Experimental Determination of Critical Conditions for Hydrogen-air Detonation Propagation in Partially Confined Geometry

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An experimental investigation was performed to determine critical semi-open channel height (h^*) in which detonation may propagate in hydrogen-air mixture. Three types of gaseous mixture composition were used: 25%, 29.6% and 40% of hydrogen in air. Experimental setup was based on rectangular (0.11x0.11x2 m) test channel equipped with acceleration section (0.11x0.11x1 m) and data acquisition system with 5 pairs of pressure transducers and ion probes. Different channel heights h in range of 15 -40 mm were used in the test channel. The critical height h* was defined for each investigated mixture. Additionally, sooted plates technique was used to determine detonation cell sizes λ and their relationship to h*. The results showed that detonation in H₂-air mixture may propagate in semi-open channel only when the channel height is equal to around 3 cell sizes. The exact h^*/λ ratios obtained were 3.6, 2.8 and 3.13 for mixtures of 25%, 29.6% and 40% H₂ in air respectively. Moreover, with decreasing the channel height to the critical value, progressive detonation velocity deficiency along the test channel was observed which suggests the gas expansion behind the detonation front as a factor responsible for the detonation failure. The detonation velocity deficiency was in range of 5.2 - 7.5% which is below the necessary range of 8 - 10% reported in the literature.