Mine Hydrogen Power: Avancements, needs

Presentation to the Hydrogen Mine Power Seminar

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Drivers for Cleaner Energy Application

Important Considerations for the Mining Industry

- Workplace health
  - New generation of diesel engines to meet cleaner air requirements (EPA Tier 4)
  - Considerations related to the 2012 WHO underground diesel power use health warning
  - Sought: alternative energy to eliminate all emissions, viable operational replacement
  - In some cases, e.g., fuel cells, significant reduction in noise generation, vehicle heat load in deep mines
- Rising oil prices
  - Replacing diesel
- Economic opportunity for the industry through cost reductions
  - Reducing required ventilation
  - Diesel equipment, maintenance, downtime, automation vs electric motor lower maintenance costs, higher reliability
  - Less loss-time due to diesel-related health issues
  - Automation, tele-remote operation improved
- Keeping pace with surface vehicle clean energy drive
- Clean Energy - Changing climatic conditions
  - GHG reduction

Hydrogen Mine Power Implementation 2000-2019

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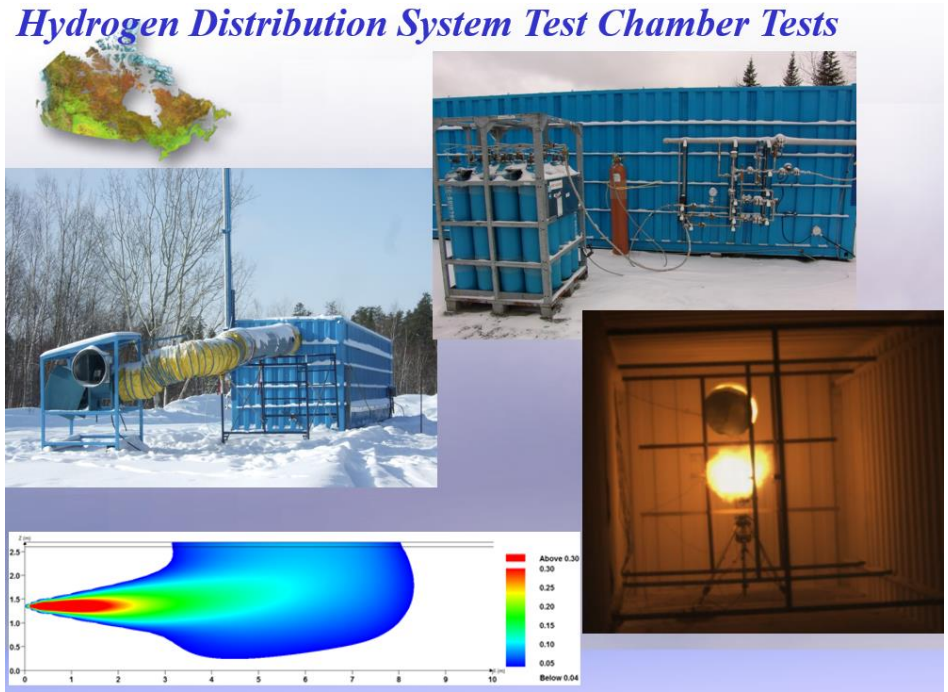
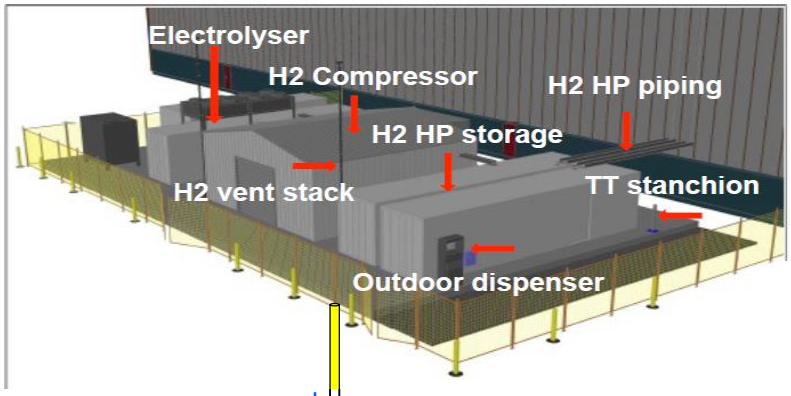
Historical Developments

- Fuel cells work in underground environments
- Hydrogen leaks from infrastructure is very small, only man-made accidents represent worse leak cases
- Hydrogen behaves underground as per theory
- 25-50% savings on ventilation ($500k-$1.5M/year)
- 25% less GHGs
- Mine production locomotive assembled, tested in mines
- Mine production loader assembled, tested in mine



Current Developments

- Design completed: standard on-site hydrogen production, storage and distribution (average mine, 1,200 kg/day, all mine vehicles)
- Design completed: refueling installation underground
- Risk potential and evaluation methodology
- Risk reduction through engineering and administrative action (e.g. safety shut-down with sensors; 3 sec hydrogen release max.; protection of pipeline; electric equipment zoning, spark-free fans, protocols)
- Codes and standards exist for infrastructure components
- Towards CHIC for mines



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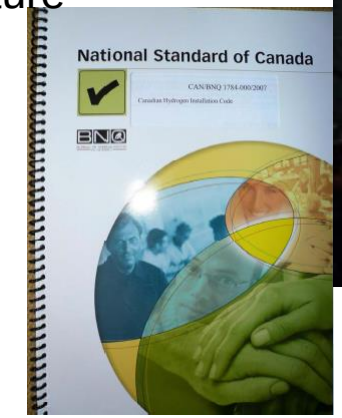


Leak Scenarios

Risk is based on the two events

- Leak occurring
- Spark

Examples, sources of sparking that commonly occur underground

- Contacts
- Electric motors
- Welding
- Diesel engines

Credible leaks from infrastructure

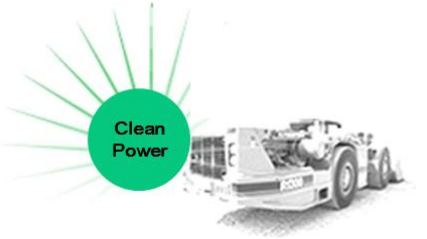
- 90-96% of all leaks
    - < 0.1-0.2 mm wide
    - 0.03%-0.1% of pipe cross-sectional area
- Worst case scenario will be man-made

The ignition source must have sufficient energy, duration and position in the leak cloud concentration

Try to remove some ignition sources, prevent man-made leaks

Mining Context

- Mine hydrogen installations require supplementary considerations for an installation code
  - Stringent mining regulations for safety in confined spaces
  - Underground atmosphere conditions (mineral dust mostly corrosive, dampness, diesel emission gases)
  - Presence of other vehicle power systems that can represent source of ignition risks (diesel ICE, lithium ion batteries)
  - Shock and vibration and impacts imposed to fuel cell vehicles
  - Stability of the underground rock mass periphery



CHIC for Mining

- For surface and underground, compliance with the jurisdiction's mine regulations adds additional considerations driven by risk and safety
- Requirements for surface installation in general follows the CHIC
- Underground distribution pipeline, dispenser, dispensing stations and surrounding areas will follow the CHIC and additions given the enclosed, mining operation context
- Main examples of underground considerations:
    - Spark free equipment and ignition avoidance
    - Protection of equipment from mining vehicles, mine fires and falls of rock
    - Placement and design of dispensing stations and ventilation
    - Underground and surface emergency shut-down
    - Marking of underground equipment and of mine accessways
    - Dispensing station and surrounding entrance protocols
    - Sensors for mine conditions

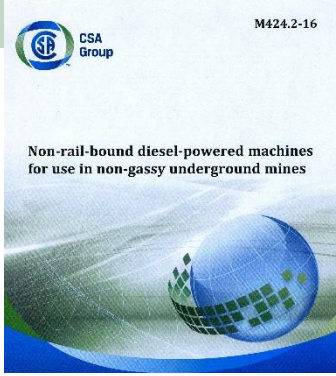
Current Developments

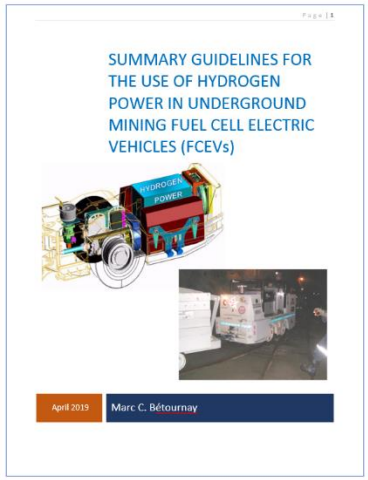
- NRCan provides funding to “kick start” new CSA M424 code for alternate energy mining vehicles, basis for mine regulation

- CHIC development

- CanmetMINING issues guidelines for the use of hydrogen power in underground mining:
  - Mining companies
  - Mining equipment manufacturers
  - Regulatory agencies
  - Technology suppliers

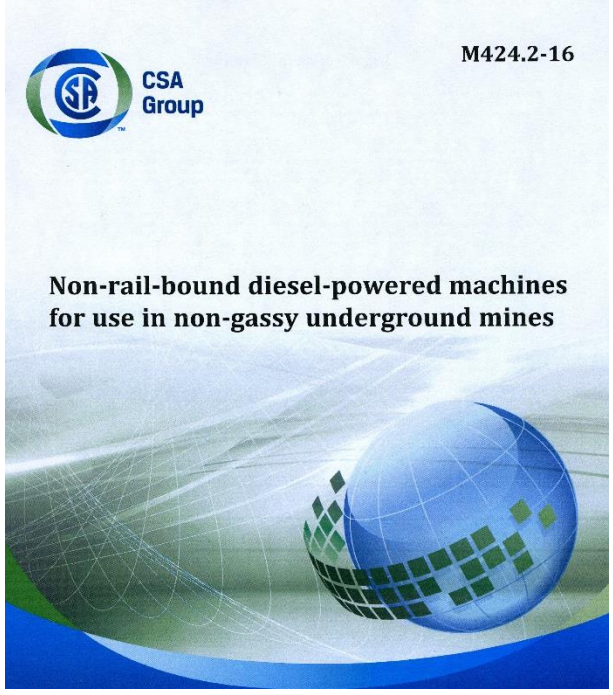
- CanmetMINING hosts major seminar for stakeholder update and interaction





Future Developments

- CanmetMINING will participate in writing the new CSA M424
- Completion of the CHIC for mines
- Risk analysis for fuel cell vehicles and leaks located in hazardous mine areas
- Mine project support
- Mine regulations development support



Questions?