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Simulation of Releases from Hydrogen Fuel-Cell Vehicles in Tunnels

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Abstract

An important issue concerning the safe use of hydrogen-powered fuel-cell vehicles is the possibility of accidents inside tunnels resulting in the release of hydrogen. Releases of hydrogen from high-pressure vehicle gaseous storage tanks are designed to occur only for conditions where a heat source, such as a fire, is present to actuate the thermal pressure relief device (TPRD). It is presumed that this heat source also serves as an ignition source that will immediately burn the released gas. A highly unlikely scenario is the case where the released hydrogen remains unignited for some period of time followed by a possible ignition. For such a scenario, computation fluid dynamics (CFD) simulations have been used to model the release from a hydrogen fuel-cell vehicle and to study the behavior of the ignitable hydrogen cloud inside the tunnel. Simulations have been performed for vehicle releases inside both longitudinally and transversely ventilated tunnels for different tunnel ventilations rates. Deflagration overpressure simulations of the hydrogen cloud within the tunnel have also been performed for different ignition delay times and ignition locations. Results of the hydrogen fuel-cell vehicle releases are compared with simulations for releases of compressed natural gas vehicles and a simple risk evaluation is presented based on the results of the simulations.