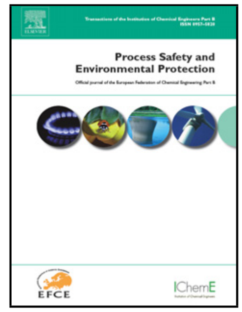

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Experimental study of turbulent explosions in hydrogen enriched syngas related fuels

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Abstract

The role of hydrogen enriched fuel streams has come to the fore due to the use of syngas and/or biogas related feedstocks in gas engine or gas turbine based power generation applications. The hydrogen addition can enhance the fuel reactivity significantly, leading to improved combustion stability and widened flammable limits, but also raises safety concerns related to accidental explosions. The current work presents a systematic study of turbulent deflagrations generated in an obstructed tube with explosion overpressures and flame speeds measured. The focus is on the use of lean and ultra-lean fuel blends using binary H_2/CO, H_2/CH_4 and ternary H_2/CH_4/CO mixtures. The H_2 levels were varied between 0 and 100% at stoichiometries of 0.80, 0.60 and 0.40. The results highlight significant differences in explosion behaviour between the two blending components, with CO mixtures providing substantially higher overpressures than the corresponding CH_4 blends. The results suggest that methane has a mitigating effect up to comparatively high hydrogen blending fractions and that synergistic effects between fuel components need to be taken into account. A new scaling parameter (β) is proposed that successfully linearises the peak explosion overpressure between different fuel blends in response to the hydrogen concentration. A scaling based on acoustic theory shows good agreement with experimental data and a simple method for estimating the overpressure change caused by variations in the mixture reactivity in a fixed geometry is also evaluated.

Keywords: Hydrogen enrichment, Syngas, Explosions, Fuel lean blends, Scaling

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