Decarbonizing H_2 Production in the Green Transition

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Project: New Porous Liquids for Gas Separation and Carbon Capture.

Funded by Norwegian Research Council.

Estimated progress of the PhD project:

Just started ...	< 50 %	> 50 %	Almost done ☺

Introduction

In 2022, 62 % of global hydrogen was produced from natural gas without carbon capture, utilization, and storage[1]. Steam Methane Reforming (SMR) with water gas shift which is the main process of H_2 production from natural gas, yields a product composition of 61% H_2, 19% CO_2, and 20% H_2O excluding the impurities [2]. It is essential to capture and store the produced CO_2 to produce blue hydrogen until the green transition takes over [3]. For H_2 to be utilized as a fuel with high energy density, the H_2 gas product mixture needs to be treated to produce high-purity H_2. The end-user applications such as different fuel cells, demand H_2 purities of 99.97% - 99.9995%. Therefore, the separation and purification unit should deliver H_2 at the highest recovery and highest purity with minimal energy input.

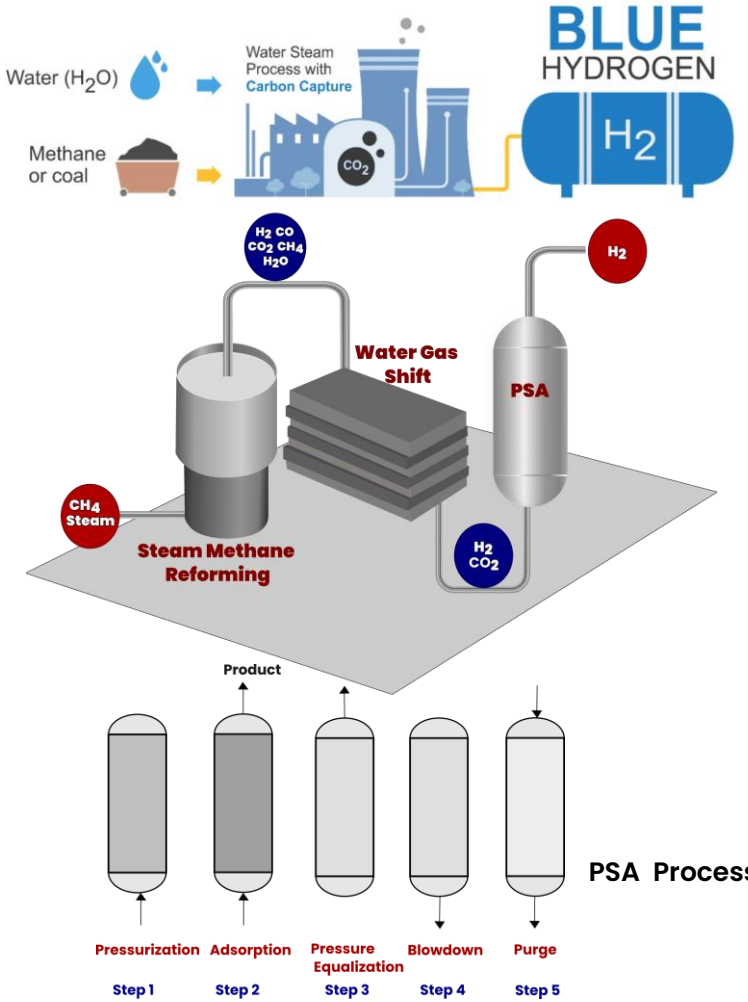
The future perspectives include enhancing the affinity of adsorbent materials for CO_2 to improve selectivity with better adsorption capacity and improving the material stability towards water and impurities. These could be achieved by modifying the surface area, pore sizes, and functionality of the materials.

Primary objective

- Investigating the potential of porous materials in gas separation.

Secondary objectives

- Developing PSA, TSA, and absorption-based systems using porous materials for carbon capture minimizing the drawbacks in current technologies.
- Purification and separation of gases such as hydrogen using the developed method.



PSA Process

Reference

1. IEA (2023), Global Hydrogen Review 2023, IEA, Paris https://www.iea.org/reports/global-hydrogen-review-2023, Licence: CC BY 4.0
2. Lei, L., Lindbråthen, A., Hillestad, M., & He, X. (2021). Carbon molecular sieve membranes for hydrogen purification from a steam methane reforming process. *Journal of Membrane Science, 627*. https://doi.org/10.1016/j.memsci.2021.119241
3. Noussan, M., Raimondi, P. P., Scita, R., & Hafner, M. (2020). The Role of Green and Blue Hydrogen in the Energy Transition—A Technological and Geopolitical Perspective. Sustainability, 13(1). https://doi.org/10.3390/su13010298

Norwegian Research School on Hydrogen and Hydrogen-Based Fuels

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