**Fire and Explosion risk indexing methods analysis and application to chemical plants**

Enrico Danzi1, Luca Fiorentini2, Giovanni Pinetti2, Marta Farinella2, Luca Marmo1

*1 Applied Science and Technology Dept. Politecnico di Torino, Cso Duca degli Abruzzi 24, 10129, Turin (Italy); 2 TECSA SRL, Via Figino 101, Pero MI, (Italy)*

*\*enrico.danzi@polito.it*

**Highlights**

* Fire and explosion risk assessment
* Chemical process plants
* Indexing methodologies

**1. Introduction**

Risk assessment in industrial workplaces is mandatory by a number of national and over national laws, directives and technical standards and it must consider the totality of potential hazards related to processes and manufacturing activities. Among them, fire and explosion hazards, and related risks, are present in most industries, particularly in chemical and process industry due to the hazardous properties of the substances handled as well as, often, the process conditions. Most common and simplified methods for oil & gas industry have been developed by Dow Chemical Company and Imperial Chemical Industries, namely Fire and Explosion Index (F&EI) [1] and the Mond Index [2]. Lately, Khan et al. have developed the SW&HI method (Safety Weighted & Hazards Index, [3])which could also apply to fire and explosion risk evaluation in chemical industrial realities. Both the methods allow a fast approach to fire & explosion risks given a number of indexes.

In the proposed work, aforementioned methods have been applied to a process plant to verify their similarities, discrepancies, and accuracy. The case study was a “chemical process” department of a chemical plant, where the main products are fine chemicals and powdered products. “Moderate” risk level have been obtained similarly by the different methods, the Mond Index being the highest among them. The most critical process for F&E risk in the facility, according to all the methods, has been identified in the the combustible powder packing operation.

A modification of the SW&HI index is proposed by the authors to overcome identified and discussed limits for a more versatile tool, to be used as a preliminary screening tool in the risk assessment workflow suitable. The new index method incorporates hazards related to solid substances having oxidizing, explosive and combustible properties. A critical and comparative analysis of the different incomes and application strategies of the three methods is given and a normalized risk index (NRI), is also proposed.

**2. Methods**

Plants not ruled by Seveso EU Directive, could although imply a high F&E risk, if any prevention/protection strategies are implemented. As to evaluate numerically this risk, indexing methods, devoted to risk evaluation screening procedure, could be applied. The SW&HI (Safety Weighted Hazard Index) method [3] has been developed as a quick and user-friendly tool for identifying hazards and assessing fire and explosion risk in the process industry. It represents an evolution of previous oil & gas based method, being more comprehensive and less time-consuming in the evaluation process.

**3. Results and discussion**

The chemical plant examined in this work is a North-western Italy company, the methods have been applied in the risk assessment of Department defined as “Chemical Product 1”, in which main products are plastic additives,



**Figure 1.** SW&HI results for case study, where packaging department is evaluated twice, before and after the algorithm modification imposed in this work (as to consider combustible powders).

Application of the Mond Index to the chemical department CP1 seemed to be most appropriate technique, due to its general approach in the identification of the substance (directly through physic-chemical characteristics, like ΔHc) and the process hazards. F&EI application underlined how effectively different risk scenario could be mitigated: the measures adopted by the company manager demonstrate to be adequate with respect to actual potential hazards

**4. Conclusions**

A normalized risk index, defined here as NRI is introduced (Eq. 1), as to compare methods outputs: this value has to be considered as a preliminary risk level indication, or to be used in comparison with other department or chemical plants, while most hazardous areas (with a higher risk than NRI) has to be considered carefully and a detailed assessment is due to adopt the adequate protection measures. The algorithm modification of SW&HI evaluation implies an increase of about 20% of the risk level (as in Figure 1), which has not been accounted in the original method and gives the analysis a broader range of application and a more conservative approach.

(1)

**References**

1. DOW Chemical Company, Fire & explosion index DOW (F&EI), 6Th EDITION, AIChE, 1987.
2. (ICI) Imperial Chemical Industries, The Mond Index, Second Edition. 1985.

[3] Khan, F. I., Husain, T. and S. A. Abbasi (2001), “Safety Weighted Hazard Index (SWeHI): A New, User-friendly Tool for Swift yet Comprehensive Hazard Identification and Safety Evaluation in Chemical Process Industries,” Process Saf. Environ. Prot., 79 (2) 65–80.