**SE-15.2 Integrated Hydrogen Separation and Storage from hydrogen-rich gas mixtures via LOHC hydrogenation (S)**

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In recent times energy storage via Liquid Organic Hydrogen Carrier (LOHC) systems has gained significant attention [1, 2]. This is mainly due to the fact that hydrogen storage in form of liquids offers the opportunity for energy storage on a very large scale and over long periods of time without losses. A high resistance of the hydrogenation catalyst system to $CH_4$, CO and $CO_2$ could open the possibility of selectively binding hydrogen from hydrogen-rich gas mixtures in liquid organic hydrogen carriers.

A potential application is the upgrading of stranded gas, for example, gas from a remote gas field or associated gas from off-shore oil drilling. Stranded gas can effectively be converted in a catalytic process by methane decomposition into solid carbon and a hydrogen/methane mixture that can be directly fed to a hydrogenation unit to load a liquid organic hydrogen carrier (LOHC) with hydrogen (see Figure 1).

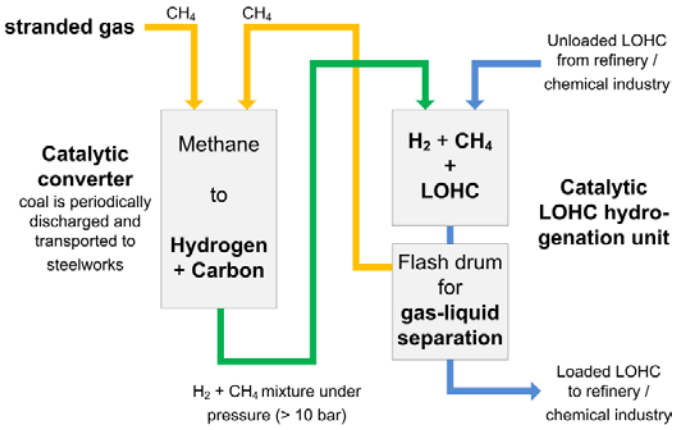


Figure 1: Two-step upgrading process for stranded gas

An integration of $CO_2$-free hydrogen generation through catalytic methane decomposition (CMD) coupled with hydrogen/methane separation and chemical hydrogen storage through LOHC systems is demonstrated [3]. Catalytic methane decomposition is an environmentally attractive approach to the production of hydrogen with reduced $CO_2$ emissions. However, nearly all studies on CMD have been performed at ambient pressure to date as an increase in total pressure is expected to have a detrimental effect on the reaction rate due to thermodynamic effects. Therefore, the influence of total pressure on the hydrogen yield in CMD was studied within the scope of this project.

Recent LOHC hydrogenation experiments applying a mixed gas phase show increased reaction rates for hydrogenation. Compared to the runs with pure hydrogen higher degrees of hydrogenation were achieved after given reaction times. Further experiments featuring different hydrogen and methane partial pressures did not reveal any further influence on reaction rate or reaction time.

Our contribution highlights the fact that a combination of catalytic methane decomposition (CMD) and hydrogen purification and storage by hydrogenation of LOHC systems offers a versatile, economically attractive and new way for upgrading stranded gas towards green, $CO_2$-free hydrogen production. The presentation will show LOHC hydrogenation as promising option for reversible hydrogen storage from hydrogen-rich gas mixtures and will discuss further aspects regarding catalyst stability and sensitivity to pressure, temperature and loading state of the LOHC system.

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[3] S. Dürr, M. Müller, H. Jorschick, M. Helmin, A. Bösmann, R. Palkovits, P. Wasserscheid, ChemSusChem 2017, 10, 42-47