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Abstract

Over more than 60 years, Canadian Nuclear Laboratories (CNL) has developed expertise on hydrogen to support the development and expansion of the Canadian nuclear industry. Hydrogen research in the nuclear industry arises from hydrogen safety in nuclear reactors, hydrogen interaction with materials, and hydrogen isotopes production and management. CNL continues to grow its expertise in areas of the hydrogen value chain including production and storage technology development. Research on hydrogen safety now includes non-nuclear applications to support the development of safety technologies and improvement of codes and standards in Canada and abroad.

As part of the hydrogen materials and storage research, CNL has developed capabilities in Underground Hydrogen Storage (UHS) research since 2018. These capabilities are aimed to develop and deploy UHS as a low-cost bulk hydrogen storage option through:

- Characterization of geologic material samples with pure hydrogen at varying conditions,
- Understanding leak mechanisms and developing control strategies,
- Site specific safety and environmental risk assessment, and
- Techno-economic analysis of UHS based on location and regional energy infrastructure.

CNL strives to assess and inform site selection for cavern project developers as an independent entity and aims to advance standards such as CSA Z341 to account for the unique hazards and properties of hydrogen. CNL has also built in-house techno-economic models to assess UHS in greater detail and set up two laboratory-scale experimental systems to test and characterize different materials. The two experimental systems, both of which have been recently commissioned and tested, are the following:

1. A uniaxial microcolumn system that was designed to assess well-completion materials for hydrogen sealing characteristics under high differential hydrogen pressure.
2. A triaxial core holder designed to analyse NQ sized core specimens.

Both systems are in CNL's Hydrogen Research Laboratory Complex in Chalk River, ON. The hydrogen laboratory complex was completed in 2015 and has been designed and built to meet the Canadian Hydrogen Installation Code (CAN/BNQ 1784-000). As such, this state-of-the-art hydrogen facility enables safe laboratory-scale testing involving large volumes of pure hydrogen at high pressures and temperatures.

Detailed description of the two experimental systems will be presented in this paper with some preliminary data obtained during commissioning.

Key words: Hydrogen, Underground Hydrogen Storage, Geologic Core Analysis