Finding the chemical carrier option for hydrogen storage

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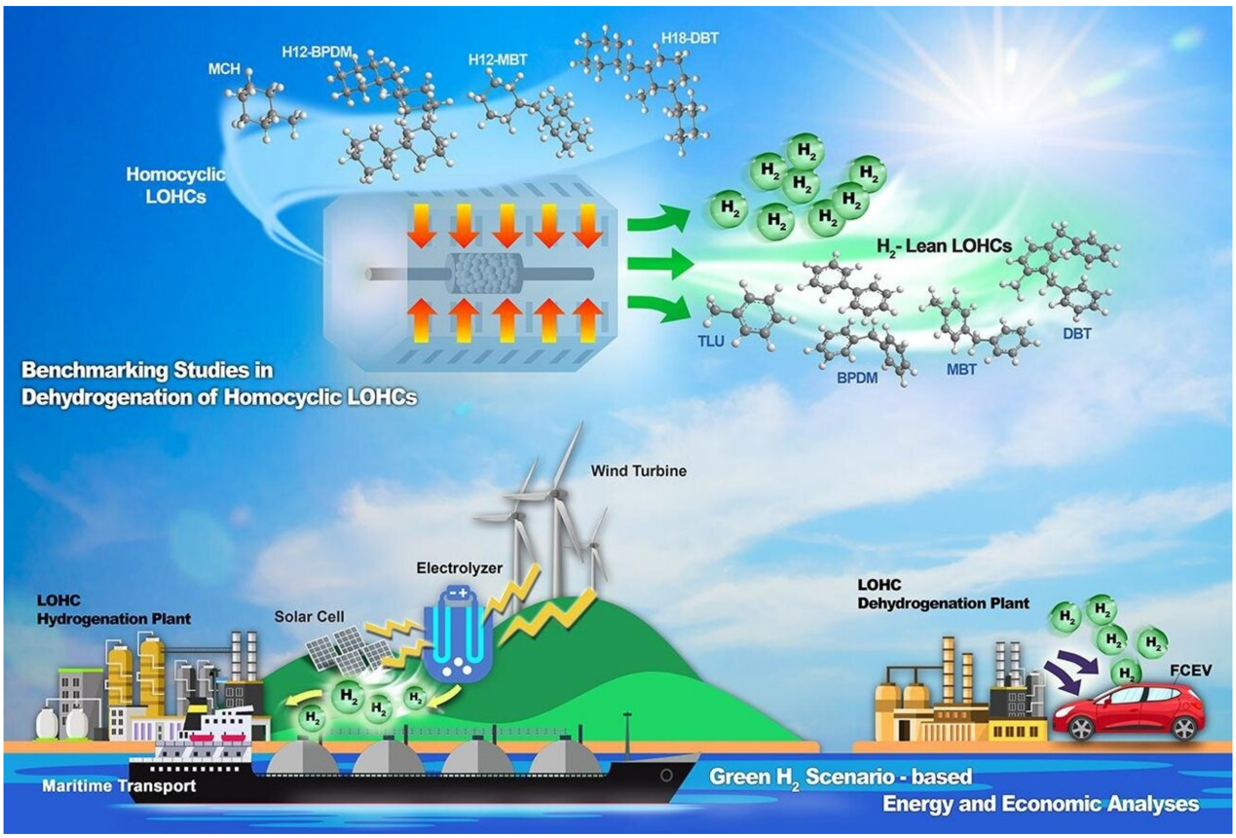
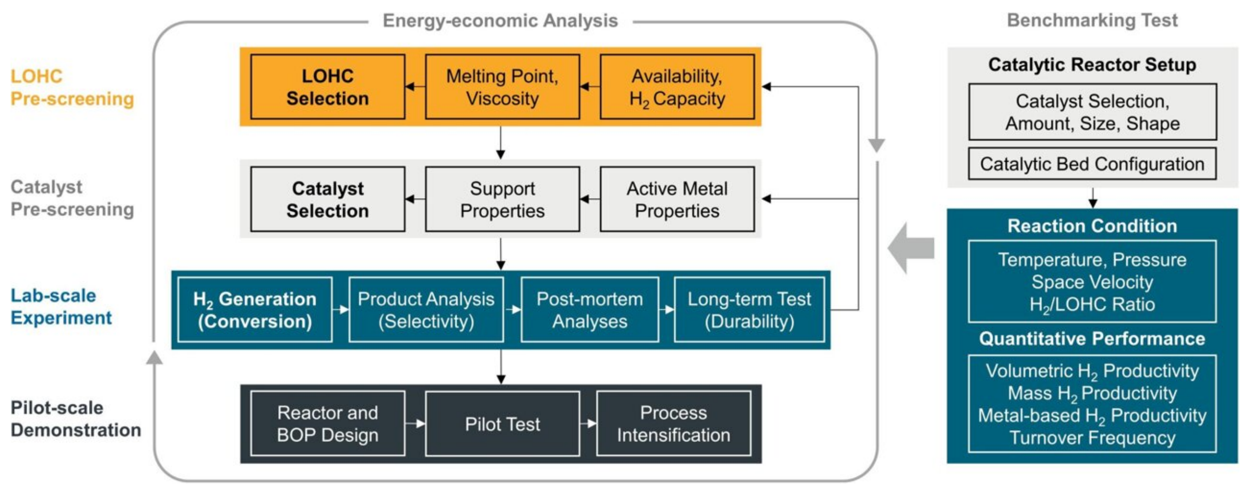


Graphical Abstract. Credit: Korea Institute of Science and Technology(KIST)

Interests in hydrogen are rapidly growing due to its potential to establish global clean energy supply chains. A typical method of hydrogen storage is physically storing hydrogen such as compression or liquefaction, which requires higher energy to increase storage capacity and expensive distributing infrastructure. To overcome these limitations, research efforts to store hydrogen chemically in liquid carriers, such as liquid organic hydrogen carriers (LOHCs) or ammonia, have been conducted. Hydrogen can be safely stored in LOHCs at room temperature and atmospheric pressure before being extracted at locations for hydrogen consumption.

Various organic compounds have been suggested for LOHCs. However, there were few comparative studies on LOHC performance, leading to a lack of scientific consensus in the hydrogen community for downselecting LOHCs and catalysts. Scientists at Korea Institute of Science and Technology (KIST) have contributed to the development of a high-throughput benchmarking protocol for the adoption of promising LOHCs and their well-matched catalysts. The KIST LOHC research team in the Hydrogen and Fuel Cell Research Center led by Dr. Yongmin Kim developed a semi-automatic evaluation system for LOHC dehydrogenation (alternatively, hydrogen extraction from LOHC). This system allows us to rapidly test dehydrogenation in well-defined and standardized reaction conditions and carry out comparative analyses to draw out optimal solutions for the successful commercial deployment of LOHCs.

One example of LOHC in the analyses is methylcyclohexane (MCH) with high technological readiness. It shows a higher dehydrogenation rate with minimal byproduct formation. Monobenzyltoluene (MBT) is another promising candidate because it has been mass-produced as a safe chemical while extracting hydrogen fast. A biphenyl-based eutectic mixture developed by KIST in 2017 shows 20% higher dehydrogenation rate than those of other LOHCs. This biphenyl-based LOHC with a superior hydrogen storage density of 6.85 wt.%-H2 is applicable for onboard hydrogen storage such as in hydrogen vehicles or trains.



Generalizable benchmarking protocol for pre-screening of LOHCs and dehydrogenation catalysts: measuring activity, selectivity, and durability in a lab-scale test, demonstrating a large-scale dehydrogenation reaction system, performing energy-economic analysis, and their iteration. Credit: Korea Institute of Science and Technology(KIST)

The proposed system for fast screening of LOHCs materials and catalysts will be also helpful for both domestic and international research collaborators in industry and academia. In addition to ongoing research collaboration with Hyundai Motor Group and Korea Gas Corporation, international collaborative research projects with Germany and Japan are being planned to widely disseminate this generalized benchmarking LOHC study platform for accelerating LOHC deployment in the hydrogen economy. Dr. Yongmin Kim said, "The as-developed platform will help develop new technology for lower cost and energy consumption, which are two key bottlenecks for the commercialization of LOHC."

More information: Yeonsu Kwak et al, Hydrogen production from homocyclic liquid organic hydrogen carriers (LOHCs): Benchmarking studies and energy-economic analyses, *Energy Conversion and Management* (2021). [DOI: 10.1016/j.enconman.2021.114124](https://doi.org/10.1016/j.enconman.2021.114124)

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