News Release

October 5, 2020

Tsubame BHB Co., Ltd.

Possibility of Reducing Catalyst Amount by 30% Confirmed at Tsubame BHB Ammonia Production Pilot Plant
—One Step Closer to Commercialization of World's First Ammonia Production Technology Using an Electride Catalyst—

Tsubame BHB Co., Ltd. (Head Office: Chuo-ku, Tokyo; Representative Director CEO: Masahiro Watanabe; hereinafter reffered to as “the Company”) has achieved ammonia production using an electride catalyst, and confirmed the possibility of reducing the necessary catalyst amount by 30% at the on-site ammonia production pilot plant at the Company’s R&D Center Kawasaki Base located in the Kawasaki Plant of Ajinomoto Co., Inc.

Achievements made at the ammonia production pilot plant

- **Catalytic activity is higher than in laboratory tests, so the catalyst amount can likely be reduced by 30%**
- **Continuous operation with an annual capacity of 20 tons**
- **The ease of handling, safety, and activity persistence of the catalyst confirmed**
- **A number of verifications conducted with the goal of achieving practical use next year**

■ Catalytic activity is higher than in laboratory tests, so the catalyst amount can likely be reduced by 30%

We tested the catalytic activity during ammonia production and examined how to optimize the operating conditions (including the reactor temperature and pressure). As a result, we could confirm that the catalytic activity was higher than that in the laboratory tests, indicating the possibility of reducing the required catalyst amount by about 30%. This result means it can be designed and operated using a smaller catalyst amount (improved economic efficiency) for implementation in machines for commercial use with a capacity of at least several thousand tons per year. We will continue catalyst testing at the pilot plant with the goal of realizing efficient ammonia production plants quickly.

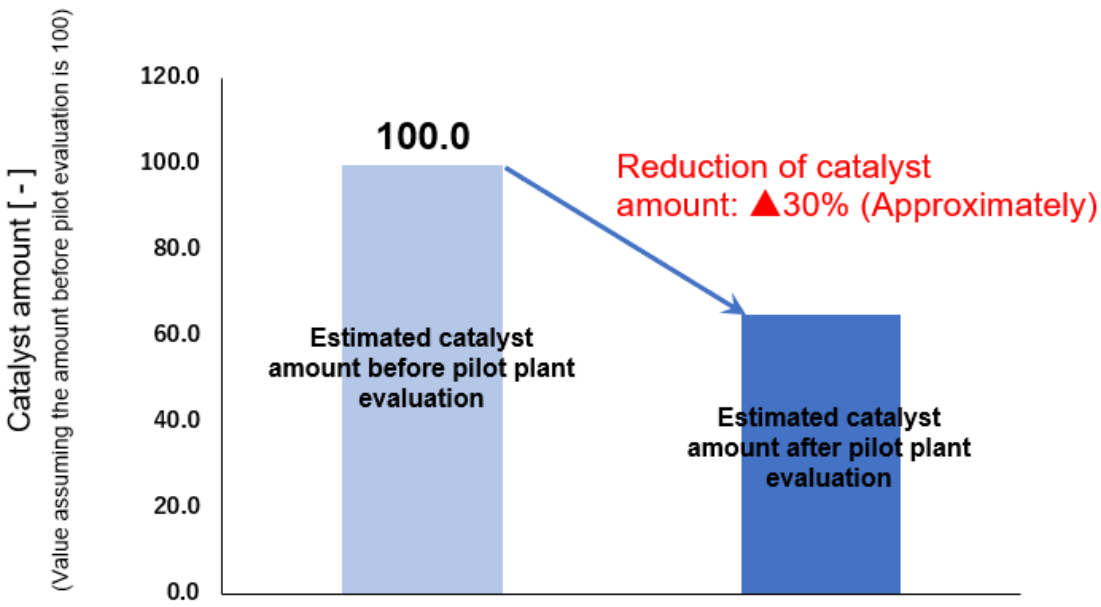

Figure: Estimated catalyst amount before and after pilot plant evaluation

■ **Continuous operation with an annual capacity of 20 tons**

After the pilot plant was completed last October, we were able to achieve continuous operation with a nominal capacity of 20 tons per year. Compared to the Haber-Bosch method (hereinafter referred to as the "HB method"), which has commonly been used for ammonia production until now, we have been able to achieve ammonia production at lower temperatures and at lower pressure. Lowering the temperature and pressure conditions makes production at small-scale plants possible with an annual production of up to tens of thousands of tons, which was difficult with the conventional HB method. This is a major step toward commercialization.

Figure: Company Pilot Plant

■ **The ease of handling, safety, and activity persistence of the catalyst confirmed**

Under the current operation, which began last December, the reaction tower has been filled and operated continuously, and extraction has been done multiple times. As a result, we were able to confirm the ease of handling, safety, and activity persistence of the catalyst. Knowledge on how to handle the catalyst with commercial machines and for continuous operation was obtained. Valuable information that can be used for future commercial machines was also gained in regards to data acquisition and activation methods for catalyst activation and deactivation.

■ **A number of verifications conducted with the goal of achieving practical use next year**

A number of verifications are planned to be carried out while continuing to operate the pilot plant. For example, we plan to carry out performance verifications on the reaction conditions of the current catalyst, tests on the gas composition of raw material, lifespan tests, and activity evaluation tests for second generation catalysts at the pilot plant.

The goal of our business development is to realize the world's first practical-use, on-site ammonia production using an electride catalyst. Our first aim is to introduce this technology at fertilizer material factories belonging to Ajinomoto Co., Inc., and in collaboration with various other partner companies, we will expand its application to agricultural fertilizers, foods/pharmaceuticals, and chemical products, and contribute to society by realizing a production system this is more environmentally friendly and sustainable.

[Background of Pilot Plant Launch]

This pilot plant is the first of its kind in the entire world. It is an ammonia manufacturing facility using the electride catalyst discovered and invented through the research and development of a research group led by Professor Emeritus Hideo Hosono of the Tokyo Institute of Technology. The research was conducted for the Japan Science and Technology Agency's CREST Program ACCEL[Note1)] “The Materials Science and Application of Electrides” (Research Director: Hideo Hosono; Program Manager: Toshiharu Yokoyama). Through continuous operation, the Company will acquire various data for practical usage; for example, data on long-term durability and optimum operating conditions. We will prepare to achieve our goal of mass production for on-site ammonia manufacturing facilities on the annual scale of several thousand to several tens of thousand tons.

Currently, ammonia is produced mainly by using the HB method, which was discovered more than 100 years ago. The HB method is an extremely outstanding production technology capable of synthesizing ammonia from only nitrogen in the air and hydrogen[Note 2)] obtained from substances such as natural gas. This method is widely used throughout the world. On the other hand, the HB method requires high-temperature and high-pressure reaction conditions. When using this method, intensive mass production must be performed in large-scale plants with high energy loads. This creates the issue of large facilities investment. Furthermore, dedicated transportation equipment and storage facilities are required in order to transport ammonia from production sites to areas of demand throughout the world. This results in the issue of extremely

high logistics costs.

The electride catalyst invented to solve this issue is characterized by high-efficiency ammonia synthesis under low temperature and low pressure conditions. These low-temperature and low-pressure reaction conditions enable production in small-scale plants with annual output of several tens of thousands of tons or less. Such small-scale production was previously difficult when using the HB method[Note 3)]. In the future, the practical application of this technology is expected to realize an on-site ammonia production model that produces the required amount of ammonia at the location where the ammonia is needed.

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Note 1) A program run by the Japan Science and Technology Agency. From among the world's leading outstanding research results, the program extracts results for which risk assessment is difficult by corporations and other organizations. Through innovation-oriented R&D management by a program manager, the program connects the R&D flow to corporations, venture corporations, and other business.

Note 2) The most abundant element in the universe. In recent years, the technology has attracted attention as for use in generating clean energy such as fuel for fuel cell vehicles.

Note 3) Generally, ammonia production using the HB method requires a production scale larger than annual output of several tens of thousands of tons.

About Tsubame BHB Co., Ltd.

Address	: Akashi-cho 8-1, Chuo-ku, Tokyo, Japan
R&D Base	: 4259 Nagatsuta-cho, Midori-ku, Yokohama City, Kanagawa Tokyo Institute of Technology, Suzukakedai Campus
Kawasaki Branch	: 1-1 Suzuki-cho, Kawasaki-ku, Kawasaki City, Kanagawa Kawasaki Plant of Ajinomoto Co., Inc.
CEO	: Masahiro Watanabe
Established	: April 5, 2017
Start of Operations	: April 25, 2017
Capital	: JPY 1,580 million
Capital Structure	: UMI Fund No. 1 Investment Limited Partnership: 53.8%; Ajinomoto Co., Inc.: 45.1%; Professor Hideo Hosono and others: 1.1%
Business Activities	: R&D and manufacturing involving on-site ammonia production systems and catalysts

(Inquiries by news media in regard to this press release.)

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