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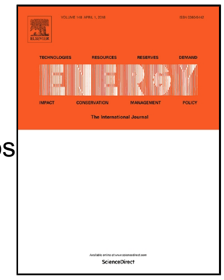

A methodology for the flexibility assessment of side wide heat integration scenarios

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A methodology for the flexibility assessment of side wide heat integration scenarios

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Abstract:

Heat integration is one of the powerful tools to improve energy efficiency in industry. Originally it was developed for heat recovery at the process level and progressively extended to establish energy synergy between multiple plants regrouped in geographical areas called eco-industrial parks. Such site wide energy integration reduces the overall costs and further increases energy savings beyond what may be achieved by the process scale. Many methodologies and tools have been developed to identify the potential heat recovery and the optimal heat transfer network design as heat integration solution at both scales. However, integrated processes will become interdependent and the major interactions between these processes constitute a risk for designers, especially in the case of fluctuations in operating conditions. Thus, the operability issues are of vital importance to be considered in design methodologies and the flexibility assessment become an essential prerequisite of the heat transfer configuration in order to better take into account fluctuations and disturbances in the energy synergy networks. This work presents a nonlinear programming (NLP) model that tests the flexibility of a heat transfer network design between multiple processes subject to multiple scenarios of capacity and flow rates variation. The model assesses the capability of the heat integration structure to satisfy the heat exchange target and its ability to operate and to cope with varying operating conditions. A virtual case study is used to demonstrate this methodology and its applicability.

Keywords:

Heat Integration, Energy Efficiency, Eco-industrial Park, Flexibility Assessment.

1. Introduction

The increasing consumption of fossil fuels, the major energy source in industry, and the alarming climate change due to greenhouse gas emissions drive the industries to implement strategies to increase energy efficiency. Actually, energy efficiency can be significantly enhanced by incorporating heat integration methodologies into design techniques that can be performed at different levels: at a process scale and at a total site scale. At the process scale, the pinch concept is the first systematic method to recover heat by matching hot and cold process streams of a plant [1]. It was followed by mathematical optimization techniques for the synthesis of heat exchanger network (HEN). The latter are divided into sequential approaches as proposed in [2] and simultaneous approaches as proposed in [3] , [4] and [5] to consider the tradeoff between energy and cost of units and heat exchangers.

Heat integration application was extended to total site scale by Linhoff and Dhole [6] to explore the potential of heat recovery between multiple plants and to design the utility systems to satisfy the heating and cooling requirement thus offering higher reduction in the overall energy consumption. The Total Site Heat integration (TSHI) method is based on a graphical tool, the Total Site profiles (TSP); It represents the overall heat surplus and heat deficit of the processes in a total site obtained by the combination of grand composite curves of the individual processes. The energy targeting procedure was developed through mathematical programming approaches in [7] using LP and MILP models to optimize the location of the tertiary network. A study for heat integration in a chemical cluster in Sweden [8] showed the benefits of energy collaboration between different plants to improve energy efficiency.