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# Safety Analysis Embedded in Heat Exchanger Network Synthesis

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## Highlights

- Safety analysis is performed during HEN synthesis
- Stage-wise MINLP programming model upgraded to different HE type and risk assessment
- Both the overall HEN and the individual HE risk should be considered simultaneously during the synthesis of HENs
- Significantly safer design can be obtained even at a small decrease of NPV

## Abstract

Optimization of Heat Exchanger Networks (HEN) has received considerable attention in last decades, but a few studies on inherent safety. In this paper, risk assessment is considered simultaneously during the synthesis of HENs. As risks depend on the equipment selected, a superstructure enabling selection of direct and indirect heat transfer between hot and cold streams and different types of heat exchangers (HEs) was tested. The individual heat transfer and the overall HEN risk were analyzed. Different individual risk limits have been introduced for certain types of heat transfer, e.g. between two process streams or between utility and process streams. The sensitivity analyses were performed first, considering only toxicity as a risk, but later flammability and explosiveness were also simultaneously tested, in order to consider the most important aspects of safety. The results obtained indicate that rather significant changes in HEN designs can increase safety, while still exhibiting similar economic efficiency.

## Abbreviation

HE heat exchanger

**Keywords:** heat exchanger network; synthesis; safety analysis; risk assessment; simultaneous risk assessment;

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