

Using the CGT-7100 to Measure CO₂ Emissions during Combustion of Additive-Containing Plastic Pellet

Minako Tanaka, Yuya Kurata, and Kazuyoshi Nakajima

User Benefits

- ◆ The “all-in-one” design of the CGT-7100 with its built-in sample pretreatment units including a pump, filter, and dehumidifier makes for easy measurements.
- ◆ The CGT-7100 supports a wide range of sample gas flowrates (100 mL to 2.5 L/min depending on the product type), minimizing the impact of the sample flowrate on the target components.
- ◆ Data is stored on USB flash drives, which are convenient for editing data on a computer or sharing between groups.

Introduction

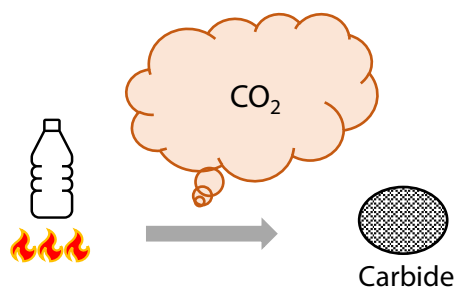
Global warming and other environmental issues are a global concern. Increasing levels of CO₂, CH₄, and N₂O, the so-called greenhouse gases, are believed to contribute to increased temperature levels worldwide and require immediate action. One of the technologies anticipated to help reduce greenhouse gas emissions are additives that, when added to recycled plastic during the recycling process, reduce CO₂ emissions upon combustion.

This article presents a case study that used the Shimadzu CGT-7100 portable gas analyzer to monitor CO₂ emitted during the combustion of a recycled plastic pellet that contained additives added during the recycling process.

Mechanism of CO₂ Emission Reduction

Fig. 1 shows how additives affect the combustion of plastic. When normal plastic combusts, some of the carbon present in the plastic is converted into CO₂ and CO and some is converted into carbide. Additives that encourage carbonization increase the amount of carbide produced during combustion. In turn, this increases the proportion of carbon converted to carbide and reduces the proportion of carbon emitted as CO₂.

Combustion of normal plastic



Combustion of plastic with additives

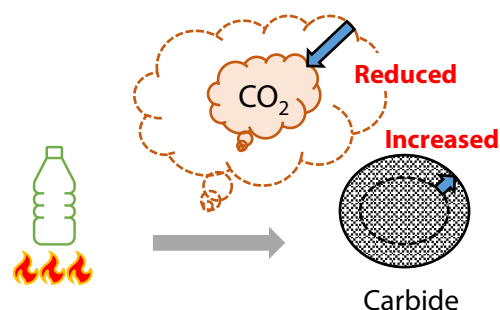


Fig. 1 Effect of Additives on Combustion of Plastic

Principle of Measurement

The CGT-7100 measures gas using non-dispersive infrared (NDIR) technology. Gases of heteroatomic molecules such as CO₂ have a unique infrared absorption spectrum. The CGT-7100 determines concentration levels of these gases by passing infrared light through the sample gas, measuring the degree of absorption by the gas, and using the unique infrared absorption spectrum of each gas. The CGT-7100 can measure up to three gases: two gases out of CO₂, CO, and CH₄ measured by NDIR method, and O₂ measured by a zirconia-based limiting current type sensor (an optional extra). The CGT-7100 can measure and monitor each of these gases over time across a wide concentration range from ppm to vol% levels.

Measurement Method

The measurement conditions used in this experiment are shown in Table 1, and a schematic representation of the experimental setup is shown in Fig. 2. A recycled plastic pellet was combusted in an electric muffle furnace, and the concentrations of CO₂, CO, and O₂ were monitored over time. Combustion was performed with the electric muffle furnace set to 450 °C.

Concentration measurements were displayed as graphs using the CGT-7100 web application.

Table 1 Measurement Conditions

Analyzer:	CGT-7100
Measured Gas and Range:	CO ₂ , 0 to 20 vol% CO, 0 to 5000 ppm (= 0.5 vol%) O ₂ , 0 to 25 vol%
Sampling Flowrate:	100 mL/min
Electric Muffle Furnace	
Heating Temperature:	450 °C

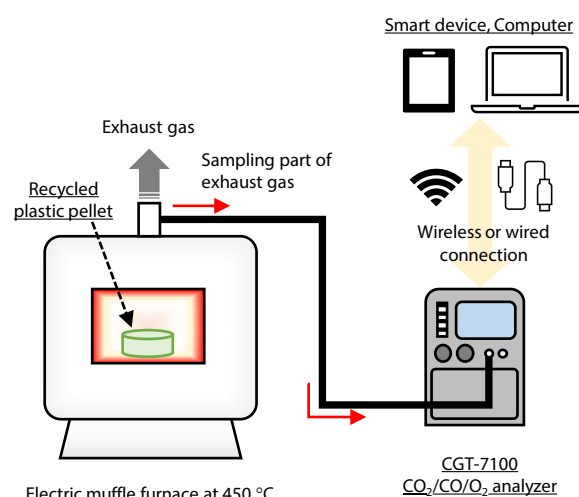


Fig. 2 Schematic Representation of Experimental Setup

■ Results

Fig. 3 shows the change in CO₂, CO, and O₂ levels during combustion of an additive-containing recycled plastic pellet. Once the electric muffle furnace started heating, a combustion reaction gradually commenced between the O₂ in the air of the furnace and the carbon in the recycled plastic pellet that produced CO. As the combustion reaction progressed further, CO production decreased and CO₂ production increased.

These data show how the CGT-7100 was used to successfully monitor levels of gases emitted during the combustion of the recycled plastic pellet. The effect of additives in reducing CO₂ emissions can be evaluated by comparing these data with measurements taken during the combustion of a recycled plastic pellet that contained no additives.

■ Conclusion

The CGT-7100 uses the same non-dispersive infrared absorption techniques utilized by well-established continuous gas analyzers to provide highly reliable and compatible data. Built-in sample preparation units, including a pump, filter, and dehumidifier, also facilitate stand-alone gas level monitoring.*1

The CGT-7100 also has a standard built-in analog output feature that can be used to output measurement data to a recording device such as a data logger for other uses. Alternatively, if a user has the optional "communication set" to activate the CGT-7100 web application, data can be saved and viewed with ease in an easy-to-interpret format on a computer or tablet and output in CSV format. The portability and simplicity of the CGT-7100 make it the perfect tool for a variety of different testing and research applications. In addition to the application presented in this article involving the study of plastic materials, the Shimadzu CGT-7100 portable gas analyzer can be an effective tool in a variety of testing and research applications related to carbon neutral technology requiring gas level monitoring, such as CO₂ fixation and absorption technology, methanation, and new energy resources. We are sincerely grateful to Professor Sugawara and students of the Tokyo University of Science for their assistance with this Application News in providing measurement data and instructions on measurement conditions.

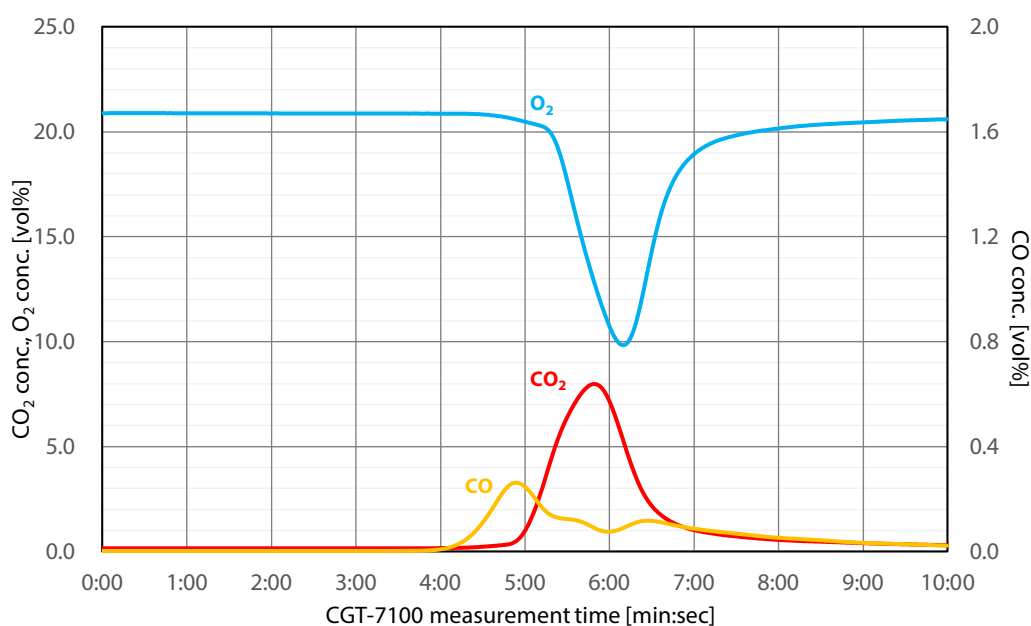


Fig. 3 Change in CO₂, CO, and O₂ Levels over Time during Combustion of Recycled Plastic Pellet



Shimadzu CGT-7100 Portable Gas Analyzer

■ Related links

Please see the product website for further information about the CGT-7100.

<https://www.shimadzu.com/an/products/continuous-monitoring-analysis/portable-gas-analysis/cgt-7100/index.html>

Please see the website below for details about the NOA-7100 portable NO_x-O₂ analyzer.

<https://www.shimadzu.com/an/products/continuous-monitoring-analysis/portable-gas-analysis/noa-7100/index.html>

*1: Dependent on measurement conditions. Contact a Shimadzu representative for further details.