Canadian Hydrogen Convention

POSTER SESSION INFORMATION

WHY PRESENT A POSTER?

Participating in the Poster Session at the Canadian Hydrogen Convention Technical Conference is a great way to showcase your research, product, or service to high-level conference and exhibition delegates. In addition, your poster will be on display on both days of the conference and exhibition.

STEP 1: CONFIRM PARTICIPATION

Confirm your participation to the Poster Session by email to Dusan Krnjaja dusankrnjaja@dmgevents.com by **February 28, 2025.**

STEP 2: REGISTER

All Poster Session presenters will need to register for the technical conference and pay the poster fee online by **Friday, March 14, 2025.**

The fee for Poster Session participation for post secondary representatives is **$495.00 CAD** - discount code **STUDENTPOSTER25.** For company representatives the fee is **$895.00** CAD - discount code **POSTER25** to be used.

Poster fee includes a two-day discounted technical conference pass. The poster fee also covers the printing cost and assembly of the poster before and onsite at the event. ***PLEASE NOTE: ALL PARTICIPANTS WILL NEED TO PAY THE FEE BEFORE THE POSTER WILL BE PRINTED.***

Registration steps below:

- To register please go to https://www.hydrogenexpo.com/about/register/
- Select Technical Courses then add the appropriate discount code and click apply.
- Pay by credit card (Visa or Mastercard)
- Once the payment has gone through you will receive a confirmation email for your registration

STEP 3: CREATE POSTER

OFFICIAL POSTER SIZE: **760mm (W) x 1220mm (H)**

The poster **MUST** include the following information at the **TOP** of the document:

- Poster Title
- Author(s) of Poster
- Name of Company
- Contact Information
- Assigned CHC number

TIPS AND RECOMMENDATIONS FOR POSTER DESIGN

- Poster must be in **color**, using the **font "Helvetica"**, please ensure the font is large enough to read from several feet away.
- Include more diagrams instead of text, this will allow for more opportunity to engage with exhibition visitors and conference delegates. It's best to keep it informative and visually interesting.
- The poster can be designed by your marketing department if you have one or can be designed by yourself.
- The poster will be printed on foam board to ensure that all the posters are visually consistent.

STEP 4: SUBMIT POSTER FILE

DEADLINE TO SUBMIT POSTER FILE: **FRIDAY, MARCH 28, 2025**

- The file must be converted to a **Print Ready PDF Format**
- If the PDF file is 10 MB or smaller – you can email it directly to Dusan Krnjaja **dusankrnjaja@dmgevents.com**
- If the file is too big to send via email, please let us know and we will provide a link for you to use to transfer the file.

STEP 5: ONSITE AT THE EVENT

The posters will be displayed in the designated Poster Session area on the exhibition show floor on all two days of the show and conference from April 23-24, 2025.

- Posters will be printed and assembled before you arrive.
- Posters will be organized and grouped together on the exhibition floor in a designated area.
- You are not required to be beside your poster the entire two days, but we do recommend you be near your poster during the conference lunch and networking breaks. Exact times will be provided closer to the conference.
- Ensure you bring plenty of business cards to distribute to conference delegates and exhibition visitors.

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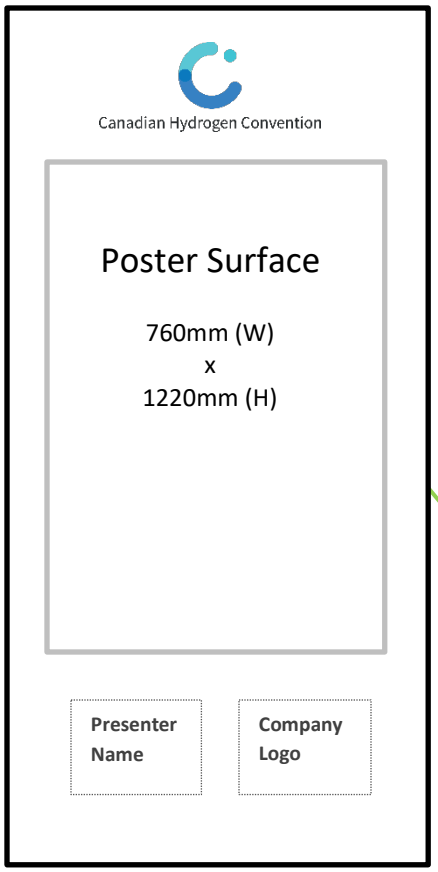
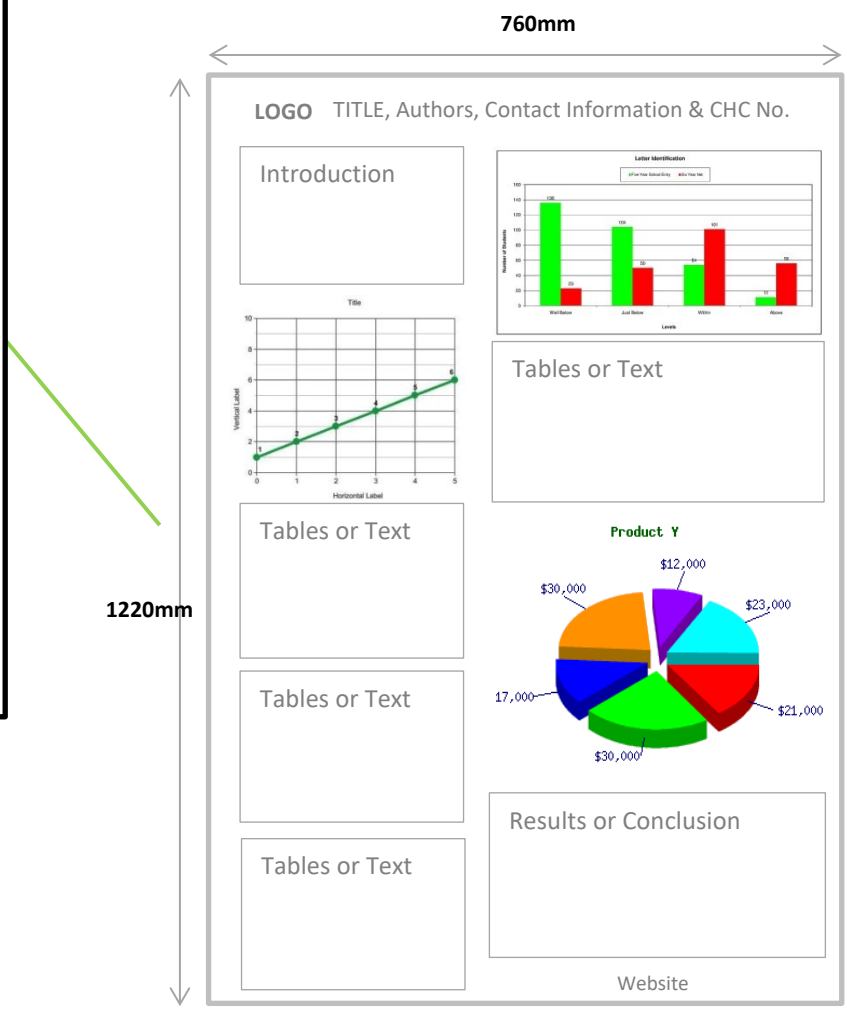
POSTER SESSION VISUAL AID

POSTER GUIDELINES (PRESENTER WILL DESIGN)

- Printed poster size is **760mm x 1220 mm**
- Font **MUST** be Helvetica
- Poster **MUST** include the following information:
  - **Full Poster Title**
  - **Author(s) of Poster** (Name, job title and company)
  - **Name or Logo of Company**
  - **Contact Information** (Email, telephone number and website address)
  - **Submission ID Number** (Number will be assigned to presenter)





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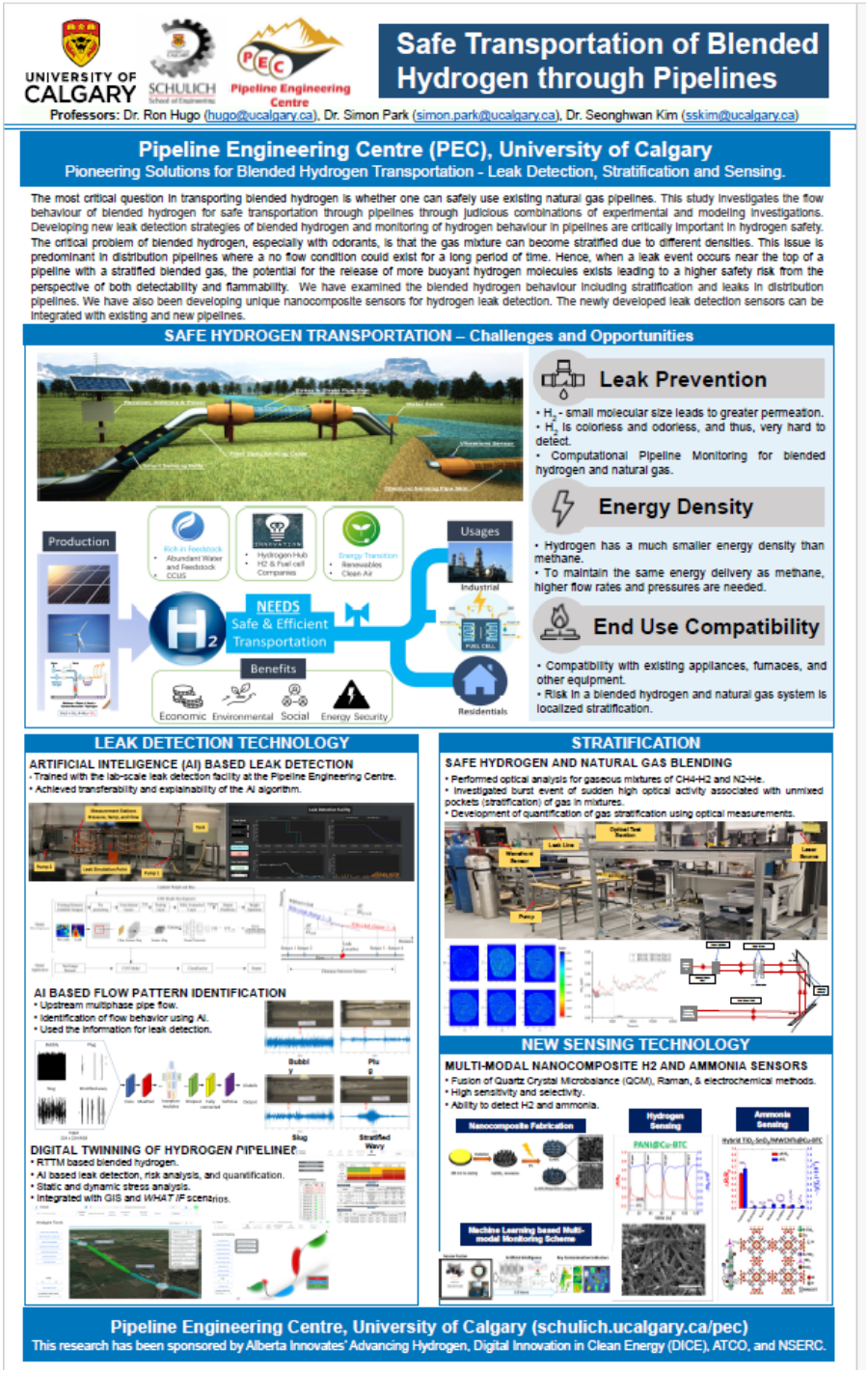
POSTER SESSION VISUAL AID

A visual representation of the Poster Session layout on the exhibition floor from previous Canadian Hydrogen Conventions.

EXAMPLES OF A SUCCESSFUL PAST POSTERS



Safe Transportation of Blended Hydrogen through Pipelines

UNIVERSITY OF CALGARY · SCHULICH School of Engineering · Pipeline Engineering Centre

Professors: Dr. Ron Hugo (hugo@ucalgary.ca), Dr. Simon Park (simon.park@ucalgary.ca), Dr. Seonghwan Kim (sskim@ucalgary.ca)

Pipeline Engineering Centre (PEC), University of Calgary

Pioneering Solutions for Blended Hydrogen Transportation - Leak Detection, Stratification and Sensing.

The most critical question in transporting blended hydrogen is whether one can safely use existing natural gas pipelines. This study investigates the flow behaviour of blended hydrogen for safe transportation through pipelines through judicious combinations of experimental and modeling investigations. Developing new leak detection strategies of blended hydrogen and monitoring of hydrogen behaviour in pipelines are critically important in hydrogen safety. The critical problem of blended hydrogen, especially with odorants, is that the gas mixture can become stratified due to different densities. This issue is predominant in distribution pipelines where a no flow condition could exist for a long period of time. Hence, when a leak event occurs near the top of a pipeline with a stratified blended gas, the potential for the release of more buoyant hydrogen molecules exists leading to a higher safety risk from the perspective of both detectability and flammability. We have examined the blended hydrogen behaviour including stratification and leaks in distribution pipelines. We have also been developing unique nanocomposite sensors for hydrogen leak detection. The newly developed leak detection sensors can be integrated with existing and new pipelines.

SAFE HYDROGEN TRANSPORTATION – Challenges and Opportunities

Production · Rich in Feedstock · Hydrogen Hub · Energy Transition · NEEDS · Safe & Efficient Transportation · Benefits · Economic · Environmental · Social · Energy Security · Usages · Industrial · Residentials

Leak Prevention

- H_2 - small molecular size leads to greater permeation.
- H_2 is colorless and odorless, and thus, very hard to detect.
- Computational Pipeline Monitoring for blended hydrogen and natural gas.

Energy Density

- Hydrogen has a much smaller energy density than methane.
- To maintain the same energy delivery as methane, higher flow rates and pressures are needed.

End Use Compatibility

- Compatibility with existing appliances, furnaces, and other equipment.
- Risk in a blended hydrogen and natural gas system is localized stratification.

LEAK DETECTION TECHNOLOGY

ARTIFICIAL INTELIGENCE (AI) BASED LEAK DETECTION

- Trained with the lab-scale leak detection facility at the Pipeline Engineering Centre.
- Achieved transferability and explainability of the AI algorithm.

AI BASED FLOW PATTERN IDENTIFICATION

- Upstream multiphase pipe flow.
- Identification of flow behavior using AI.
- Used the information for leak detection.

Bubbly · Plug · Slug · Stratified Wavy

DIGITAL TWINNING OF HYDROGEN PIPELINES

- RTTM based blended hydrogen.
- AI based leak detection, risk analysis, and quantification.
- Static and dynamic stress analysis.
- Integrated with GIS and WHAT IF scenarios.

STRATIFICATION

SAFE HYDROGEN AND NATURAL GAS BLENDING

- Performed optical analysis for gaseous mixtures of CH4-H2 and N2-He.
- Investigated burst event of sudden high optical activity associated with unmixed pockets (stratification) of gas in mixtures.
- Development of quantification of gas stratification using optical measurements.

NEW SENSING TECHNOLOGY

MULTI-MODAL NANOCOMPOSITE H2 AND AMMONIA SENSORS

- Fusion of Quartz Crystal Microbalance (QCM), Raman, & electrochemical methods.
- High sensitivity and selectivity.
- Ability to detect H2 and ammonia.

Nanocomposite Fabrication · Hydrogen Sensing · Ammonia Sensing · Machine Learning based Multi-modal Monitoring Scheme

Pipeline Engineering Centre, University of Calgary (schulich.ucalgary.ca/pec)

This research has been sponsored by Alberta Innovates' Advancing Hydrogen, Digital Innovation in Clean Energy (DICE), ATCO, and NSERC.

Depleted reservoir storage: mixing of hydrogen and cushion gas

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CHC23-206

Introduction / objectives

- Surface storage is prohibitively expensive given the large volumes of H_2 to be generated from renewables
- Options for underground H_2 storage (UHS) include (i) rock / salt caverns, (ii) aquifers, and, (iii) depleted hydrocarbon reservoirs (Tarkowski, 2019)
- For (iii) rates of mixing of H_2 and cushion gas (e.g. N_2 or CH_4) are typically unknown but are of critical importance when estimating formation losses and post-production purity

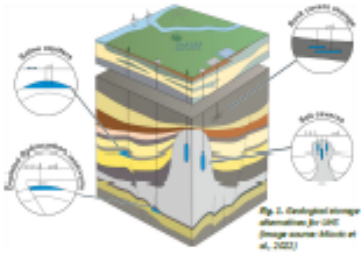


Fig. 2. Geological storage alternatives for UHS (Image source: Miocic et al., 2022)

Q? Can we develop simple models to predict rates of H_2 mixing by dispersion into cushion gas so as to inform feasibility assessments for industrial-scale projects?

Modeling

Theoretical model

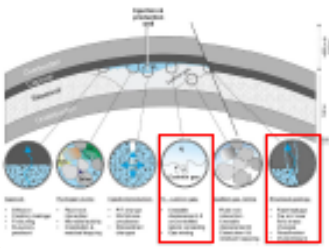
- Porous media flow described using Darcy's law and a semi-empirical expression for the mixing of H_2 and cushion gas adapted from Sahu & Neufeld (2020)

Similitude experimental model

- Complementary laboratory experiments run at ambient conditions to characterize injectate mixing in a saturated porous medium comprised of glass beads (c.f. Bharath & Flynn, 2021)

Numerical model

- Complementary numerical experiments run using COMSOL Multiphysics using Darcy's law (di) and transport of diluted species (tds) interfaces



In all of the above models, we allow for simultaneous dispersion and (fissure) drainage of H_2

Fig. 3. Factors impacting H_2 storage security (Image source: Heinemann et al., 2021)

Results

- Laboratory images confirm that significant dispersion arises downstream of fissure(s)
- Source fluid drains from fissure(s) so cannot overtake dispersed fluid formed from the mixing of the injectate (mimicking H_2) and the ambient fluid (mimicking e.g. N_2 or CH_4)

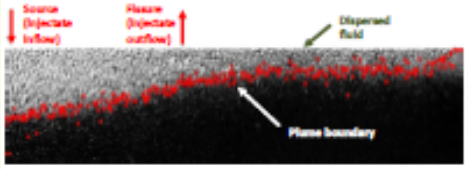


Fig. 5. Flow and dispersion of an injectate plume in a saturated porous medium comprised of glass beads

- Evidence of dispersion is likewise apparent in COMSOL-based numerical simulations, which are more amenable to comparison with theory
- Despite requiring minimal computational resources, the theoretical model correctly predicts the location of the source-dispersed interface and the dispersed-ambient interface

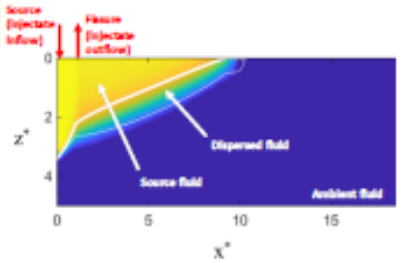


Fig. 6. Flow and dispersion of an injectate plume as determined from COMSOL-based numerical simulations. The third and fifth solid lines respectively indicate the theoretically predicted source-dispersed interface and the dispersed-ambient interface.

- By increasing the dip angle or the fissure width / permeability, draining becomes more robust and the volume of dispersed fluid increases
- The theoretical model allows us to predict the volume and buoyancy of the dispersed vs. source fluid as a function of dip angle, fissure properties and source conditions
- Estimates can therefore be made of the amount of H_2 that will be impacted by H_2-cushion gas mixing processes

Conclusions / outlook

- By combining similitude laboratory experiment, numerical simulation and theoretical analysis, we have developed a way to estimate the severity of H_2-cushion gas mixing
- So far, we have considered discrete (vs. distributed) drainage and uniform (vs. nonuniform) porous media; relaxing these assumptions is the topic of on-going research
- H_2-cushion gas mixing has a direct bearing on the economic viability of UHS projects because too much mixing implies unacceptably high losses / impurities
- On the other hand, H_2 storage in depleted hydrocarbon reservoirs has enormous potential to lower seasonal storage costs by avoiding many of the challenges of using e.g. salt caverns
- Given the large number and variety of depleted hydrocarbon reservoirs in Alberta and Saskatchewan, Canada is uniquely positioned to advance this technology to pilot then full-scale operations

References

1. Bharath, K.S. and M.R. Flynn, 2021: Buoyant convection in heterogeneous porous media with an inclined permeability jump: an experimental investigation of filling-box-type flows. *J. Fluid Mech.*, **924**, A35.
2. Heinemann, N. et al., 2021: Enabling large-scale hydrogen storage in porous media – the scientific challenges. *Energy Environ. Sci.*, **14**, 853.
3. Miocic, J. et al., 2022: Underground hydrogen storage: a review. *Geological Society, London, Special Publications*, **528**(1). https://doi.org/10.1144/SP528-2022-88
4. Sahu, C. and J.A. Neufeld, 2020: Dispersive entrainment into gravity currents in porous media. *J. Fluid Mech.*, **898**, A5.
5. Tarkowski, R., 2019: Underground hydrogen storage: Characteristics and prospects. *Renewable and Sustainable Energy Reviews*, **105**, 86-94.

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