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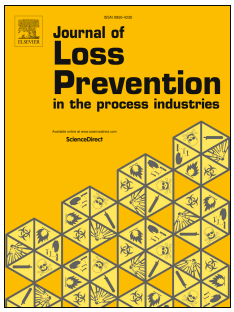

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A method for the estimation of overpressure generated by open air hydrogen explosions

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Abstract

The existing methods for calculating overpressure resulting from a vapor cloud explosion (VCE) were tested for their ability to predict overpressures from unconfined hydrogen explosions. For it, data collated from five reported experimental investigations on open air hydrogen explosions covering 1.4 to 300 m^3 volume of hydrogen-air mixtures and concentrations ranging 20 -57% were employed. It was found that the existing VCE models are grossly inadequate for predicting the overpressure generated by unconfined hydrogen explosions. A new method was then developed for assessing overpressures from hydrogen explosions for a given concentration and volume of release based on Sach's scaling laws. The new model has much greater ability to fit the experimental data, hence much stronger ability to forecast the severity and consequences of hydrogen-based VCEs compared to the existing models.

Keywords: hydrogen; vapour cloud explosion; overpressure, blast wave, unconfined vapour cloud

Introduction

Hydrogen as a potential source of energy

A number of chemical processes use hydrogen as a raw material or as an intermediate (Khan and Abbasi 1998; 1999; 2001; Meibom and Karlsson, 2010; Abbasi and Abbasi, 2007; 2011). Its use as an energy carrier is being advocated and given patronage all over the world because it is perceived to have a far lesser greenhouse gas generation potential and significantly lesser deleterious impact on the environment compared to fossil fuels (Bose and Malbrunot, 2007; Winter, 2009). Once the technology to generate hydrogen at costs comparable or lesser to fossil fuels is developed, it may become as ubiquitous a source of energy as petroleum and natural gas presently are (Kang et al. 2015; Thomas et al. 2015; Ahmed et al. 2016; Alanne and Cao 2017; Ahmadi and Kjeang 2017).

Risks associated with hydrogen usage

When considering scenarios based on hydrogen as an energy source, questions inevitably arise on the safety aspects associated with the use of hydrogen. Such concerns can be addressed only by carrying out detailed risk assessments, of which an essential component is the assessment of consequences arising from accidents involving hydrogen. One of the most