and the convection section is determined using the one gas zone furnace model.

Keywords: Fired heater; Fired heater integration; Heat exchanger network; Cost targeting

1. Introduction

Tools of pinch technology help in establishing energy efficient design of a modern process plant prior to its detailed design. Subsystems, independently designed and integrated into the process may lead to suboptimal design of the overall plant. Thus, appropriate integration of various subsystems into the overall process has to be performed for optimal design of the entire process plant. The improved procedure for area-energy targeting of fired heater integrated processes considers individual component design-parameters along with their energy and economic interactions. Fired heaters are energy as well as capital intensive equipment. The cost of the furnace system usually ranges from 10% to 30% (Jegla et al., 2000) of the plant's total investment.

Fired heaters are used in various chemical and process industries such as refineries, petrochemical, fertilizer, etc. In industry, fired heaters are also known as process heaters, furnaces, and direct-fired heaters. The primary function of a fired heater is to supply a specified quantity of heat to the process stream. Typically, when desired temperature of the process stream is above the practical range of steam heating (363–477 K), fired heaters are used (Allen and Rosselot, 1997). The desired energy is generated in the fired heater by combustion of the fuel. Oil and natural gas are the major fuels used in fired heaters. The hot flue gases of combustion supply the required energy to the process fluid that flows inside the tubes. Tubes are contained within refractory lined chamber that reradiate heat to the tubes and reduce heat leakage. The heat duty of a fired heater is usually controlled through fuel flow rate.

The overshoot of the cold composite curve over the hot composite curve is the hot utility, Q_{hu} required for a process corresponding to a minimum approach temperature of ΔT_{min} at the pinch. Similarly the overshoot of the hot composite over the cold composite is the cold utility, Q_{cu} required for the process. Recently, Bandyopadhyay and Sahu (2010) have proposed a modified problem table algorithm to target minimum utility requirement for a given ΔT_{min}. The optimization of the pinch approach temperature ΔT_{min} is a trade-off between the capital and energy (capital and operating cost). Heat exchanger area required for the heat exchanger network is used to estimate the capital requirement. Area targeting involves area estimation of process to process heat exchangers and utility heat exchangers in a heat exchanger network. The total capital can be estimated using the total heat exchanger area and number of units with an appropriate cost correlation. Using the capital and operating cost, the total annualized cost may be estimated

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