Introduction:

• Hydrogen is an important carbon free emissions energy carrier for future.

• The hydrogen can be introduced into the pipeline network to reach end-users (e.g., fuel cell or burning).

• The existing gas pipeline networks are designed, constructed, and operated based on natural gas.

Hydrogen deflagration and detonation:

![Chemical Explosion]

- **Deflagration**
  - A subsonic wave
  - Duration of many milliseconds
  - Flat, without abrupt shock front
  - Low maximum pressure (1-2 atm)

- **Detonation**
  - A supersonic wave
  - Duration of < 1ms
  - Sharp, with an abrupt pressure
  - A maximum pressure of > 10 atm

Safety concerns:

• From a safety point of view, H₂ is different with a unique set of physical properties and combustion characteristics:
  - Small atom/molecule
  - High diffusion rate in solid matter
  - Wide range of flammability
  - Fast flame propagation in flammable mixtures
  - Low ignition energy (0.017mJ that is 200 times less than CH₄)

Small leaks of hydrogen have potential to burn or explode

![Flammability Range]

- 0% - 4% Flammability range
- 4% - 75% Flammability range
- Detonation range

![Minimum Ignition Energy]

- Hydrogen: 0.017 mJ
- Methane: 0.2 mJ
- Propane: 0.5 mJ
- Gasoline: 0.7 mJ
- Methanol: 0.9 mJ

Objectives:

• Bench-scale study using the flame propagation tube (4m long) at UON

• Pilot-scale study using the detonation tube facility (30m long) at UON

- Effect of different parameters on the explosion pressure rise/flame temperature and flame deflagration velocity profiles:
  - H₂ concentration
  - Obstacles (e.g., circular opening, square opening, etc.)
  - Tube configuration (e.g., Straight tube, Elbow-shaped tube, Branched tube)
  - Flame arrester
- Mitigation studies using countermeasures such as burst panels, detonation arrestors, chemical suppression system, and water spray.

Expected outcome:

• Acquire a comprehensive set of data to assist in the design and fabrication of hydrogen explosion prevention and mitigation countermeasures for industrial and residential applications.

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