Hydrogen Risk Assessment and Management for Hydrogen Economy

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1. Objectives and Primary Stakeholder

- Support the development of new energy-related technologies and develop hydrogen hazard assessment tools and mitigation measures to ensure safety for hydrogen production, storage, delivery and dispensing.
- NRCan (important for hydrogen economy and use of hydrogen for transport).

2. Hydrogen Hazard Assessment Approaches and Tools

- Performed a literature review to gather the state-of-art knowledge on **quantitative risk assessment** (QRA) methodologies and engineering correlations.
- Establishing **theory manual** for an engineering toolkit developed by the Université du Québec à Trois-Rivières (UQTR); collaboration with UQTR for further development.
- Evaluated **engineering correlations** of H_2 jets to determine maximum extent (ME) of flammable mixture (Fig. 1).

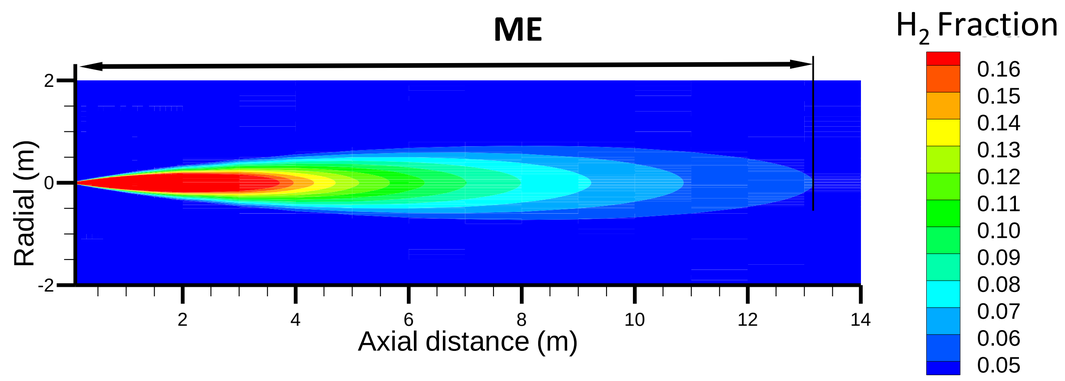

Figure 1 2D contour of unignited H_2 jet

3. Passive Hydrogen Ventilation System

- Venting is the most **effective** measure to prevent hydrogen explosions, but **expensive** in extreme climates.
- Developed a **passive ventilation** concept to mitigate hydrogen risks in case of leaks from an indoor hydrogen storage system (e.g., hydrogen vehicles in a garage);
- **Patent** application for the conceptual design is in progress.

[1] Z. Liang, A. McKenna, T. Clouthier, R. David, Experimental study on accumulation of helium released into a semi-confined enclosure without ventilation, *8th Int. Conf. Hydrog. Safety*, Australia, Sep. 24-26, 2019

4. Hydrogen Accumulation in Semi-Confined Space

- **Hydrogen accumulation** in confined spaces (e.g., fuelling station or garage) is a **safety concern** for the use of hydrogen as an energy carrier.
- Experiments in a polycarbonate enclosure, visualized with Background Oriented Schlieren (BOS) technique (Fig. 2) to examine the **effect of ventilation** on hydrogen mitigation.

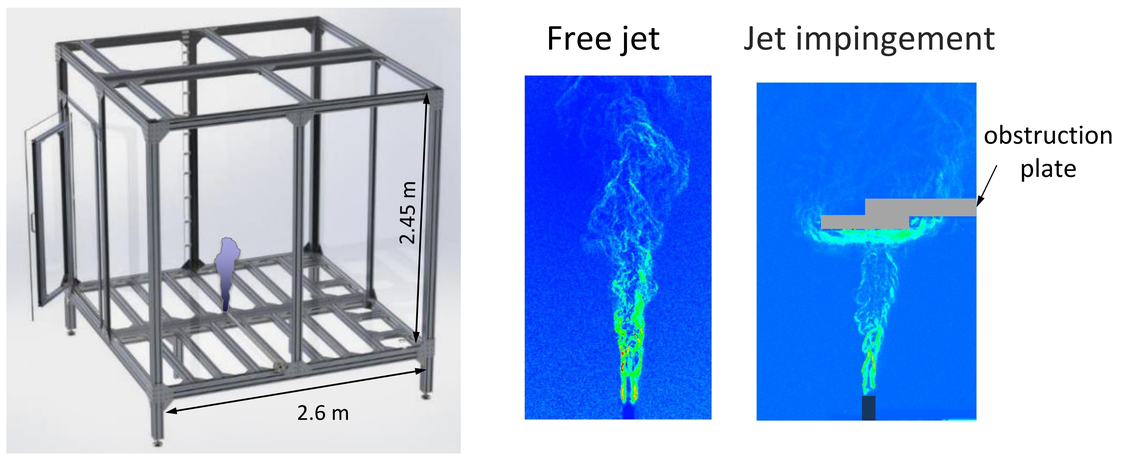

Figure 2 Schematic of test facility and examples of BOS technique for jet release

- Liang et al. [1] showed that the helium (a simulant of H_2) was nearly well mixed in the volume without an opening in the upper region (Fig. 3). Tests with vents on side walls to examine the effect of **natural/forced venting** are planned.

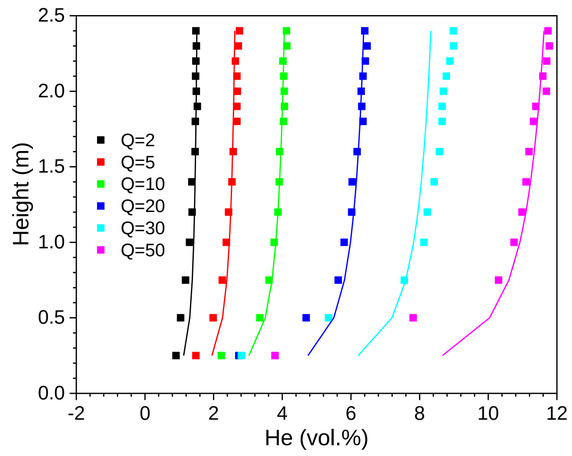

Figure 3 Comparison of measured & predicted vertical helium profile at various release rates (Q = 2 to 50 L/min)

5. Achievements, Expected Outcome and Future Work

- **Journal publications** on experimental studies and patent submission for passive ventilation strategy for mitigation of hydrogen risk for indoor storage.
- Validated **engineering toolkit** to assist with the design and assessment of hydrogen installations.
- **Training material** for safe production, storage, transport and use of hydrogen.
- Considering **memberships** to connect with broader hydrogen community.