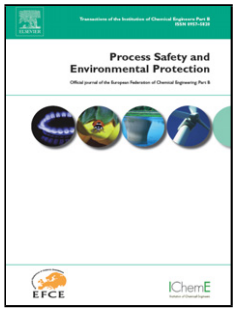

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A Risk Based Methodology for Optimal Placement of Flammable Gas Detectors within Open Process Plants

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Abstract

Although the main objective of utilizing gas detection systems is risk reduction by detecting high risk scenarios, majority of published placement procedures do not address risk concept quantitatively. To include this concept, a risk based methodology is proposed which consists of four key steps: Input Data, Dispersion Analysis, Risk Analysis and Optimization. In the first step, a set of release scenarios are defined and required data including frequency of release, wind rose and grid set are provided. In dispersion analysis step, the set of scenarios are simulated using a dispersion simulation tool and the ability of grid points to detect any scenario is stored in a binary matrix called detection matrix. In risk analysis, the risk of each scenario is calculated incorporating these factors: frequency, damage to personnel, asset loss and probability of delayed ignition. Once the detection matrix and risk of scenarios are provided, at last step optimal placement is performed using a risk-based objective function which is defined as the sum of the risk of undetected scenarios. The optimization formulation called MRR (Maximum Risk Reduction) is solved by a greedy approach called Dynamic Programming in which the location of detectors are determined via an iterative procedure: each time finding the grid point that can cover maximum undetected risk. The applicability of the methodology is shown in a case study and the results are compared with a coverage based formulation.

Key Words: Risk, Detector, Sensor Placement, Flammable Gas, Optimization.

1. Introduction

Flammable gas detection system is known as an essential safety element in process plants. The main goal of flammable gas detection is normally set on detection of accumulation and leaks as early as practical with minimum nuisance alarm and total cost. In-time detection of flammable releases may prevent major fire and explosion hazards such as Vapor Cloud Explosion (VCE), flash fire and potential subsequent property losses. However, the performance of this system is largely dependent on the number of detectors used and their layout. Current standards and regulations such as API (2001), ISA (2003) provide only general qualitative recommendations on installation of gas detectors which are based on rule