

Explosion characteristics assessment of premixed biogas/air mixture in a 20-L spherical vessel

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ABSTRACT

The understanding of biogas explosion characteristics is needed to describe the severity of the explosion. Biogas is a flammable gas and will explode when ignited. This study reports the experimental results on biogas explosion characteristics in a standard 20-L spherical vessel under quiescent conditions using electric spark (10 J) as an ignition source. Computational Fluid Dynamic (CFD) code FLame ACceleration Simulator (FLACs) was used to simulate the biogas explosion based on the experimental case study. The dependence of explosion characteristics such as explosion pressure (P_{\max}), rate of pressure rise (dP/dt), and deflagration index (K_G), on biogas concentration and carbon dioxide, CO_2 composition is demonstrated. The data allow for the evaluation of the potential severity of biogas explosion, which in turn helps engineers design the explosion mitigation and prevention device related to this gas. The experimental data reported from this study concluded that $P_{\max} = 8\text{--}8.50$ bar, the $dP/dt = 100\text{--}400$ bar/ms and the $K_G = 32.7\text{--}121$ bar m/ms were recorded at equivalence ratio, (ER) = 1.2 with CO_2 composition in the biogas = 30% vol/vol. It was found that the severity of the biogas explosion increased proportionally with the biogas concentration. On the contrary, the explosive intensity was weakened by increasing the CO_2 concentration due to the physical effects of CO_2 and thermal instability. This study also recorded that the biogas explosion was categorized under hazard level = St-3 indicating a catastrophic explosion. These data are important for preventing and mitigating the biogas explosion.

KEYWORDS

Biogas; Deflagration index; Explosion pressure; Maximum explosion overpressure; Maximum rate of pressure rise

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