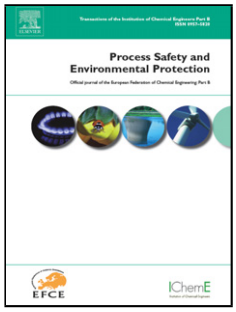

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Investigating the effect of inherent safety principles on system reliability in process design

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Highlights

- Relationship between inherent safety and system reliability for process design
- Methodology is applicable for different stages of process design
- Correlation between inherent safety and reliability varies based on the design stage

Abstract: During the last decade, inherent safety has emerged as an area of interest in both academic and industrial research. Various regulatory bodies have enforced the consideration of inherently safer design alternatives. This enforcement, however, may not serve the purpose of reducing the risk associated with process incidents due to the drawback of risk migration associated with inherent design philosophy. The philosophy of inherent safety has emerged from the need to reduce the consequence element of risk with an objective to prevent high consequence–low likelihood events. Thus, this philosophy is plagued with the drawback of risk migration where the lowering of consequence element can lead to an undesired increased likelihood element, leading to an overall increase in risk associated with the system. The likelihood element of risk of the system under consideration depends on the system reliability. The developed methodology involves quantifying inherent safety based on the design stage under consideration using a quantification technique that utilizes process data available during the specific stage of design. This is followed by determining reliability and availability of the system using reliability databases or static reliability modeling for various design alternatives considered during the specific design stage. Lastly, the trend observed between quantified inherent safety and reliability/availability is used to determine the required relationship between inherent safety and reliability. Thus, this developed methodology evaluates the possibility of increased risk due to lowered system reliability caused by the implementation of inherent design philosophy.

Keywords: inherent safety; reliability; process design; risk; availability; maintenance-downtime

Introduction

Hazard, risk and inherent safety

Due to the current economic downturn of oil and gas industry, more research impetus has been dedicated towards the design of processes that are superior in performance with respect to their profitability. A process that is economically superior tends to be generally safer as well, since a safer process has lesser downtime and thus, more productivity. However, there is a tradeoff between the economic and safety objectives in the design of a chemical process or its equipment. As noted by Reniers *et al.* (2016), a safety measure involves both costs and benefits, and a decision-making process on whether to invest in a safety measure must account for both aspects. There are many categories of the possible costs of safety measures. Initially, a proposed safety measure must be selected and the applicable material and training for company personnel must be completed. Afterwards, the installation of the equipment involved may require the plant or part of it to be shut down resulting in production losses. From an operating perspective, a safety measure may incur higher operational costs if it requires higher utility consumption. Also, maintenance, including possible production loss, and inspection costs for the proposed measure must be accounted for. As for benefits of safety measures, they can be viewed as avoided costs and are also divided into several categories for consideration.