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CFD modelling of pre-mixed natural gas-air deflagrations in an open ended tube using FLACS

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The combustion of pre-mixed flammable hydrocarbons are a major safety hazard for people working in petroleum extraction, refinement, and transportation. Fires and explosions due to gas leaks being exposed to ignition sources have the potential to cause catastrophic accidents. Resulting in fatalities, equipment damage, and property loss. The aim of this study was to investigate the conditions required for flame propagation and deflagration. A 30 m steel pipe with 0.5 m diamater was filled with a natural gas-air mixture (consisting of 1.25%, 2.5%, 5%, 7.5%, 9.5%, 10%, 12.5%, and 15% v/v.) and ignited using a 50 mJ chemical igniter. The tube was opened at the non-ignition end. This experiment was simulated using the computational fluid dynamics (CFD) software FLACS 10.4 – developed by Gexcon. Comparison was made between simulation results, and the data collected from detonation tube experiments at the University of Newcastle, Australia, and was used to validate the computational methods. Various improvements to the modelling technique were made, and considerable agreement between simulations and experiemental results was found. Particularly concerning the rate of combusion, flame speed, and the pressure wave development. FLACS was able to predict when a combustion event would develop from a flame into a deflagration, and also predict when Deflagration-to-Detonation Transition (DDT) was likely to occur. Allowing the interrogation of these processes to a much greater extent than might be possible with experimental work. This study will aid the understanding of flame propagation and enable the improvement of explosion mitigation technologies.

Biography

B A Pitkin is a Post-graduate research candidate at the University of Newcastle, NSW, Australia. He has over 10 years of industry experience, as a mechanical engineer, in the defence, manufacturing, and coal mining industries. His current research topic is on the application of water based mitigation of fires and explosions caused by pre-mixed hydrocarbon-air combustion.

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