講演番号	056

文献番号	20225056

Application of Massive Hydrogen Storage and Transportation System to Hydrogen Refueling Station

- Hydrogen Refueling Station by using SPERA Hydrogen™ System -

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KEY WORDS: hydrogen, refueling station, LOHC, SPERA hydrogen system, methylcyclohexane

Since 2002, Chiyoda Corporation has focused on the "Liquid Organic Hydrogen Carrier, LOHC" as a safe and inexpensive method for massive storage and transportation of hydrogen, and started its development. By 2010, we completed the development of the novel dehydrogenation catalyst, which is the key to practical application. We built a pilot plant in our R&D center in Yokohama in 2013, and conducted a demonstration operation for around 10,000 hours. We completed the technical establishment of the system in 2014 and the system was named the SPERA Hydrogen™ System. After that, the company participated in a NEDO project to conduct a large-scale international hydrogen transportation demonstration, and successfully completed in 2020 by transporting more than 100 tons of hydrogen from Brunei Dursaalam in Southeast Asia to the Kawasaki waterfront in Japan, including all processes of marine and land transportation. As a result, SPERA Hydrogen™ System for the massive storage and transportation system has moved to the commercialization stage.

On the other hand, since this system can be applied to small- and medium-scale hydrogen storage and transportation systems, we are also developing its application to hydrogen refueling station, and have completed the demonstration of a compact dehydrogenation reactor unit that can be applied to hydrogen stations through a NEDO project in FY2017. Currently, we are planning to implement and operate a hydrogen refueling system for heavy-duty vehicles at the port in Singapore.

In this presentation, the outline and features of the SPERA Hydrogen System, the international hydrogen supply chain demonstration, the finally integrated hydrogen supply chain that can be realized by the SPERA hydrogen system, and the SPERA Hydrogen System applied to the hydrogen refueling station will be introduced.

Fig. 1 shows a scheme of SPERA Hydrogen system. Hydrogen atoms are stored in the molecules of methylcyclohexane (MCH), which is produced from Hydrogen and Toluene. This hydrogenation process makes it possible to "store" and "transport" hydrogen as a liquid MCH at room temperature and pressure. After transport by sea or land, the necessary amount of hydrogen is extracted from MCH by dehydrogenation reaction and utilized. The toluene produced in the dehydrogenation process is returned to the hydrogen shipping point and used again as a raw material for the hydrogenation process.

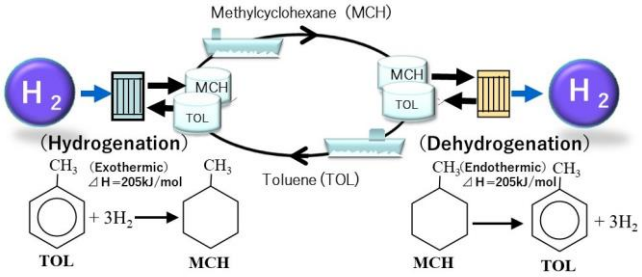

Fig.1 Scheme of SPERA Hydrogen™ System

(a) Hydrogenation plant (Brunei Darussalam)

(b)Dehydrogenation plant (Kawasaki, Japan)

Fig.2 Hydrogenation plant and Dehydrogenation plant of International Hydrogen Supply Demonstration Project

The system has moved to the commercialization stage through the completion of international hydrogen supply chain demonstration. Fig.2 shows the hydrogenation and dehaydrogenation plant in the project. The system can be deployed in small- and medium-scale systems.

Chiyoda is already developing the application of SPERA hydrogen system to hydrogen refueling stations as shown in Fig.3. and plans to complete the development of hydrogen refueling station in Singapore within a few years.

Chiyoda hopes to contribute to the spread of hydrogen stations for FCVs by enabling the large-scale supply of inexpensive MCH to small- and medium-scale systems such as hydrogen stations through the realization of the massive and low cost hydrogen supply chain for hydrogen-fired power generation, toward the realization of a de-carbonized society.

Fig.3 Dehydrogenation Unit for H_2 Refueling Station