November 13, 2023

Successful Demonstration of Hydrogen High-Pressurization Using Hydrogen Storage Alloy

- Commercialization of Cost-Effective Hydrogen-Storage-Alloy Hydrogen Compressor Expected -

Kobe Material Testing Laboratory Co., Ltd. (President: Masaaki Tsurui), in collaboration with Mitsubishi Kakoki Kaisha, Ltd. (President: Toshikazu Tanaka), NASU DENKI−TEKKO CO., LTD. (President: Tomoharu Suzuki), DAITEC Co., Ltd. (President: Daigo Shimizu), Hiroshima University, and Tani Green Energy research (President: Yoshikatsu Tani)*1, has developed a hydrogen-storage-alloy hydrogen compressor*2 and successfully conducted a test operation using a demonstration unit. This compressor is capable of increasing the pressure to a hydrogen pressure range of 19.6 MPaG, which is the pressure range for hydrogen compressed into hydrogen cylinders and curdles for distribution.

1. Background of Development

In recent years, efforts have been made to create a "Hydrogen Society," and we have been working to develop high-quality, low-cost hydrogen supply facilities.

In this effort, we focused on the property of practically used hydrogen storage alloy which allows us to boost hydrogen pressure by heating an alloy that has absorbed hydrogen at low temperatures. This led to the development of a hydrogen-storage-alloy hydrogen compressor.

The developed hydrogen-storage-alloy hydrogen compressor is capable of boosting low-pressure hydrogen with less than 1 MPaG pressure up to 19.6 MPaG and achieving a discharge flow of 1 Nm^3/h. We designed and manufactured a demonstration unit*3 and conducted a test operation.

Feature of Hydrogen-storage Alloy Hydrogen Compressor

- Unlike conventional mechanical compressors, the system does not require mechanical drive parts. It operates quietly with no vibration and potentially reduces maintenance cost.
- Operating costs can be reduced since hydrogen is pressurized using relatively low temperature-differences (from room temperature to approximately 250˚C), allowing for the utilization of waste heat.

2. Overview of Demonstration Unit and Result of Test Operation

The demonstration unit is designed to repeat cycles of hydrogen absorption and pressurization. In this process, it elevates the pressure of low-pressure hydrogen, which is below 1 MPaG at room temperature, up to 19.6 MPaG by heating the reactor containing the hydrogen-storage alloy to 250˚C. In the subsequent cycle, the reactor is cooled down using a coolant, allowing the hydrogen-storage alloy to reabsorb hydrogen.

Hydrogen pressurization cycle testing of 50 cycles was conducted at Hydrogen Energy Test and Research Center (HyTReC). During the testing, a discharge pressure of 19.6 MPaG was achieved as well as a hydrogen flow of 1 Nm^3/h. The discharging performance remained constant throughout the testing, maintaining the target hydrogen flow of not less than 1 Nm^3/h.*4

3. Achievement of Development

As a result of the test operation, we have obtained fundamental data and confirmed that the targeted performance has been achieved. In the future, we will explore scaling up the project, with the goal of promptly commercializing the hydrogen-storage-alloy hydrogen compressor.

If successfully commercialized, the hydrogen-storage-alloy compressor will not only pressurize hydrogen to the commercially available hydrogen pressure range of 19.6 MPaG, but also potentially reduce the pressurizing load on conventional compressors at hydrogen stations when combined with the mechanical compressors.

As a new addition to the technological lineups in our hydrogen business, we aim to expand our business opportunities further.

*1: See Figure 1 for the responsibilities of collaboration developers.
*2: See Figure 2 for a schematic diagram for the hydrogen-storage-alloy hydrogen compressor.
*3: See Figure 3 for the appearance of the demonstration unit.
*4: See Figure 4 for the results of the test operation.

KMT Kobe Material Testing Laboratory Co., Ltd.
HP https://en.kmtl.co.jp/
TEL +81-79-435-5010
Contact

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Figure 1　Responsibility of Collaboration Developer

Responsibility of Each Collaboration Developer	
Mitsubishi Kakoki Kaisha, Ltd.	Project management, basic and detailed design, demonstration unit fabrication, and test operation
Kobe Material Testing Laboratory Co., Ltd.	Conceptual design, basic and detailed design support, and test-operation data analysis
NASU DENKI−TEKKO CO., LTD.	Development, manufacture, and characterization of hydrogen storage alloy
DAITEC Co., Ltd.	Manufacturing of static equipment and demonstration unit
Hiroshima University	Technical support for hydrogen-storage alloy
Tani Green Energy research	Project support

Figure 2　Schematic Diagram for Hydrogen-Storage-Alloy Hydrogen Compressor

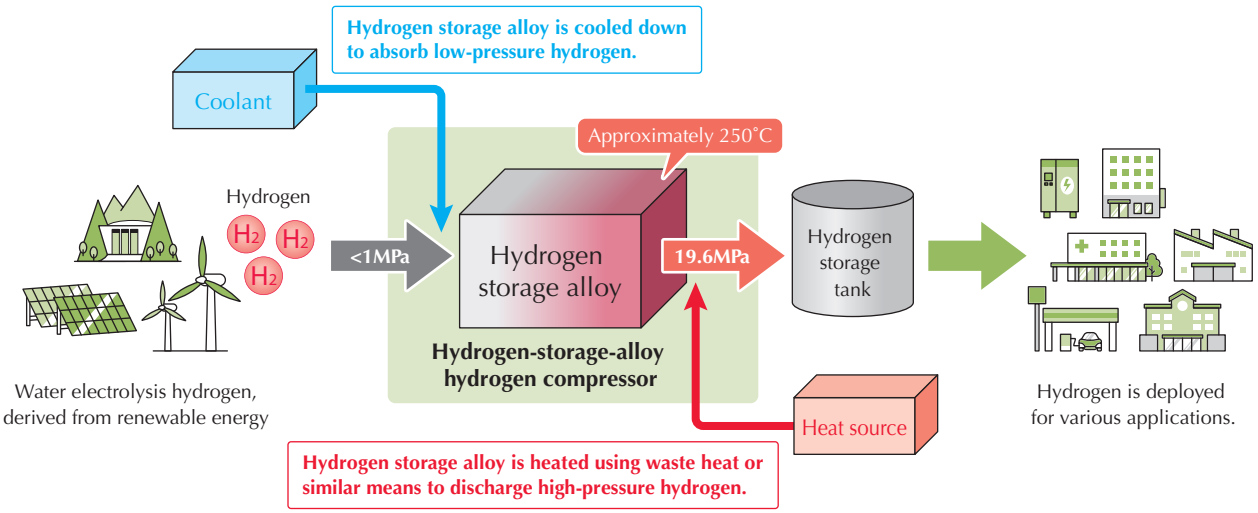

Figure 3　Appearance of Demonstration Unit

*Full view of the demonstration unit

*Demonstration unit during operation
Photo courtesy of Hydrogen Energy Test and Research Center (HyTReC)

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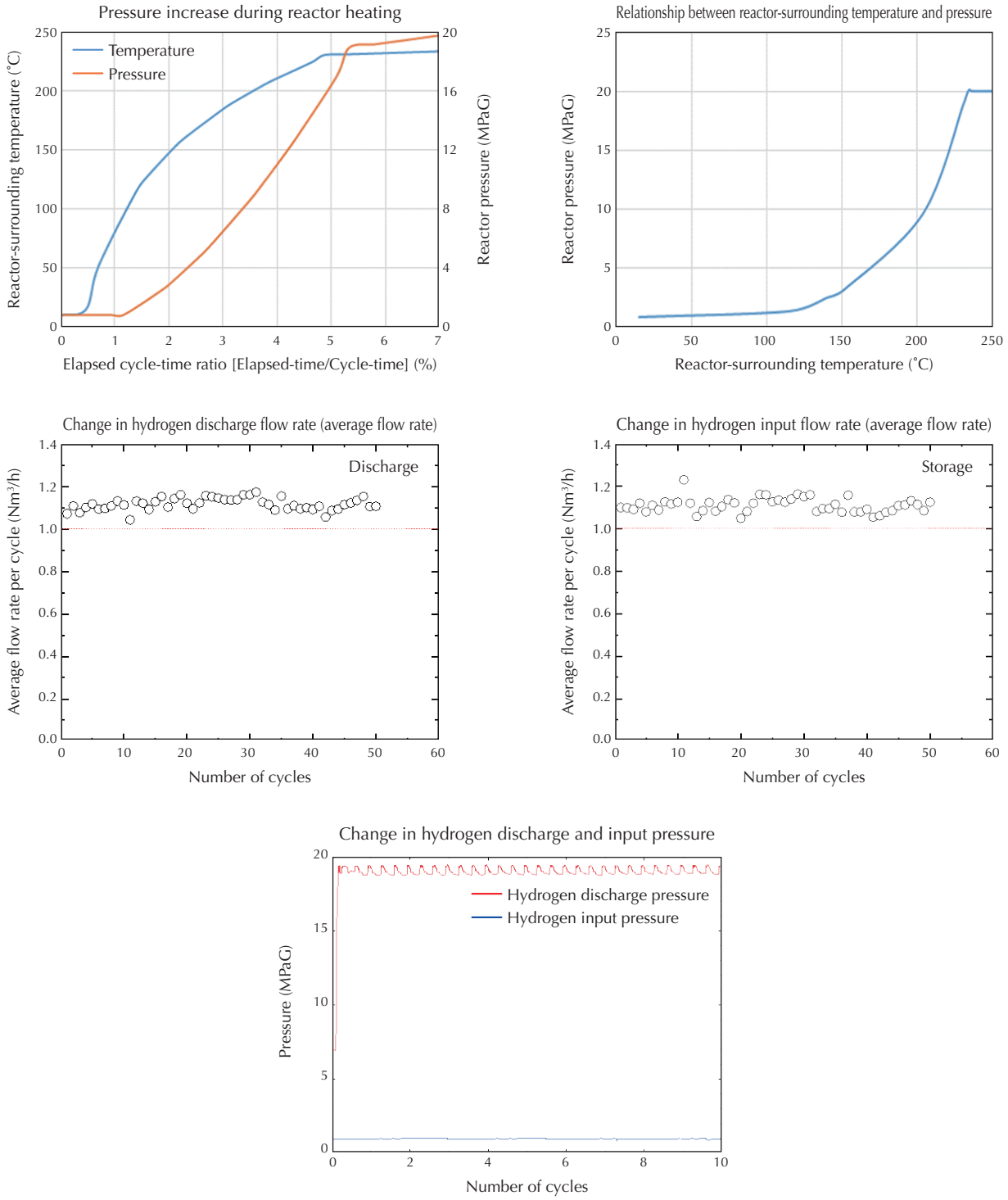
Figure 4　Result of Test Operation



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For inquiries, please contact

三菱化工機株式会社

Mitsubishi Kakoki Kaisha, Ltd.
Management Planning Section, Planning Dept.
2-1 Okawa-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa 210-8560
TEL：+81-44-333-5377　FAX：+81-44-333-5279
URL：https://www.kakoki.co.jp/
(Contact: Nishihira)

KMT 神戸工業試験場
KOBE MATERIAL TESTING LABORATORY GROUP

Kobe Material Testing Laboratory Co., Ltd.
47-13 Niijima, Harima-cho, Kako-gun, 675-0155 Japan
TEL：+81-79-435-5010　FAX：+81- 79-435-5335
URL：https://www.kmtl.co.jp/
(Contact: Nobuhito Tsurui)

広島大学

Hiroshima University
Graduate School of Advanced Science and Engineering
Materials Engineering for Energy Conversion and Storage
(Contact: Ichikawa)

NASU 那須電機鉄工株式会社

NASU DENKI−TEKKO CO., LTD

DaiTec Co.,Ltd. 株式会社ダイテック

DAITEC Co., Ltd.

TGE 谷グリーンエネルギー研究所

Tani Green Energy research