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Safety Science

Volume 50, Issue 4, April 2012, Pages 1098 – 1103

First International Symposium on Mine Safety Science and Engineering 2011

Using process stream index (PSI) to assess inherent safety level during preliminary design stage

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http://dx.doi.org/10.1016/j.ssci.2011.11.015, How to Cite or Link Using DOI

Abstract

In the current practice, safety assessment is conducted once the process design has been completed. At this stage of design, the freedom to change the conceptual design is very limited and whatever strategies to be implemented will only control the hazard. This paper reports on the development of inherent safety index known as a process stream index (PSI) for inherent safety level assessment at preliminary design stage from the perspective of an explosion. The aim for PSI is to calculate, compare and prioritize the level of inherent safety of process streams during simulation work that influences the explosion. By prioritizing the streams based on the potential for the explosion, the design engineers can easily identify the critical streams to be considered for improvement in order to avoid or minimize explosion hazards. An enhancement technique to reflect the contribution of the individual components in the mixture is introduced, which provide significant contribution to the ranking of inherent safety level of process streams. The assessment of inherent safety level using PSI is demonstrated by case studies of HYSYS simulation for Acrylic Acid Plant and Natural Gas Liquid (NGL) plant.

Highlights

► Process stream index (PSI) assesses inherent safety at preliminary design stage. ► PSI calculate, compare and prioritize the level of inherent safety of streams. ► The level of inherent safety is obtained based on explosiveness of a gas mixture. ► PSI using relative ranking concept to identify the most hazardous process streams. ► The identified streams could be further improved to avoid or minimize the explosion.

Keywords

Inherent safety; Preliminary design; Streams index; Inherent safety index

Figures and tables from this article:

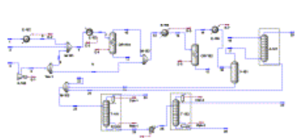

Fig. 2.1. HYSYS simulation of a typical Acrylic Acid Plant.

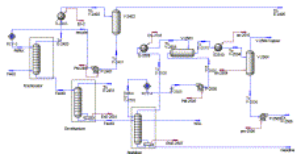

Fig. 2.2. HYSYS simulation of a typical Natural Gas Liquid (NGL) Plant.

Figure options

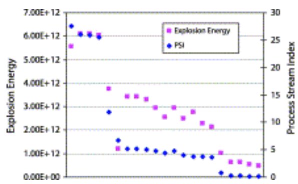

Fig. 2.3. Graph from Microsoft Excel for determination of correlation coefficient between PSI and explosion energy data.

Figure options

Table 1.1. General principles of inherent safety (Kletz, 1991).

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Table 2.1. Flammability limits of individual components.

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Table 2.2. ISI score for explosiveness (Heikkilä, 1999).

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Table 2.3. I_e for 28 process streams from Acrylic Acid Plant.

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Table 2.4. Relative ranking of PSI for 28 process streams.

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Table 2.5. PSI and explosion energy for NGL simulation process streams.

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