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Application News

CGT-7100 Transportable Gas Analyzer

# Using the CGT-7100 to Measure the Indoor Ventilation Rate —Model Experiment with $CO_2$ as Indicator—

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## User Benefits

- Non-dispersive infrared absorption spectrophotometry by ratio photometry achieves excellent measurement value stability.
- Offers both the portability and simplicity essential for workplace measurements.
- Acquired data can be stored on a USB flash drive for easy editing on a computer or sharing with other departments.

## ■ Introduction

From the perspective of preventing infectious diseases, gas poisoning accidents, and improving the working environment, there has been rapidly growing interest in regularly exchanging the air in indoor spaces and vehicle interiors.

Two methods are widely used to determine ventilation rates based on measuring $CO_2$ as a tracer gas. The $CO_2$ concentration decay method determines the exchange rate based on how much indoor $CO_2$ concentration levels decrease over time due to ventilation measures, whereas the constant $CO_2$ concentration method determines the ventilation rate based on the amount of $CO_2$ that must be generated within a room to maintain a constant concentration.

For this experiment, the $CO_2$ concentration decay method was used with a glovebox as a model for simulating room air to demonstrate the utility of CGT-7100 transportable gas analyzers for measuring indoor ventilation rates.

Given a starting $CO_2$ concentration inside the glovebox that is higher than in the external air, when ventilation is started, the external air flowing into the glovebox dilutes $CO_2$ to gradually decrease the concentration level. The CGT-7100 determines the ventilation rate by measuring that concentration change.

## ■ Measurement Method

The volume of the acrylic glovebox used for the experiment was about 176 L (internal dimensions of about W72 × D51 × H48 cm). Removable caps were installed in the glove holes (about 14 cm in diameter) instead of gloves.

A fan was placed inside the glovebox to ensure a uniform $CO_2$ concentration. The fan was oriented so that its back was near one of the glove holes.

A tube for supplying 20 vol% $CO_2$ was connected to one glovebox connector, and the CGT-7100 sampling tube was connected to the other connector (refer to Fig. 1 to 3).

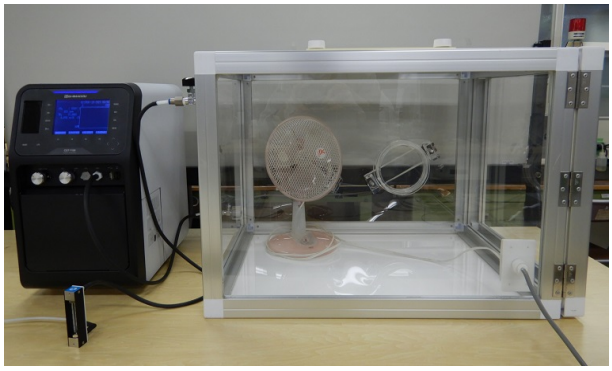

Fig. 1 Photo of Model Experiment for Using the CGT-7100 to Measure the Ventilation Rate

With the fan switched on, 20 vol% $CO_2$ gas was added until the $CO_2$ concentration inside the box exceeded 4000 ppm. Then the gas supply was shut off, and simultaneously the caps were removed from the glove holes.

In this way, by opening the glove holes and using the CGT-7100 unit to exhaust internal air, the glovebox was ventilated at about 2.5 L/min. In addition, the $CO_2$ concentration in the surrounding atmosphere was measured before and after the internal air measurements, and the average concentration was used as the $CO_2$ concentration in the external air.

To determine how the position and number of open glove holes affect the ventilation rate, measurements were performed for the following three conditions.

Condition A: Glove hole farther from the fan open

Condition B: Glove hole closer to the fan open

Condition C: Both glove holes open

Table 1 Measurement Conditions

| | |
|---|---|
| Analyzer: | CGT-7100 |
| Measured substance: | $CO_2$ |
| Measurement range: | 0 to 5000 ppm |
| Sampling flowrate: | About 2.5 L/min |

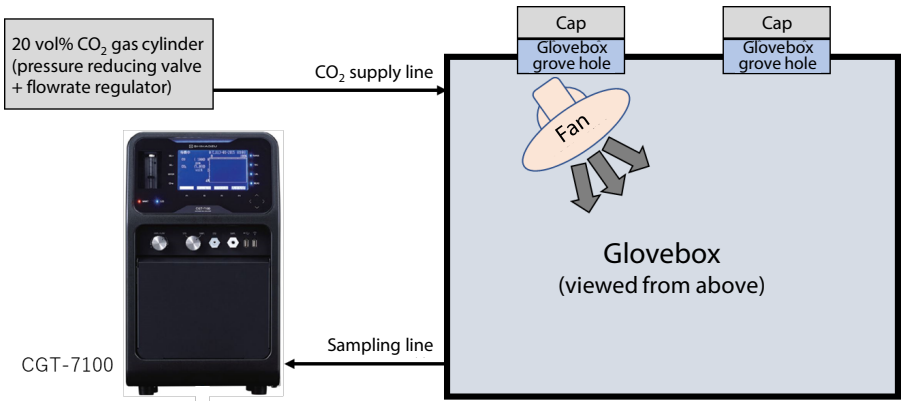


Fig. 2 Diagram of Model Experiment for Using the CGT-7100 to Measure the Ventilation Rate

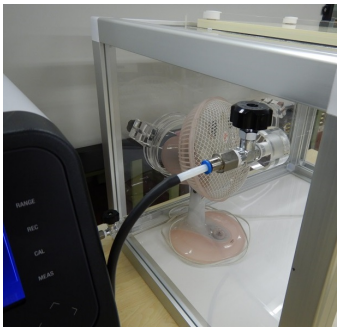

Fig. 3 20 vol% $CO_2$ Inlet

## ■ Measurement Results and Discussion

Measurement results of $CO_2$ concentration inside the glovebox using the CGT-7100 are shown in Fig. 4.

The ventilation rate Q (L/min) is calculated using the formula below. The ventilation rates calculated using the formula based on the three experimental conditions indicated in Fig. 4 are listed in Table 2. The response time of the CGT-7100 unit was not considered.

$$Q = 2.303 \times (V/t) \times \log\{(Co - Cout)/(Ct - Cout)\}$$

Ct: $CO_2$ concentration (ppm) inside glovebox at time t
Co: $CO_2$ concentration (ppm) inside glovebox at time zero
Cout: $CO_2$ concentration (ppm) of external air
V: Volume of glovebox (L)
Q: Ventilation rate (L/min)
t: Elapsed time (min)

The ventilation rate was Condition A < Condition B << Condition C.

Although Conditions A and B involved identical opening sizes, Condition B resulted in a higher ventilation rate value, presumably because the fan was located in a position that facilitated drawing in external air through the glove hole. Condition C doubled the opening area but more than doubled the ventilation rate, presumably due to one glove hole functioning as an external air inlet and the other as an internal air outlet.

Table 2 Ventilation Rate Calculation Results

| Experimental Conditions | Time (min) | $CO_2$ Conc. (ppm) | Ventilation (L/min) | Avg. Ventilation (L/min) |
|---|---|---|---|---|
| Condition A | 0.5 | 3465 | 59.4 | 59.7 |
| | 2.0 | 2297 | 59.8 | |
| | 5.0 | 1171 | 60.1 | |
| Condition B | 0.5 | 3379 | 70.6 | 68.9 |
| | 2.0 | 2133 | 68.5 | |
| | 5.0 | 1049 | 67.6 | |
| Condition C | 0.5 | 2353 | 227.4 | 232.1 |
| | 1.0 | 1456 | 233.1 | |
| | 2.0 | 773 | 235.9 | |

## ■ Conclusion

Although the experiment described was a small-scale model, the same principle can be used to measure the ventilation rate in an actual room or car. The CGT-7100 analyzer (with an oxygen analyzer attached) can also be used to measure the ventilation rate in showcases for artworks, based on the known technique[1] of using nitrogen gas as a tracer gas instead of $CO_2$. Due to the portability and simplicity of the CGT-7100 analyzer, it can be used for measuring ventilation rates in a wide variety of locations, such as in offices, vehicle interiors, warehouses, greenhouses, and showcases.

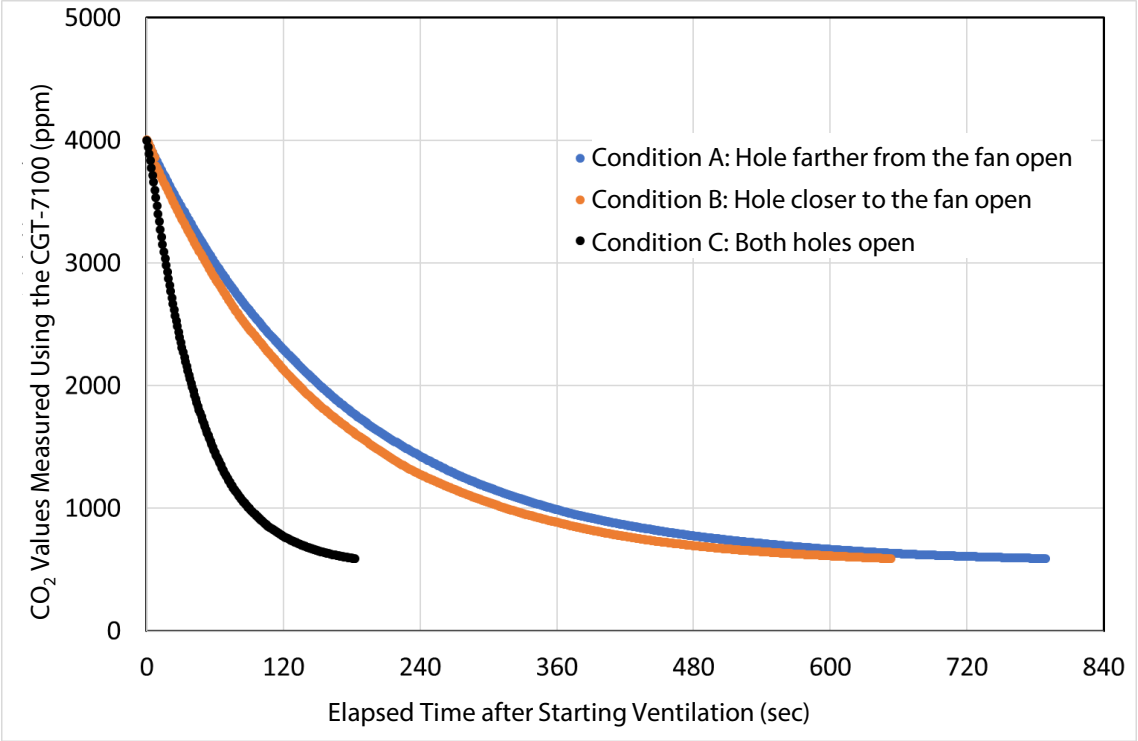


Fig. 4 Change in $CO_2$ Concentration inside Glovebox

## ■ Reference

1) Masahide Inuzuka, Toshiyuki Torigoe, Takeshi Ishizaki, and Mitsuko Honda: Measurements of Ventilation Rate, Temperature and Relative Humidity inside Showcases Equipped on the Walls in the Kyushu National Museum, Science for Conservation, No. 44, 83-96 (2005)

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