Demonstration of CO_2 Capture from Flue Gas of Waste Incineration Facility for Use in Methanation

YUKI ENDO[*1] TOSHIKI SHIMIZU[*2]
SHINSUKE NAKATANI[*3] AKIRA KANEKO[*4]
AYUMI IWAMOTO[*5]

Mitsubishi Heavy Industries, Ltd. (MHI) and MHI Environmental & Chemical Engineering Co., Ltd. (MHIEC), together with the City of Yokohama and Tokyo Gas Co., Ltd. (Tokyo Gas), started a demonstration test of the carbon dioxide capture and utilization (CCU) process, in which CO_2 is separated and captured from the flue gas of the Tsurumi waste-to-energy (WTE) plant of the Resources & Waste Recycling Bureau, Yokohama City, and then used as a resource. The captured CO_2 is transported to a different demand location, where it is subject to methanation. This CCU demonstration project based on regional cooperation is Japan's first of its kind. The project purpose and overview are presented in this report.

1. Introduction

The Japanese Government's Plan for Global Warming Countermeasures, which was revised in 2021, sets a target of reducing greenhouse gas (GHG) emissions by 46% by 2030 from the baseline year of 2013. A further 50% reduction will be aimed in order to achieve carbon neutrality (CN) by 2050. In 2020, the GHG emissions from the waste treatment sector accounted for 3.5% of the total emissions in Japan, and about 80% of these emissions came from the incineration of waste, etc.

Also with a view to achieving CN by 2050, in the Sixth Strategic Energy Plan, the synthetic methane produced by methanation of hydrogen and CO_2 is considered to have high potential for decarbonizing city gas, because of its applicability to the existing infrastructures and facilities such as city gas pipelines.

Burning biomass releases CO_2, which is also counted as the CO_2 from waste incineration. With this in mind, if CO_2 is captured to achieve net zero of GHG emissions and the captured CO_2 can be supplied in a circular manner as a resource to the industrial and civilian sectors (i.e., realizing a circulation of carbon), this will be able to greatly contribute to transition towards CN in Japan.

This report presents the ongoing demonstration test at the Tsurumi WTE plant, in which CO_2 in flue gas is separated and captured for use in methanation.

2. Demonstration project structure

This demonstration project is jointly conducted by the City of Yokohama, Tokyo Gas, MHI and MHIEC. The role of each participant is shown in **Figure 1**.

*1 Manager, Project Management Unit, Engineering Division, Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd.
*2 Engineering Manager, Project Management Unit, Engineering Division, Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd.
*3 Manager, Low Carbon Solutions Technology Development Department, GX Solutions, Mitsubishi Heavy Industries, Ltd.
*4 Low Carbon Solutions Technology Development Department, GX Solutions, Mitsubishi Heavy Industries, Ltd.
*5 Ecosystems Research Department, Research & Innovation Center, Mitsubishi Heavy Industries, Ltd.

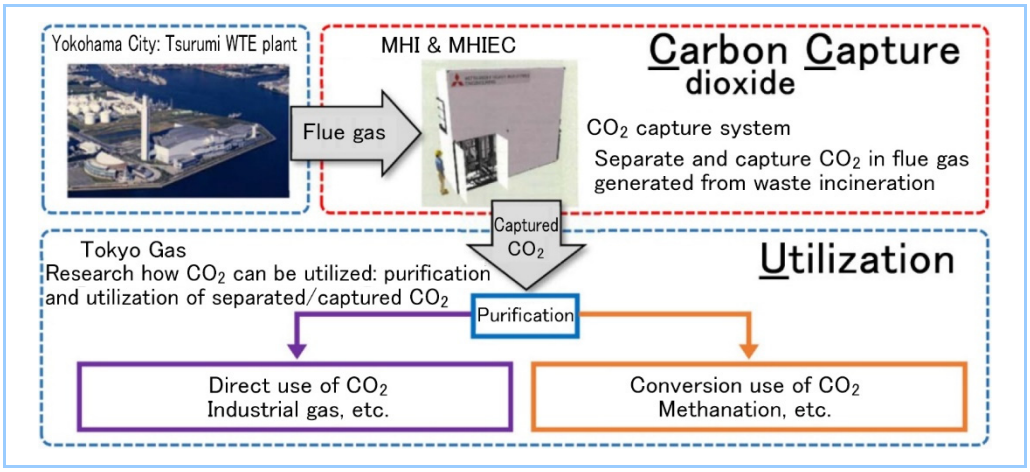

Figure 1 Role of each participant in demonstration project[1]

3. Demonstration project purpose and facility overview

The purpose of this demonstration project is to confirm the capability of separating and capturing CO_2 from the flue gas generated at a waste incineration facility in a stable manner, which is followed by the use of the captured CO_2 as feedstock for methanation. The adopted technology for separation and capture is a proven method of chemical absorption. The possible concerns about burning waste are the quickly changing combustion properties, and the impact of trace amounts of acid gases and trace constituents on the absorption solution degradation and the methanation process, which we investigated.

The demonstration test is outlined as CO_2 in the flue gas from the Tsurumi WTE plant being separated and captured, followed by transportation by tank containers for approximately 800 meters to the Tokyo Gas Yokohama Techno Station for use in methanation. **Figure 2** shows the locations of the two facilities. **Figure 3** is a flow diagram of the demonstration process. The exterior views of the equipment are given in **Figure 4**.

Figure 2 Locations of facilities

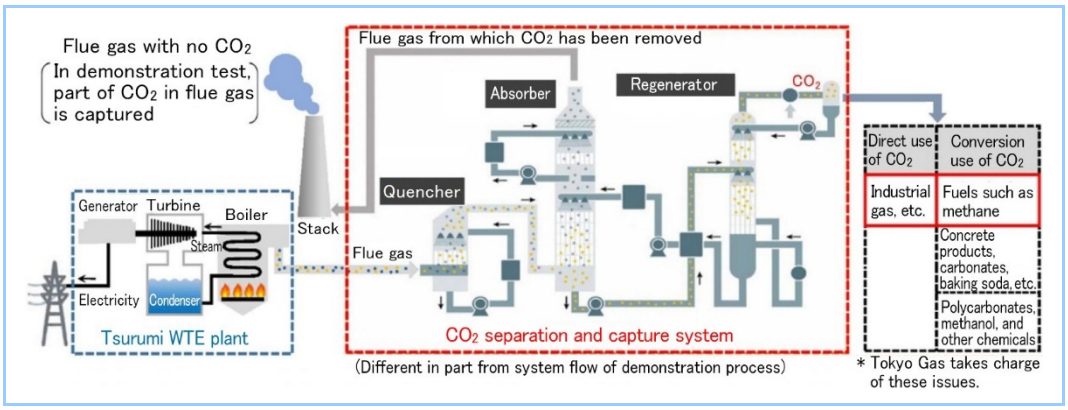

Figure 3 Flow diagram of demonstration process[1]

Figure 4 Exterior views of equipment (left: separation and capture system, and right: compressor)

The temperature of flue gas from the Tsurumi WTE plant is approximately 180°C. At the inlet of the stack, part of the flue gas is diverted from the existing flue gas duct and sent to the CO_2 separation and capture system. This flue gas containing CO_2 is cooled by the quencher before it is pressurized by the blower installed downstream of the quencher. The flue gas is then sent to the absorber, in which it comes in contact with the amine absorption solution, allowing CO_2 to be absorbed into the absorption solution. The flue gas from which CO_2 is removed is washed with water before returned to the stack as a flue gas with almost no CO_2. On the other hand, the absorption solution containing large amounts of CO_2 is sent to the regenerator, where it is heated to release CO_2. The absorption solution is thus regenerated. This absorption solution is returned to the absorber for reuse. The captured CO_2 is sent to the compressor, where it undergoes the processes of compression and dehumidification before being stored in ISO tank containers.

Table 1 gives the specifications of the CO_2 separation and capture system. Two ISO tank containers are prepared for use. The compressor at the Tsurumi WTE plant is used to fill the containers. Once filling is completed with one container, the other empty container takes its place. The filled container is transported to the methanation facility of Tokyo Gas.

Table 1 Specifications of CO_2 separation and capture system

CO_2 capture capacity	0.3 t/d
CO_2 purity	99.9 vol%-dry

4. Demonstration test results

This demonstration was conducted in two stages. It started with the operation of the CO_2 separation and capture system in January 2023. In June 2023, the compressor was installed. The methanation test using ISO tank containers commenced on July 28, 2023.

The captured CO_2 was supplied to the methanation facility installed on the premises of the Tokyo Gas Yokohama Techno Station. The performance of the facility was evaluated. The produced methane was fed to commercial gas engine generators or was used for boiler operation testing, without being purified.

At present, both the CO_2 separation and capture system and the methanation facility are operating continuously in a stable manner. We will collect more data such as long-term operational data, thereby enabling the CO_2 separation and capture system to be rolled out widely for the application to waste incineration facilities.

5. Conclusion

One of the contributions expected toward achieving CN by 2050 is the promotion of decarbonization by introducing the technology for capturing and effectively utilizing CO_2 from waste incineration facilities. This project is based on regional cooperation and is Japan's first of its kind, aiming to demonstrate the separation and capture of CO_2 generated at a waste incineration facility and the use of captured CO_2 in methanation. The role of a waste incineration facility, which is expected to be fulfilled as a regional base of decarbonization, is significant. Looking forward, we will improve the reliability of our CO_2 capture system by acquiring the long-term operational data, as well as expand the range of effective applications.

References

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