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# Buoyant Gas Dispersion in a Small Fuel Cell Enclosure: A Comparison Study Using Plain and Pressed Louvre Vent Passive Ventilation Schemes

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**Abstract :** The transition from a 'carbon rich' fossil fuel dependent to a 'sustainable' and 'renewable' hydrogen based society will see the deployment of hydrogen fuel cells (HFC) in transport applications and in the generation of heat and power for buildings, as part of a decentralised power network. Many deployments will be low power HFCs for domestic combined heat and power (CHP) and commercial 'transportable' HFCs for environmental situations, such as lighting and telephone towers. For broad commercialisation of small fuel cells to be achieved there needs to be significant confidence in their safety in both domestic and environmental applications. Low power HFCs are housed in protective steel enclosures. Standard enclosures have plain rectangular ventilation openings intended for thermal management of electronics and not the dispersion of a buoyant gas. Degradation of the HFC or supply pipework in use could lead to a low-level leak and a build-up of hydrogen gas in the enclosure. Hydrogen's wide flammable range (4-75%) is a significant safety concern, with ineffective enclosure ventilation having the potential to cause flammable mixtures to develop with the risk of explosion. Mechanical ventilation is effective at managing enclosure hydrogen concentrations, but drains HFC power and is vulnerable to failure. This is undesirable in low power and remote installations and reliable passive ventilation systems are preferred. Passive ventilation depends upon buoyancy driven flow, with the size, shape and position of ventilation openings critical for producing predictable flows and maintaining low buoyant gas concentrations. With environmentally sited enclosures, ventilation openings with pressed horizontal and angled louvres are preferred to protect the HFC and electronics inside. There is an economic cost to adding louvres, but also a safety concern. A question arises over whether the use of pressed louvre vents impairs enclosure passive ventilation performance, when compared to same opening area plain vents. Comparison small enclosure (0.144m³) tests of same opening area pressed louvre and plain vents were undertaken. A displacement ventilation arrangement was incorporated into the enclosure with opposing upper and lower ventilation openings. A range of vent areas were tested. Helium (used as a safe analogue for hydrogen) was released from a 4mm nozzle at the base of the enclosure to simulate a hydrogen leak at leak rates from 1 to 10 lpm. Helium sensors were used to record concentrations at eight heights in the enclosure. The enclosure was otherwise empty. These tests determined that the use of pressed and angled louvre ventilation openings on the enclosure impaired the passive ventilation flow and increased helium concentrations in the enclosure. High-level stratified buoyant gas layers were also found to be deeper than with plain vent openings and were within the flammable range. The presence of gas within the flammable range is of concern, particularly as the addition of the fuel cell and electronics in the enclosure would further reduce the available volume and increase concentrations. The opening area of louvre vents would need to be greater than equivalent plain vents to achieve comparable ventilation flows or alternative schemes would need to be considered.

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