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Application News

Transportable Gas Analyzer CGT-7100

Measuring Changes in Carbon Dioxide Concentrations Due to Adsorption on Porous Materials

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User Benefits

- Based on a highly stable measuring principle, the CGT-7100 is ideally suited to the evaluation of greenhouse gas sorbents that require continuous monitoring of gas levels.
- The CGT-7100 is a simple-to-operate, transportable, all-in-one gas analyzer with a built-in sample pump, filter, and moisture removal system.
- It can save recorded data on a USB flash drive for easy editing on a computer or sharing between groups.

■ Introduction

Environmental issues, such as global warming, have become an international concern. Rising levels of CO_2, CH_4, N_2O, and other greenhouse gases cause global warming and is an issue that requires immediate action. Carbon capture and storage (CCS) and carbon capture, utilization, and storage (CCUS) technologies that capture, store, and reuse greenhouse gases offer a potential solution to this issue, and developing them is now a global activity. To develop these technologies, materials, such as zeolites and amine solvent sorbents, are being used to capture greenhouse gases.

This article presents a demonstrative case study that used a CGT-7100 transportable gas analyzer to monitor changes in CO_2 levels during CO_2 adsorption on a zeolite.

■ Mechanism of Gas Adsorption on Porous Materials

Zeolites (Fig. 1) have a microporous structure with numerous pores that can adsorb molecules smaller than the diameter of those pores. This property allows zeolites to be used as a molecular sieve that separates molecules based on their size. For example, zeolites with pore sizes larger than the diameter of CO_2 molecules can be used as a CO_2 sorbent. Also, fine-tuning pore sizes between the diameter of CO_2 molecules (approximately 0.33 nm) and CH_4 molecules (approximately 0.38 nm) allows zeolites to be used as separation membranes that separate these two molecules.

Fig. 1 Zeolite (Molecular Sieve)

■ Measuring Principle

The CGT-7100 measures gas levels using non-dispersive infrared (NDIR) absorption. Heteronuclear diatomic gases, such as CO_2, have unique infrared absorption spectra that can be used to determine the concentrations of individual heteronuclear diatomic gases in a mixed sample gas by irradiating the gas with infrared light and detecting the intensity of transmitted infrared light in absorption bands that are unique to each gas species. The CGT-7100 can measure up to three gases, including two gases from among CO_2, CO, and CH_4 (measured by NDIR) and oxygen if an optional O_2 meter (zirconia limiting current type) is installed. The CGT-7100 is capable of monitoring the concentration of each of these gases over time across a wide concentration range from ppm to vol % levels.

■ Methods

A zeolite with pores larger than the diameter of CO_2 molecules was selected as the sorbent (molecular sieve 13X).

A schematic illustration of the test system used is shown in Fig. 2. The test system has a flow path that passes the sample gas through the zeolite (flow path (2)), a flow path that bypasses the zeolite (flow path (1)), and three-way valves that switch between the two flow paths.

First, CO_2 from the gas cylinder was supplied to the test system at a fixed flowrate of 100 mL/min and directed through flow path (1) while the CGT-7100 measured CO_2 levels in the exit gas. Then the CO_2 feed was switched to flow path (2) while continuing to measure the CO_2 concentration in the exit gas. The test system revealed any changes in CO_2 concentrations in the exit gas that resulted from switching to flow path (2) and adsorption on the zeolite. The analytical conditions used are outlined in Table 1.

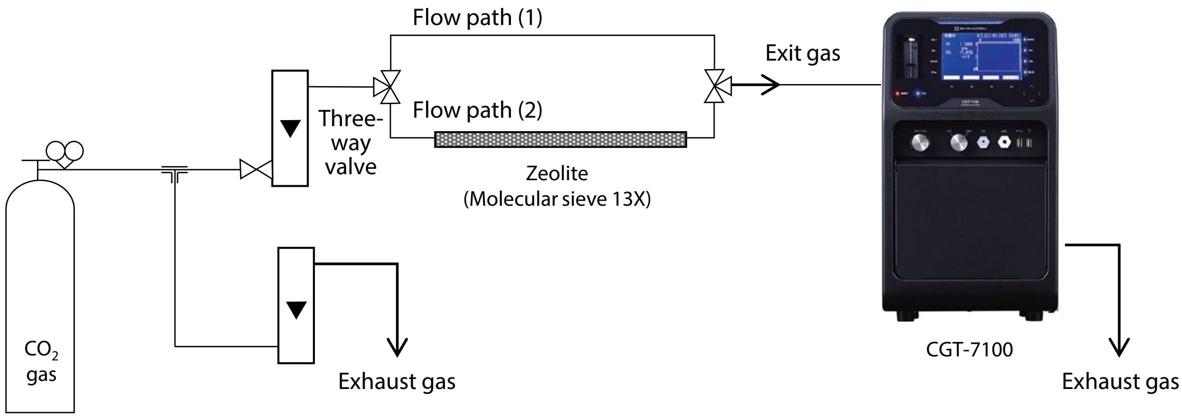

Fig. 2 Test System Schematic

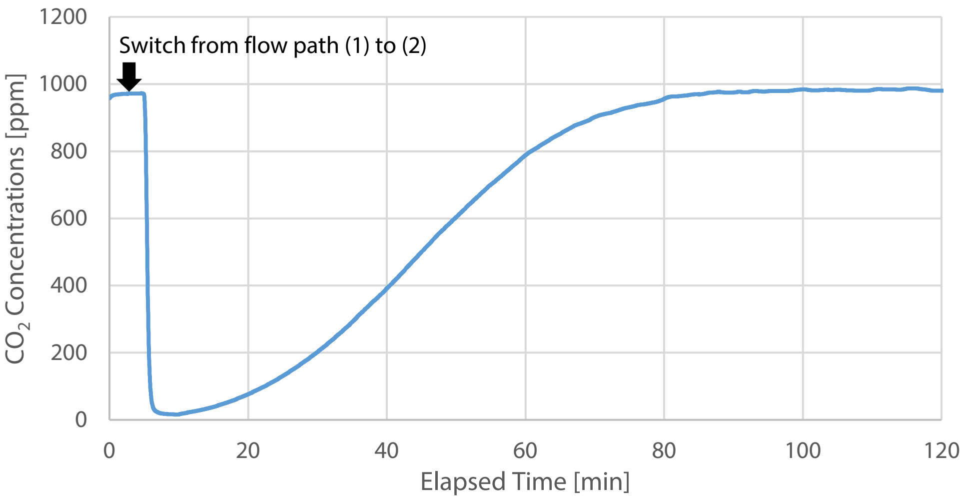

Fig. 3 Change in CO_2 Concentrations Due to Adsorption on Zeolite

Table 1 Analytical Conditions

Analyzer:	CGT-7100
Measured Component:	CO_2
Measurement Range:	CO_2 0–2500 ppm
Concentration of Reference Gas:	CO_2 968 ppm
Sample Gas Flowrate:	100 mL/min
Sorbent:	Zeolite (Molecular Sieve 13X)

■ Results

The CO_2 measurements are shown in Fig. 3. When the flow path was switched from (1) to (2), the CO_2 concentration in the exit gas suddenly dropped to almost zero as the CO_2 fed into flow path (2) was adsorbed on the zeolite and so did not appear in the exit gas. This reduced the CO_2 in the exit gas to zero, which was recorded by the gas analyzer as a CO_2 concentration close to zero.

Over time, the zeolite reached its adsorption capacity for CO_2 (breakthrough volume), and CO_2 not adsorbed by the zeolite appeared in the exit gas of flow path (2). This was detected as a gradual rise in CO_2 concentrations in the exit gas that eventually reached almost the same concentration as the feed gas (968 ppm).

Using the CGT-7100 for continuous CO_2 level monitoring revealed how CO_2 adsorption on a zeolite varied over time, from the initial adsorption to reaching the breakthrough volume.

■ Conclusion

This article presents a demonstrative case study that monitored CO_2 levels over time to show how CO_2, a greenhouse gas, is adsorbed on a zeolite sorbent.

The CGT-7100 uses non-dispersive infrared (NDIR) absorption, the same highly reliable measurement method used by continuous gas analyzers that monitor emissions at power stations. Also, with the onboard sample preparation including a pump, filter, and moisture removal system, the CGT-7100 offers a simple-to-operate, standalone unit that can perform continuous gas level monitoring for the evaluation of greenhouse gas sorbents. The analog data output feature included as standard can be used to send monitoring data to a data logger or another recording device.

By adding the Data Transmission Set to the CGT-7100, the user can view data more readily on a PC or tablet device, and it supports saving data and data output in CSV format.

The transportability and simplicity of the CGT-7100 make it a flexible tool and an ideal gas analyzer for a variety of testing and research applications. From applications in CO_2 capture and storage covered in this article to others related to carbon neutrality, such as methanation technology and new energy, Shimadzu's transportable gas analyzer offers an excellent tool for a variety of situations that require gas level measurement and monitoring.


Fig. 4 CGT-7100 Transportable Gas Analyzer

■ Related links

More information about the CGT-7100 can be found on the product website.

[CGT-7100: Analytical and Measuring Instruments (Analytical Instruments) Shimadzu (shimadzu.com)]

Please use this link for information about the NOA-7100 transportable NOx/O2 gas analyzer.

[NOA-7100: Analytical and Measuring Instruments (Analytical Instruments) Shimadzu (shimadzu.com)]

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