Shifted Retrofit Thermodynamic Diagram: A Modified Tool for Retrofitting Heat Exchanger Networks

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Chemical industries are constantly looking for ways to improve the plants' energy efficiencies due to increasing energy price. One of the ways is to perform retrofit on heat exchanger networks. Over the decades, much research has been performed in this area and can be generally classified into insight-based methods and optimisation-based methods. In this paper, Shifted Retrofit Thermodynamic Diagram (SRTD) is introduced, which is a modification from Retrofit Thermodynamic Diagram (RTD) is found in literature. SRTD has the features of RTD and incorporates thermodynamic feasibility representation as well as minimum allowed temperature difference. This paper also includes an illustrative case study.

In SRTD, the hot streams are shifted to include the analysis of ΔT_{min}. The ends of both streams of a heat exchanger are connected to show the thermodynamic feasibility. This will create either positive slant lines or vertical lines. The vertical lines show the locations of the Pinches. The presence of a negative slant line this indicates that the cold stream has higher temperature than the hot streams, which should be determined as an error in data collection. The tendency for a line to become a Pinch can be seen from its horizontal gap, which is the temperature difference between the hot stream and cold stream. Line that has smaller temperature difference has higher tendency to become the next Pinch. This paper also discusses about the Pinches, particularly Network Pinch, its effect on SRTD and how to deal with them.

By using the SRTD, the Pinches are easier to be detected and retrofits are easier to be done. More heat can be recovered and more utilities can be saved by following the methodology that is described in this paper. An illustrative case study is made as an example on how to apply the methodology and the potential of heat can be recovered and utilities can be saved. A case study showed around 9 % of heat can be recovered more if the chemical plant undergoes the retrofits. The final retrofit is also just uses 20 kW of utilities more when compared to minimum hot and cold utilities required calculated using Pinch Analysis. For further work, this paper will be extended to the effect of split stream on Pinch and retrofit, flexibility of a heat exchanger network design using RSTD, and the cost of retrofit associated with mainly the additional heat exchanger area needed due to the change of duty and log mean temperature difference. RSTD will be research into total site as well.