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Miyakojima Bio- Industrial Innovation Agency and Hitachi Developed Prototype of Power Generation System Using the 40% Low Concentration Bioethanol

Achieving 45% thermal efficiency in a 40 kW Power Generation System

Tokyo, February 8, 2016 --- Miyakojima Bio-Industrial Innovation Agency (MIIA) and Hitachi, Ltd. (TSE: 6501) have developed the prototype of a high efficient power generation system using the 40% low concentration bioethanol. This prototype of a 40kW power generation system is capable of producing hydrogen from the low concentration bioethanol utilizing exhaust heat in engine. The produced hydrogen can be combusted with the low concentration bioethanol to power the engines. Furthermore, its thermal efficiency[*1] has reached to 45% in the validation test. Another advantage of this system is that the applied bioethanol is with 40% low concentration, which does not require special handling procedure as hazardous materials. This feature has provided a great safety measure. The low concentration bioethanol used here is produced from an efficient process, which is to distill after fermenting the Miyokojima sugarcane molasses[*2] using wild yeast[*3] from Miyokojima. This process has reduced the energy use by 40% compared with the conventional production[*4] of the low concentration bioethanol.

The achievement of this prototype has provided the possibility for expanding the application of bioethanol in electricity generating field from its main use as vehicle fuel. From now, MIIA and Hitachi will continue the development in aiming at commercializing distributed generation, which is to generate power at the site of use. This type of power generation is capable of reducing CO_2 emissions.

The implementation of renewable energy for reducing CO_2 emissions has been accelerated globally. The bioethanol fuel from sugarcane and corn is the carbon-neutral[*5] fuel, which means that the fuel will not impact the total amount of CO_2 in the atmosphere. This type of fuel has already been used for the vehicle fuel mixture in the US, Brazil, Europe, and the Southeast Asian countries. Currently, the bioethanol fuel that is used in vehicles is with more than 90% purity that is produced from a repeated process of distillation, dehydration after fermenting crops. As to expand the application of bioethanol fuel in the future, it is required to develop the following two technologies. One is the engine technology that uses the low concentration bioethanol

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less than 60% purity for ensuring safety without handling it as the hazardous material. Another is the production technology that can efficiently produce the low concentration bioethanol to be used as fuel.

Therefore, MIIA and Hitachi have collaboratively developed the power generation system using the low concentration bioethanol. In this collaborative project, Hitachi developed a engine technology that can efficiently generate power using the low concentration bioethanol with 40% purity, and MIIA developed a production technology that can efficiently produce the low concentration bioethanol suitable for the developed engine technology.

The features of the developed technology are the following:

1. The engine technology that high-efficiently generates power using the low concentration bioethanol and exhaust heat.

This engine technology is capable of generating energy efficiently by combusting a mixture of the low concentration bioethanol and the hydrogen producing from a process, which uses catalyst[*6] to react with the low concentration bioethanol that is with a large amount of water, under high temperature of 350 – 450 °C. The engine that is equipped in commonly used power generator exhaust up to 40% of the total energy that was taken in. Hitachi has focused on this ineffectiveness and developed a reactor in the exhaust pipe of the engine to let the low concentration bioethanol (ethanol solution) to react with catalyst. This reactor is capable of generating hydrogen efficiently from the low concentration bioethanol that reacted with catalyst in the heated reactor due to the exhaust heat. By combusting the generated hydrogen and the low concentration bioethanol that is directly supplied to the engine under a high pressure condition, the greatly improved thermal efficiency with the low concentration fuel was achieved. As to test the newly developed prototype with a 40kW power generation system, Hitachi validated that the 45% thermal efficiency using the 40% bioethanol fuel.

2. The technology that produces the low concentration bioethanol with less energy use.

As to apply molasses from the Miyakojima sugar cane that contains high levels of salt and has lower fermentation efficiency, a technology of manufacturing bioethanol that is capable of producing bioethanol at a rate of 10g/Lh (10g in 1L fermentation solution in an hour) was developed by optimizing the fermentation condition using the

Miyakojima wild yeast (MY17) that is heat resistant, salt tolerant and highly active. The fermentation temperature of the MY17 is 40 °C that allows the process to use tap water instead of freezer for cooling. Furthermore, the distillation process of the bioethanol is devised to reduce the energy consumption by applying vapor compression[*7] method for getting 40% ethanol from the fermented broth. By optimizing the processes of fermentation and distillation, the total energy consumption can be reduced to 40% compared to the conventional process.

MIIA and Hitachi will promote the practical use of this system for distributed power generation to enable the significant reduction of CO_2 emission, development of the recycling-oriented system for sustainability, by expanding the scale of power generation and providing the by-products from ethanol production for use as fertilizer or animal feed in local areas.

The achievement of this research is part of a three-year project of “Low Carbon Technology Research and Development Program (innovative high-efficiency engine fueled by low concentration bio-ethanol contractor)” which is funded by Ministry of Environment of Japan.

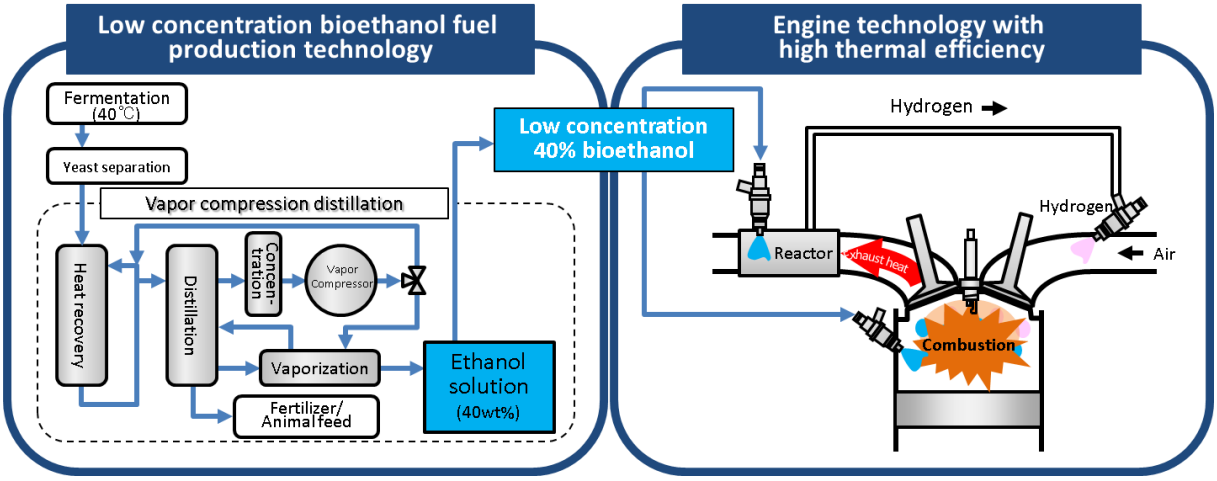

Fig. 1 A flow from producing the low concentration bioethanol fuel to power generation

*1 Thermal efficiency: a definition of engine output divided by a total input of ethanol energy.

*2 Molasses: the remaining liquid from a crystallization of sugar that is made from extracted sugarcane juices.

*3 Wild yeast: the strain of yeast has not been modified but inhabits in the wild.

*4 The conventional production: in here it is the method of distillation column.

*5 Carbon-neutral: a balanced condition that the amount of CO_2 emission is equivalent with the released CO_2.

*6 Catalyst: the material that speed up the certain chemical reaction.

*7 Vapor compression: a method that uses heat for self vaporization with an increased pressure that is using the principle that the temperature of condensation increases when there is no heat transfer to compress vapor.

About Hitachi, Ltd.

Hitachi, Ltd. (TSE: 6501), headquartered in Tokyo, Japan, delivers innovations that answer society's challenges with our talented team and proven experience in global markets. The company's consolidated revenues for fiscal 2014 (ended March 31, 2015) totaled 9,761 billion yen ($81.3 billion). Hitachi is focusing more than ever on the Social Innovation Business, which includes power & infrastructure systems, information & telecommunication systems, construction machinery, high functional materials & components, automotive systems, healthcare and others. For more information on Hitachi, please visit the company's website at http://www.hitachi.com.

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