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Application of ortho-para hydrogen conversion to hydrogen liquification process

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Abstract

Liquid hydrogen (LH2) has a density of 70.8 kg/m^3 at 1.01 bar and -252.9 °C, and the distribution and storage of hydrogen as liquid is regarded as one of the most feasible options from energy, technical and economic perspective. However, the high energy consumption for hydrogen liquification is one of the major challenges. In order for a long-term storage of LH2, the hydrogen in the ortho form must be converted to its para form. However, the conversion from the ortho to the para is an exothermic process (532 kJ/kg) and hence it further increases the energy consumption. In this talk, we presented the small-scale hydrogen liquefier that was recently designed, manufactured and commissioned in the CSIRO Clayton site. LH2 formation was evident from the temperature change in the liquefier. Ortho-para hydrogen conversion (OPC) at a LN2 temperature (e.g., 77 K) was carried out in the presence of hydrous ferric oxide catalyst. Effect of gas hourly specific velocity (GHSV) on the OPC catalytic conversion was investigated while the quantification of orthohydrogen and parahydrogen was carried out by a Raman spectrum. The integration of catalyst with a Plate Fin Heat Exchanger (PFHE) was modelled including heat and mass transfer, and chemical reaction kinetics. Effects of operation parameters on the PFHE performance were carried out. The experimental and modelling works are essential for designing a novel OPC reactor, aiming for reducing energy requirements for hydrogen liquification. This is crucial to support industries who endeavours transportation of a large-scale hydrogen in liquid, for example export from in Australia to overseas (e.g., Japan, Korea, etc).

Note: This document will be opened to the participants on IERE website before the Workshop and opened to the public afterward.