Toyota Industries and Daigas Group Successfully Achieve Metal Heat Treatment Using an Ammonia-fired Furnace

Japan's first mass-production-scale demonstration furnace achieves the same level of quality as that of actual products.

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Toyota Industries Corporation
Osaka Gas Co., Ltd.
Daigas Energy Co., Ltd.

Toyota Industries Corporation (President: Koichi Ito, hereinafter referred to as "Toyota Industries") and Daigas Energy Co., Ltd. (President: Hiroyoshi Fukutani, hereinafter referred to as "Daigas Energy"), a wholly owned subsidiary of Osaka Gas Co., Ltd. (President: Masataka Fujiwara, hereinafter referred to as "Osaka Gas"), have successfully conducted Japan's first[1] demonstration and evaluation test of a metal heat treatment process using only ammonia fuel (hereinafter referred to as "this demonstration") on the casting line at Toyota Industries' Higashichita Plant (Handa City, Aichi Prefecture), which manufactures automotive and industrial engines.

In this demonstration, an ammonia burner developed by Daigas Energy was installed in a mass-production-scale demonstration test furnace to perform metal heat treatment on automotive engine parts, and it was verified that the product quality matched that of mass-produced products. The two companies will continue to work together to further expand the use of ammonia.

1. Background

Toyota Industries' Higashichita Plant manufactures cast parts for engines and operates many heat treatment furnaces and aluminum melting furnaces. For this plant, it is an important challenge to reduce CO_2 emissions towards its goal of becoming carbon neutral by 2050. Meanwhile, in the area around Kinuura Port in Aichi Prefecture, where this plant is located, consideration is being given to developing an environment to receive ammonia, a decarbonized fuel. Against this backdrop, the plant has been exploring technologies for using ammonia.

Daigas Energy has developed numerous city gas burners for commercial equipment and industrial furnaces and has accumulated technology that ensures efficient and safe combustion. In recent years, the company has also been working on developing burners that use hydrogen and ammonia as fuel in response to customer needs.

Since 2021, Toyota Industries and the Daigas Group, including Osaka Gas, have deepened their partnership through the technological development and demonstration of a small engine system fueled by ammonia. Furthermore, as a new initiative, Toyota Industries and Daigas Energy jointly conducted this demonstration with the aim of showing the feasibility of using ammonia fuel in manufacturing processes.

2. Objectives of Demonstration

In this demonstration, Daigas Energy's newly developed burner, which is compatible with both city gas and ammonia combustion, was installed in a demonstration test furnace newly constructed by Toyota Industries, and the impact of ammonia combustion on product quality during the heat treatment process on the engine parts casting line was verified.

Ammonia has several technical issues, such as its slow combustion speed making stable combustion difficult and the large amount of nitrogen oxides (NO_x) it produces during combustion. To solve these issues, Daigas Energy developed an ammonia burner intended for use in metal heat treatment processes, thereby leveraging its accumulated knowledge of developing burners and the fundamental knowledge of ammonia combustion held by the Osaka Gas Advanced Technology Institute. This burner is compatible with both city gas and ammonia firing and is designed to meet the standards and specifications for the amount of NO_x and unburned ammonia generated in the demonstration test furnace.

The demonstration test furnace equipped with this burner was used to demonstrate production of

automotive engine parts, and it was shown that ammonia combustion fulfilled temperature conditions comparable to those of city gas combustion, that there was no *nitriding* effect, which makes metals brittle due to the nitrogen component in ammonia, and that the product quality matched that of actual mass-produced products.

Through this demonstration, the two companies discovered the potential for ammonia fuel to be used in metal heat treatment. Going forward, based on the results of this demonstration, the two companies will continue to study ways to resolve issues related to the introduction of ammonia fuel into metal heat treatment processes and to expand its use to other manufacturing facilities.

Toyota Industries considers the pursuit of environmental initiatives to be one of its top management priorities and is working to switch to clean energy sources such as renewable energy, ammonia, and hydrogen in its production activities. It aims to create a sustainable society through the decarbonization of its manufacturing processes.

The Daigas Group, under the Daigas Group Energy Transition 2050 initiative announced in February 2025, remains committed to developing technologies and services that contribute to a decarbonized society and help solve social issues, including climate change, in order to become a corporate group that contributes to the *further evolution* of customers' lives and businesses.

1: This is the first time in Japan that a metal heat treatment process has used an ammonia-fired furnace to achieve the same level of quality as that of mass-produced products.
According to a survey conducted by Toyota Industries and Daigas Energy (as of January 2026)

Features of the newly developed ammonia burner

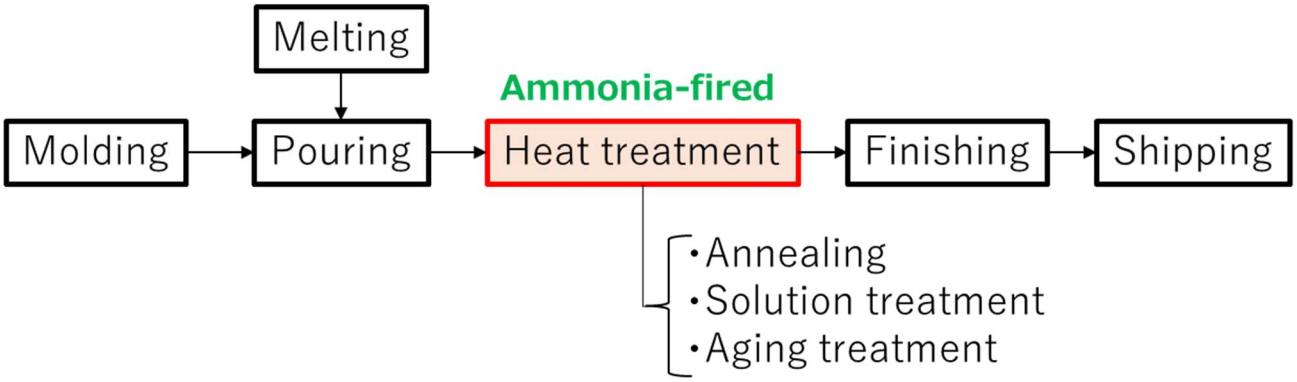
By facilitating the formation of a circulating flow and using a structure that activates the mixing of ammonia and combustion air, the burner achieves stable combustion, making sure that the flame is less likely to be blown out. Additionally, NO_x emissions are reduced by using a structure that supplies combustion air in multiple stages toward the burner tip.

Combustion flames of the newly developed burner
(For the combustion, the same temperature and heat conditions were used at Osaka Gas's research facilities. The photos show stable combustion in both cases.)

About the demonstration furnace

The demonstration test furnace manufactured by Toyota Industries has a structure that simulates mass production equipment and was designed to conduct combustion experiments using the newly developed ammonia burner. Moreover, this equipment can evaluate heat treatments such as those for improving the strength and hardness of aluminum alloys and removing distortions by ammonia-only combustion.

Demonstration test furnace for ammonia combustion



Casting Process Overview