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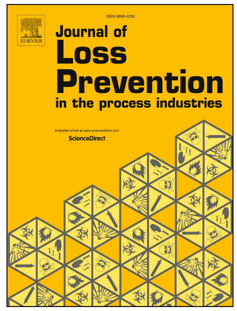

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INHERENTLY SAFER DESIGN FOR HEAT EXCHANGER NETWORK

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Abstract

The failure of shell and tube heat exchangers is a chronic problem in the chemical process industries. Meager safety analysis and lack of inherently safer design considerations are noticeable issues resulting in the failure of these heat exchangers. Existing inherent safety level quantification methods mostly focus on the process route selection in the preliminary design stage. Nevertheless, existing methods have never been applied to quantify the inherent safety level in a heat exchanger network. Therefore, this paper presents a coherent framework to outline an inherently safer heat exchanger network in the preliminary design stage. In this framework, newly developed safety indices are introduced to estimate the inherent safety level of a single heat exchanger and the heat exchanger network. The worst heat exchanger is identified based on the lowest inherent safety level. An inherent risk assessment (IRA) of the worst heat exchanger is carried out to analyze the inherent risk of potential explosion event. Moreover, normal distribution of the safety index values is analyzed through the normality test. Inherent risk assessment and the normal distribution of index values are configured as a decision-making steps for implementing the inherently safer design strategies. This framework is integrated with a process design simulator (Aspen HYSYS) for seamless transfer of the process information. A heat exchanger network of a typical ammonia synthesis loop was considered as a case study. Inherently safer designs for this heat exchanger network are presented by using moderation and simplification methods. The inherent safety level of the heat exchanger network can be improved by applying inherently safer design strategies.

Keywords; inherent safety level, inherently safer design, heat exchanger network, preliminary design stage, process design simulator.