

Effect of TPRD Diameter and Direction of Release on Hydrogen Dispersion in Underground Parking

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ABSTRACT

Unignited hydrogen release in underground parking could be considered inherently safer if the safety strategy to avoid the formation of the flammable hydrogen-air mixture under a ceiling is followed. This strategy excludes destructive deflagrative combustion and associated pressure and thermal effects in the case of ignition. This paper aims at understanding the effects of the thermally activated pressure relieve device (TPRD) diameter and direction of release on the build-up of hydrogen flammable concentration under the ceiling in the presence of mechanical ventilation required for underground parking. The study employs the similarity law for hydrogen jet concentration decay in a free under-expanded jet to find the lower limit of TPRD diameter that excludes the formation of a flammable mixture under the ceiling during upward release. This approach is conservative and does not include the effect of mechanical ventilation providing flow velocity around a few meters per second, which is significantly below velocities in hydrogen momentum-dominated under-expanded jets. Hydrogen releases downwards under a vehicle at different angles and with different air velocities due to mechanical ventilation were investigated using computational fluid dynamics (CFD). The joint effect of TPRD diameter, release direction and mechanical ventilation is studied. TPRD diameters for the release of hydrogen upwards and downwards preventing the creation of flammable hydrogen-air mixture under the parking ceiling are defined for different ceiling heights and locations of TPRD above the floor. Recommendations to the design of TPRD devices to underpin the safe introduction of hydrogen fuelled vehicles in currently existing underground parking and infrastructure are formulated."

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