Keywords

S5 renewable energy

A Renewable energy utilization is indispensable for sustainable growth of the human society. Hydrogen produced from a renewable energy is expected to play a key role in the low-carbon society of the future, since hydrogen produced from the renewable energy is used for “storage” and “transportation” of the renewable energy as a fuel. It is necessary a technology for the storage and transportation of hydrogen in large-scale for the above realization, however such technology has not been established. Chiyoda has developed the world’s first technology that enables the storage and transportation of large quantities of hydrogen. It is named “SPERA Hydrogen®” system. “SPERA” means “hope” in the Latin language.

In this system, an organic chemical hydride (OCH) method is employed. Hydrogen and toluene are reacted to methylcyclohexane (MCH) in which hydrogen is stored in a molecule. Hydrogen is able to be stored and transported in a large-scale as MCH in the liquid state under the ambient temperature and pressure. Toluene and MCH are both of components of gasoline or diesel oil, the system has a merit of decreasing a risk for the storage and transportation of hydrogen in a large-scale to the risk of the conventional storage and transportation of gasoline or diesel oil. At a hydrogen utilization place, hydrogen is generated from MCH and toluene is reproduced. Toluene is transport back to hydrogen producing place and converted to MCH again. Toluene is used repeatedly as a hydrogen carrier.

The method had been proposed in 1980’s. However, a technology for hydrogen generation from MCH stably has not been established. Chiyoda started a dehydrogenation catalyst development and it was achieved success in 2009. A novel dehydrogenation process was developed using simple tubular reactor with the developed catalyst in the fix bed. Through a success of a long term demonstration with a pilot plant located in Chiyoda’s Koyasu Office & Research Park in Yokohama in 2014, Chiyoda completed the technical establishment of the technology.

Features of the system are following.
(1) Safety system in which large quantities of hydrogen is stored or transported in the same risk of conventional gasoline or diesel oil, since toluene and MCH are both of a components of them and it is in the liquid state under ambient temperature and pressure.
(2) Conventional infrastructure of chemical tankers or chemical tracks will be used for hydrogen storage and transportation. (Ex. Around 3,000 tons of hydrogen is transported by the 50,000 tons of a chemical tanker)
(3) High energy efficiency is expected and the system is an only technology demonstrated a practical performance through the long-term pilot plant operation.
(4) The system will be applied for national storage of hydrogen energy, since energy loss is almost nothing for long term storage in large-scale.

Basic Concept or Summary

Fig.1 shows a scheme of OCH method.

Hydrogenation is exothermic reaction and dehydrogenation is endothermic reaction. The each reaction heat is 30% of hydrogen energy produced at hydrogen production place. The exothermic heat from hydrogenation is recovered and utilized at the hydrogen production place. The thrown heat energy into dehydrogenation is converted to hydrogen energy through the dehydrogenation. So, heat energy from a power generation or garbage incineration facility etc. will be used for dehydrogenation and converted to hydrogen energy.
Effects or Remarks

For a sustainable development of human society, it is important to prevent global warming by reducing CO₂ emissions, while also establishing systems that do not restrict energy consumption itself. A system of renewable and hydrogen energy is considered that it is ultimate system for a solution of global warming and energy issues. Fig.2 shows the concept of hydrogen supply chain with the “SPERA Hydrogen” system. As the first step, hydrogen produced from fossil resources will be promote as the hydrogenation utilization. CO₂ generated from fossil resource will be sequestrate by EOR (Enhanced Oil Recovery) or CCS (Carbon dioxide Capture and Sequestration).

The recovered high concentrated CO₂ will be able to be used for a feedstock for the chemical production in the future in which hydrogen will be produced from renewable energy with low cost. If hydrogen is produced from renewable energy with low cost, we will produce such chemicals from CO₂ and H₂ in the future after the depletion of the fossil resources.

The final goal of the concept is attainment to the global low carbon society through the renewable energies and hydrogen energy system. Hydrogen produced from fossil resources with carbon dioxide sequestration will be used as an assistant fuel for reducing carbon dioxide emission for the time being, and in the future, for the solution of global warming and energy issues. The concept is for the smooth transition to the low carbon society with the solution of global warming and energy issues.

Chiyoda completed technical demonstration for totally around 10,000hrs operation with stable performance with a demonstration plant shown in Fig.3 in 2014. Now, we are executing the first international hydrogen supply chain demonstration project founded by NEDO (New Energy and Industrial Technology Development Organization). In the project, hydrogen produced in Brunei Darussalam in South-East Asia will be transported as SPERA Hydrogen to seaside of Kawasaki city in Japan and generated hydrogen will be used as a mixture fuel for thermal power generation in 2020. The amount of hydrogen transportation will be maximally 210tons/year. The project is executing by AHEAD (Advanced Hydrogen Energy Chain Association for Technology Development) which was established by Chiyoda corporation, Mitsubishi Corporation, Mitsui & Co., Ltd. and Nippon Yusen Kabushiki Kaisha.

https://www.ahead.or.jp/en/organization.html

Installation in Practice or Schedule

**Domestic**
Demonstration plant (constructed in March, 2013, worked from April, 2013)
Location: Chiyoda Corporation, Koyasu Office and Research Park in Yokohama City.
Capacity: 50Nm³/h (H₂ amount for storage to MCH and generation amount from MCH)

**Abroad**
In 2020, Hydrogen will be transported from Brunei Darussalam to Japan with SPERA Hydrogen system as the first international hydrogen supply chain demonstration project founded by NEDO.

---

Contact: Chiyoda Corporation
4-6-2 Minatomirai, Nishi-ku, Yokohama, Japan
Project Development Department Hydrogen Supply Chain Development Section
Phone: 045-225-4872 FAX: 045-225-4990
URL: http://www.chiyoda-corp.com/