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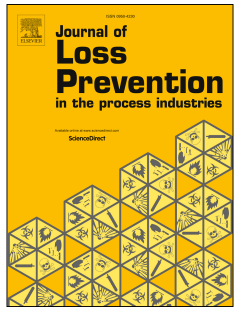

Numerical simulations of vented hydrogen deflagrations in a medium-scale enclosure

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Numerical simulations of vented hydrogen deflagrations in a medium-scale enclosure

I.C. Tolias[a,b], J.R. Stewart[c], A. Newton[c], J. Keenan[d], D. Makarov[d], J.R. Hoyes[c], V. Molkov[d], A.G. Venetsanos[a]

[a]Environmental Research Laboratory, National Center for Scientific Research Demokritos, Agia Paraskevi, Athens 15341, Greece
[b]National Technical University of Athens, School of Chemical Engineering, Heroon Polytechniou 9, Zografou, 15780, Greece.
[c]Health and Safety Executive, Harpur Hill, Buxton, SK17 9JN, UK
[d]HySAFER Centre, Ulster University, Newtownabbey, BT37 0QB, UK

Abstract

A validation study was performed to investigate the ability of Computational Fluid Dynamics (CFD) models to predict hydrogen deflagrations in vented enclosures. The validation exercise was aimed at assessing the suitability of CFD as a reliable tool for explosion safety assessments and involved comparing CFD predictions with measurements from an experiment carried out by FM Global in a 64 m^3 enclosure. The enclosure included a large square vent located in the center of one of its walls. The enclosure was filled with a homogenous hydrogen-air mixture of 18% v/v composition before ignition at its center. In this paper, CFD model predictions of the transient pressure and the flame speed are compared against experimental measurements. Additionally, peak over-pressure predictions are compared against empirical correlations and the NFPA 68 vent sizing standard. The study focuses on the prediction of the first overpressure peak that is generated by external explosion. The agreement between the models' predictions and experimental results is found to be satisfactory, which suggests that CFD models have the potential to predict explosion phenomena with reasonable accuracy. However, more extensive model validation and sensitivity studies are required before CFD models can be used with confidence in explosion safety assessments.

Keywords: CFD validation, FM Global experiment, vented hydrogen deflagration, external explosion, safety assessment

NOMENCLATURE

S_u	Burning velocity (m/s)	*Greek letters*	
S_u^w	Subgrid burning velocity (m/s)	ρ	Mixture density (kg/m^3)
S_L	Laminar burning velocity (m/s)	μ	Dynamic viscosity (kg/m/s)
S_{QL}	Quasi-laminar burning velocity (m/s)	Ξ_k	Wrinkling factor due to turbulence generated by the flame front itself
S_t	Turbulent burning velocity (m/s)	Ξ_{lp}	Wrinkling factor due to leading point mechanism
u'	SGS or fluctuating velocity component (m/s)	Ξ_f	Wrinkling factor due to fractal increase of flame surface area