# Measurement of $CO_2$ concentrations in temperature changes

Comparison of temperature characteristics
between Senseair's $CO_2$ sensor and competitors' products

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# Introduction

In recent years, attention has been focused on improving indoor air quality (IAQ) by measuring $CO_2$ concentrations and providing appropriate ventilation to provide safe and comfortable living environments. Efficient control of air conditioning and ventilation systems requires high accuracy and temperature-independent $CO_2$ sensors. Also, the Green Building Certification Program LEED [1] recommends the use of a $CO_2$ sensor with a measurement accuracy of ±75ppm [2].

In this evaluation of a $CO_2$ sensor used in air conditioning and ventilation systems, we set the measurement accuracy of $CO_2$ concentrations recommended by LEED to ±75ppm, and compared the temperature characteristics of Senseair's $CO_2$ sensor and competitors' products.

The $CO_2$ sensor in the HVAC (Heating, Ventilation, and Air-Conditioning) system is also an important component. In order to evaluate, it is necessary to build an evaluation system that maintains a stable $CO_2$ concentration and constant $CO_2$ temperature, so it is not easy to evaluate the sample. We hope that this temperature characteristic evaluation will also serve as reference as the results of the basic characterization of the $CO_2$ sensor.

[1] LEED is an environmental performance assessment system for building environments (buildings and urban environments) developed and operated by USGBC (U.S. Green Building Council), a non-profit organization, with certification audits conducted by GBCI (Green Business Certification Inc.).

[2] https://www.usgbc.org/credits/eq12

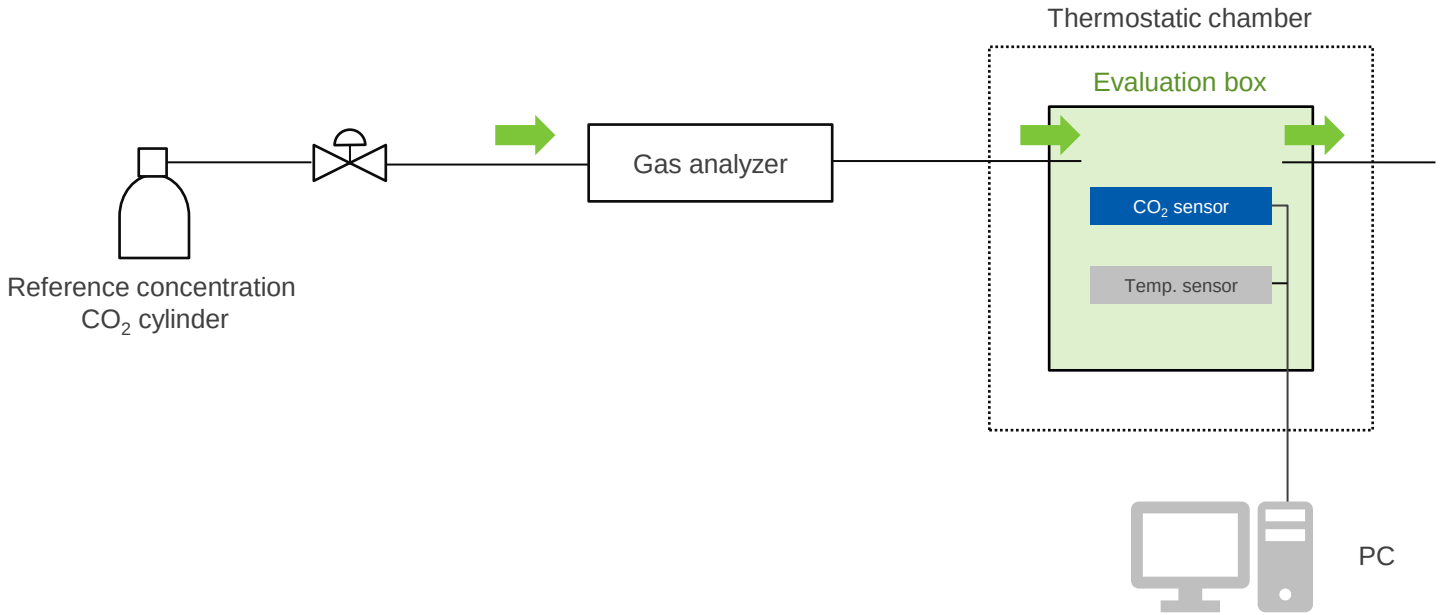
# Evaluation system

## Evaluation conditions

**Reference concentration $CO_2$ cylinder** [1]  395ppm, 994ppm  (Measured with gas analyzer)

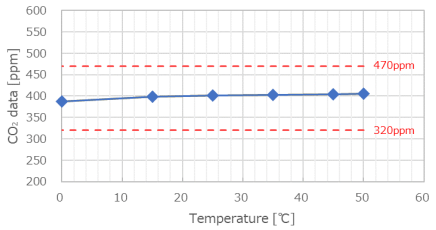
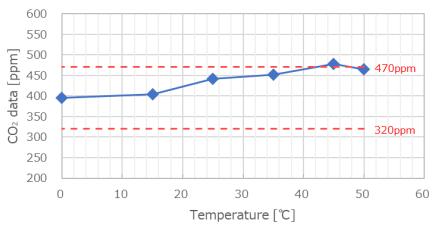
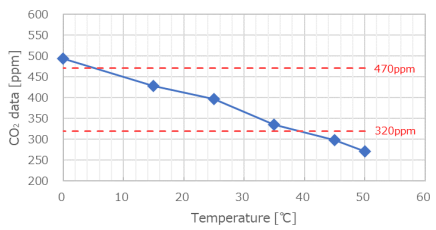
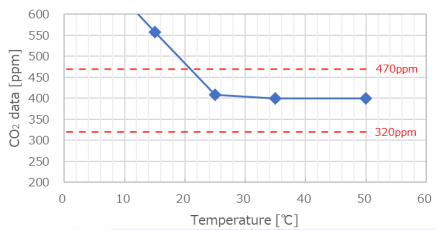
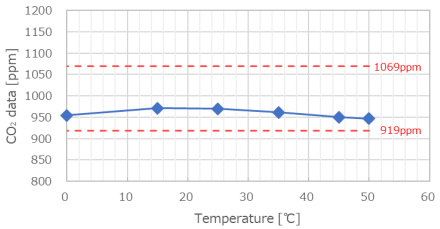
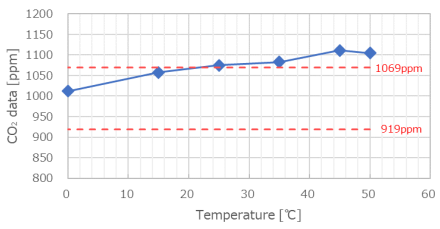
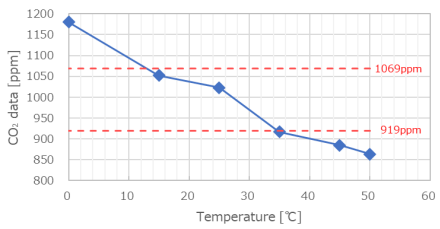
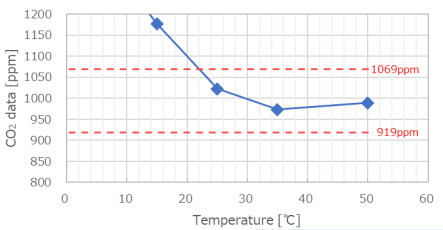
[1]  Reasons to choose between two $CO_2$ concentrations
Approximately  400ppm :  Equivalent to atmospheric $CO_2$ concentration
Approximately 1000ppm :  Equivalent to the standard $CO_2$ concentration for building air conditioning management

**Temperature**  0°C, 15°C, 25°C, 35°C, 45°C, and 50°C  (6 points in total)




Note :  In order to make the evaluation conditions of each $CO_2$ sensor equal, the calibration recommended by each manufacturer is performed. The evaluation box is supplied with a standard concentration of $CO_2$ gas at a constant flow rate.

# Evaluation results

| $CO_2$ Concentration | AKM | Manufacturer | | |
|---|---|---|---|---|
| | **Senseair** | A | B | C |
| 395ppm |  |  |  |  |
| 994ppm |  |  |  |  |



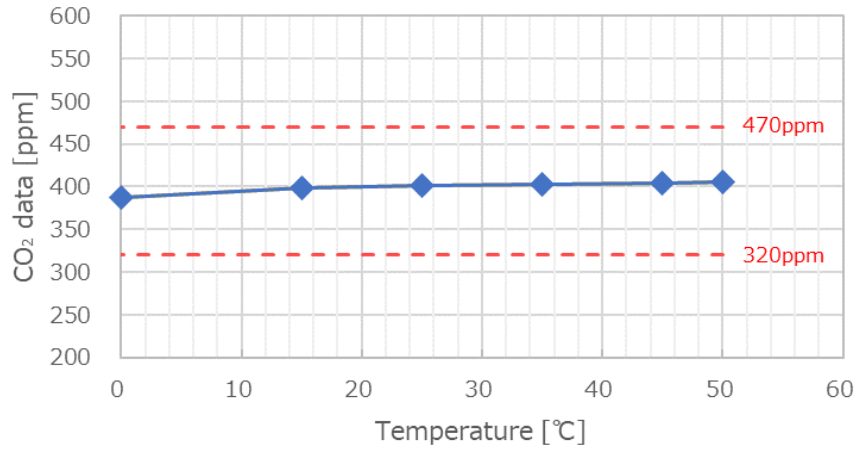
Note) The **red dashed line** shows the measurement value of the reference $CO_2$ concentration ±75ppm [1].

[1] LEED recommended $CO_2$ sensor accuracy.

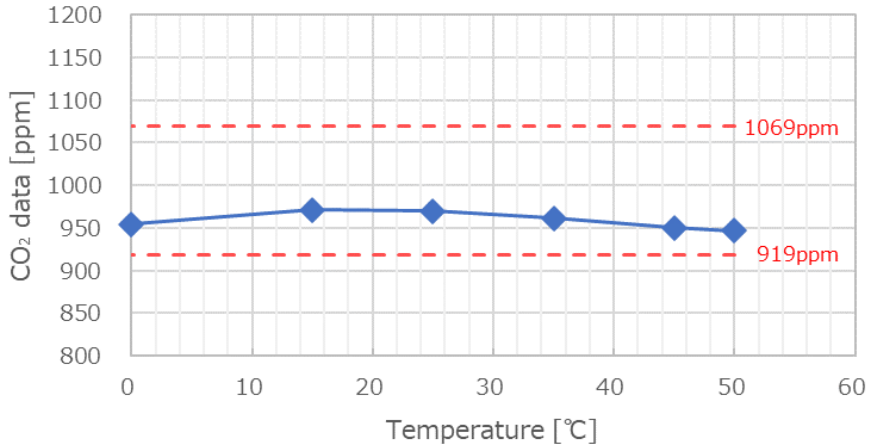
- The graphs above show the measurement results using 2 reference concentrations of $CO_2$ gas (395ppm, 994ppm) after performing the calibrations recommended by the manufacturers for each $CO_2$ sensor.
- Only the Senseair $CO_2$ sensor has an accuracy of less than ±75ppm of the reference $CO_2$ concentration between 0 and 50°C.

# Senseair

$CO_2$ concentration: 395ppm




$CO_2$ concentration: 994ppm




## Target specification

Accuracy ($CO_2$ concentration output) : ±75ppm

Measurement temperature range: 0°C ~ 50°C

## Measurement results

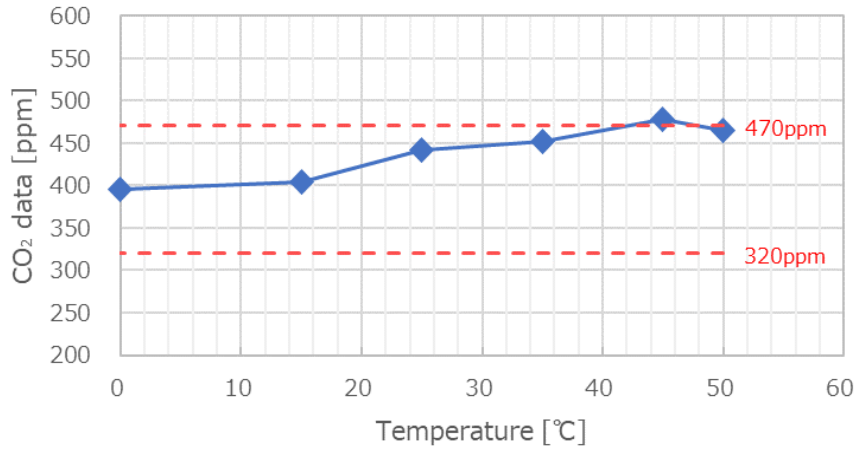
The $CO_2$ concentration that meets the target specifications was output in the measurement temperature range.

## If installed in an HVAC system

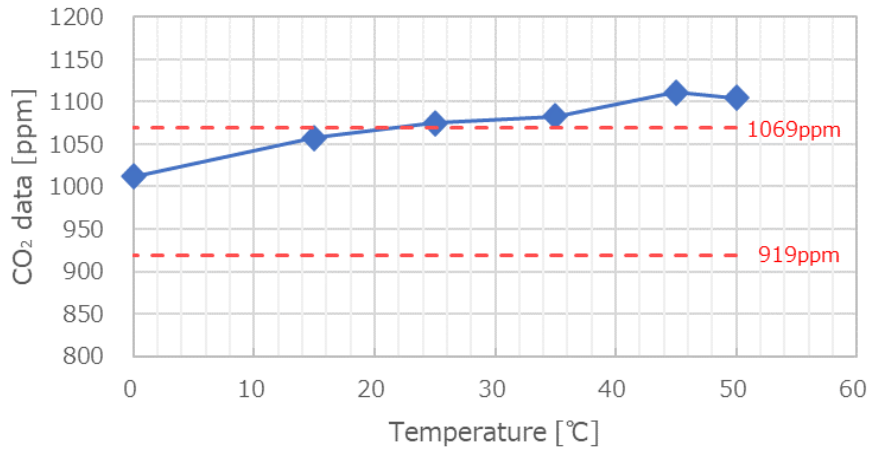
Appropriate ventilation control is possible.

# Manufacturer A

$CO_2$ concentration: 395ppm




$CO_2$ concentration: 994ppm




## Target specification

Accuracy ($CO_2$ concentration output) : ±75ppm

Measurement temperature range: 0°C ~ 50°C

## Measurement results

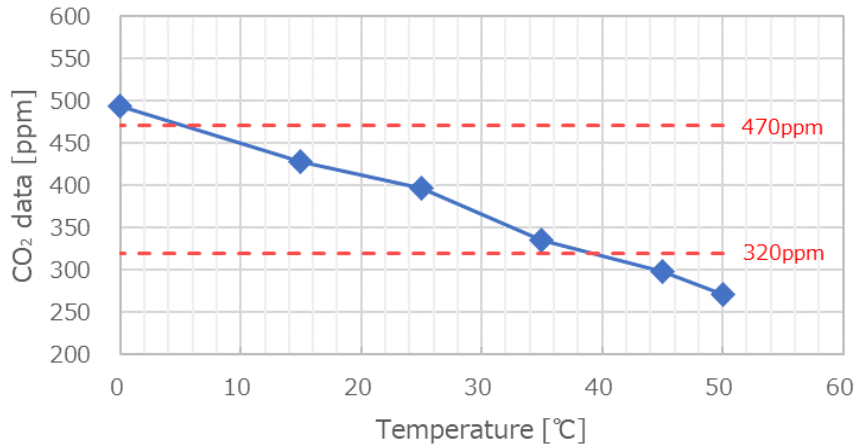
In the 994ppm environment, a higher $CO_2$ concentration was output around 25°C or above, which deviated from the target specifications.

## If installed in an HVAC system

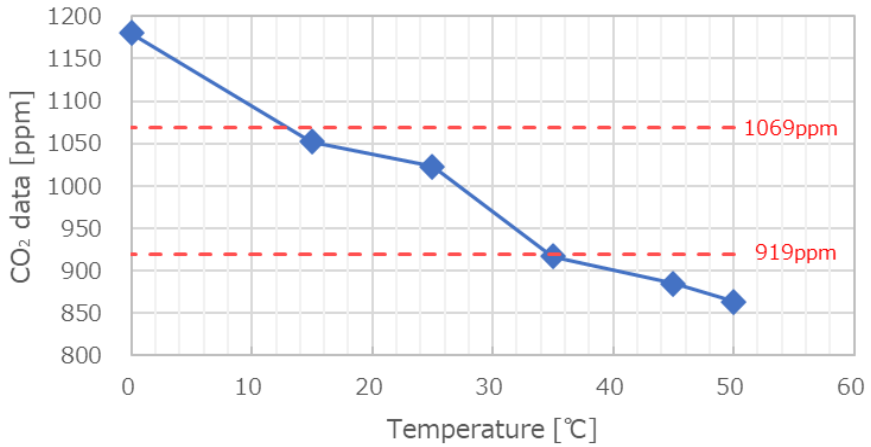
In the 994ppm environment, a higher $CO_2$ concentration was output around 25°C or above. In this case, overventilation can cause energy loss.

# Manufacturer B

$CO_2$ concentration: 395ppm




$CO_2$ concentration: 994ppm




## Target specification

Accuracy ($CO_2$ concentration output) : ±75ppm

Measurement temperature range: 0°C ~ 50°C

## Measurement results

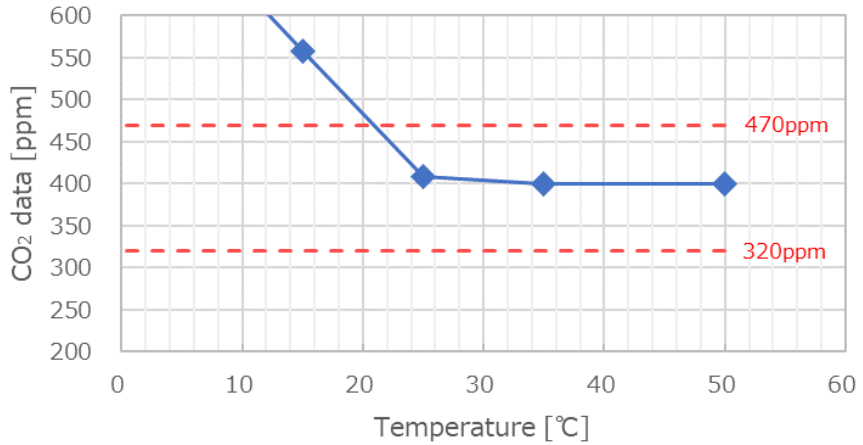
A higher $CO_2$ concentration was output around 10°C or below, while lower output was seen around 40°C or above, which deviated from the target specifications.

## If installed in an HVAC system

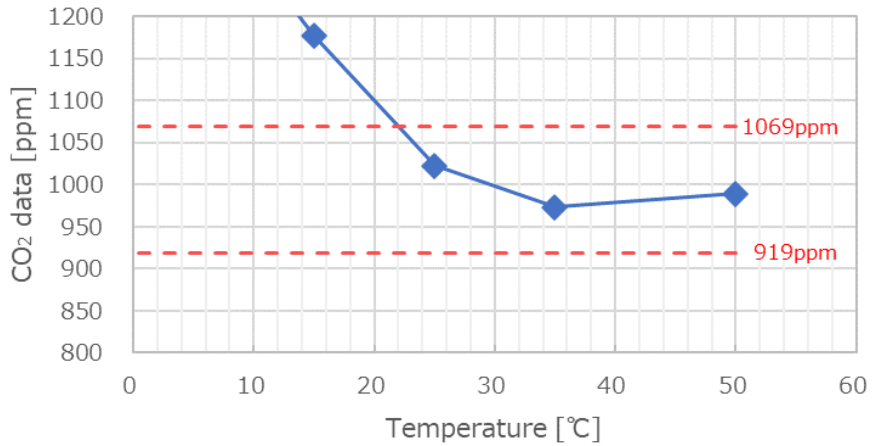
A $CO_2$ concentration that was higher than the actual value was output around 10°C or below. In this case, overventilation can cause energy loss. However, a $CO_2$ concentration that was lower than the actual value was output around 40°C or above. In this case, ventilation will be insufficient and will not provide the expected ventilation control.

# Manufacturer C

$CO_2$ concentration: 395ppm




$CO_2$ concentration: 994ppm




## Target specification

Accuracy ($CO_2$ concentration output) : ±75ppm

Measurement temperature range: 0°C ~ 50°C

## Measurement results

A higher $CO_2$ concentration was output around 20°C or below, which deviated from the target specifications.

## If installed in an HVAC system

A higher $CO_2$ concentration was output around 20°C or below. In this case, overventilation can cause energy loss.

# Conclusion

- The Green Building Certification Program LEED (Leadership in Energy & Environmental Design) recommends the use of $CO_2$ sensors with a measurement accuracy of ±75ppm or less.
- In this measurement, only Senseair's $CO_2$ sensor achieved the required accuracy recommended by LEED (±75ppm).
- Senseair's $CO_2$ sensor is ideal for efficient control of HVAC systems.

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boldly anticipating the emergence of new needs.
This is what we mean by “Creating for Tomorrow.”