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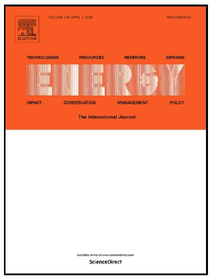

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Abstract

To reduce the dependence on fossil fuel, Process Integration and energy efficiency are crucial in chemical process industry to minimise the consumption of fossil fuels and electricity demand through Heat Exchanger Network (HEN). Pinch Analysis is well established to optimal HEN design to maximize the energy recovery in a process. The stream matches for energy recovery in HEN is important to ensure the temperature potential is not wasted, which the temperature potential could be converted into mechanical work. Therefore, Exergy Analysis has been introduced to work with Pinch Analysis, which ensure the heat recovery stream matches with appropriate temperature differences to minimize the work potential (exergy) loss. This paper demonstrates how Pinch Analysis and Exergy Analysis is simultaneously applied to determine exergy targets (rejection, requirement and avoidable losses) in low temperature HEN. A novel numerical tool known as Exergy Problem Table Algorithm (Ex-PTA), is proposed in this paper as a numerical method to the conventional graphical representation in Extended Pinch Analysis and Design (ExPAnD) method. The proposed tool produces more realistic and achievable results. The net shaft work requirement of the refrigeration system is also determined together with the system COP. This paper explored the effect of setting heat exchangers' minimum approach temperature (ΔT_{min}) on the exergy targets for low temperature HEN design. The external utility requirement and unavoidable exergy losses increased with ΔT_{min}, while avoidable exergy losses and energy recovery reduced with respect to ΔT_{min}. The net power requirement of the system increased with the ΔT_{min} increment, however, the system COP reduced due to higher increment rate of compression compared to expansion work generation. The optimal ΔT_{min} was determined at 2 °C for heat recovery system in the case study based on super-targeting approach, which considers the total annualised cost, operating cost and capital cost.

Keywords: Process integration, Pinch analysis, Exergy analysis, Low Temperature, Heat Exchanger Network