Advanced Test Facility to Characterise ortho-para Hydrogen Conversion and Liquid Hydrogen Boil-Off

Kwanghee Jeong[1, S], Fuyu Jiao[1], Eric May[1], Michael L. Johns[1] and Saif Z.S. Al Ghafri[1, C]

[1]*Chemical Engineering, The University of Western Australia, Perth, Australia*
saif.alghafri@uwa.edu.au

Technologies that enable cost-effective hydrogen storage and distribution will be critical to developing domestic and global hydrogen supply chains. In this regard, liquid hydrogen (LH2) has emerged as a viable option that offers advantages in certain contexts, particularly when extremely high purities are required in end-use applications such as fuel cells. However, current hydrogen liquefaction technologies are limited by interconnected and related challenges, including ortho-para (O-P) hydrogen conversion and boil-off gas management. The substantial deficiency of LH2-relevant experimental data regarding the catalyzed O-P conversion kinetics and boil-off gas (BOG) during liquefaction must be addressed and validated. Here, we developed a laboratory capability (LH2Facility) at the University of Western Australia to characterize the catalytic O-P conversion kinetics and liquid hydrogen boil-off gas (BOG). The LH2Facility consists of (i) ortho to para hydrogen conversion, (ii) hydrogen liquefaction, and (iii) hydrogen boil-off monitoring. A single-stage cryocooler enables ortho-para measurements with varying amounts of catalyst, temperatures ranging between (350 and 25) K, and pressure up to 5 MPa, where the ortho-para ratio is monitored by in situ Raman spectroscopy using an in-line fibre optic probe. A dual-stage cryocooler is then used to liquefy hydrogen (at around 20 K and 1 bar) which is then transferred to a BOG test chamber, where temperature stratification and boil-off rates are studied at a varied heat ingress, liquid level, and system pressure. This talk will provide a summary of the design, engineering drawings, HAZOP, safety review, construction and commissioning of the LH2Facility. Initial measurements regarding O-P conversion, liquefaction performance and BOG rates will be presented.