DYNAMIC FLAME BEHAVIOUR IN A STRAIGHT AND 90-DEGREE BEND PIPE FOR PREMIXED HYDROGEN/AIR AND METHANE/AIR FLAME PROPAGATION

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Abstract:
Flame propagation inside a pipe is a complex phenomenon[1]. Worst, the fundamental issues on the physical and dynamic flame behaviour such as flame acceleration, pressure waves and flow turbulence are still unclear[2]. This paper reports on the experimental and numerical analyses towards understanding the combustion wave propagation in hydrogen and methane explosions, with the effect of pipe sizes and configurations. The experimental works were performed in a straight and 90-degree bend pipe with the length to diameter ratio, L/D is 40 and 51. FLACs code simulation was adopted to investigate the dynamic of flame behaviour in the pipes. From the results, it was observed that the presence of 90-degree bend enhances the explosion severity by a factor of 1.03-3.58 as compared to that of the straight pipe. Based on the simulation analysis (refer to the Figure 1), the compression effect and reversal flow at the bending region and the compression effect at the end of the pipe plays an important role to attenuate the burning rate, which results to a higher flame speed and hence, increases the pressure wave[3]. A maximum pressure wave of 700 kPa with the flame speed of 600 m/s was observed in the smaller pipe of L/D=40 with hydrogen fuel which indicated that the detonation-like event takes place. The ability of the flame to quench becomes insignificant in a smaller pipe, promoting a strong interaction of the fast flame and turbulence, particularly at the bending[4]. This phenomenon amplifies the mass burning rate, increases the flame speeds and leading to a higher pressure rise. From the results, it shows that fuel reactivity and pipe size and configuration gives a significant effect on the pressure wave and flame acceleration development which can lead to a catastrophic explosion.

Keywords: Pressure wave, Fast flame, Compression effect, Reversal flow, Turbulence

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