Test Report

Kitasato Research Center for Environmental Science

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VCN16A514

MITSUBISHI ELECTRIC CO.

Test Report

To investigate the removal efficacy of

"Air conditioner with disinfecting function" ,

on airborne bacteria

(25 m^3 space)

KRCES－Bio. Test Report No. 2016_0118

August 2, 2016

Approved by : Toshihiro Itoh

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1. Test objectives

Removal efficiency of the air purifier, "Air conditioner with disinfecting function" in a 25 m^3 test chamber for airborne bacteria was investigated in this study. (Evaluation method for the removal efficiency was referring to Annex D "The removal efficiency evaluation test for airborne virus" in Japan Electrical Manufacturers' Association standard JEM 1467 "household air cleaner".)

2. Client

Name: Mitsubishi Eectric Corporation Shizuoka Works
RAC Advanced Development Section Room Air Conditioner Dept.
Address: 3-18-1 Oshika, Suruga-ku, Shizuoka 422-8528, Japan

3. Test laboratory

Name :Kitasato Research Center for Environmental Science
Address:1-15-1 Kitasato, Minami-ku, Sagamihara-shi, Kanagawa 252-0329, Japan

4. Test period

July 28, 2016～August 1, 2016

5. Test device

"Air conditioner with disinfecting function" (Model number : MSZ-LN series, Mode: High operation, Air flow rate :13.5 m^3/min, Disinfecting function : ON) ・・・Photo A

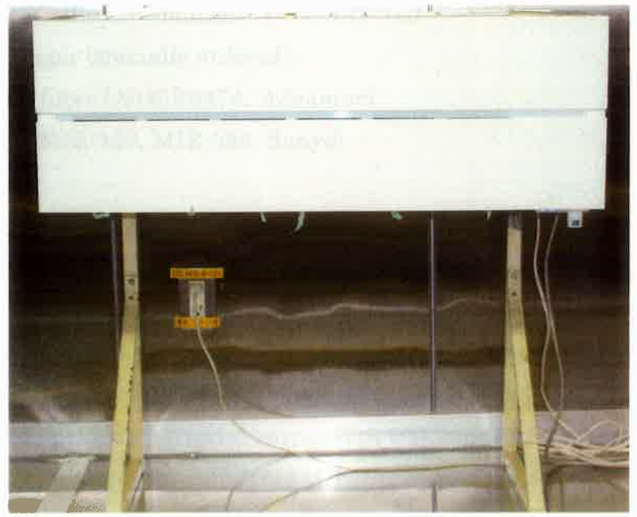


Photo A. "Air conditioner with disinfecting function"

6. Test condition

1) Natural reduction as a negative control ; periodical changes in bacterial count were monitored when the test bacteria suspension was sprayed into the chamber with the test device off.

2) Test device ; periodical changes in bacterial count were monitored when the test bacteria suspension was sprayed into the chamber with the test device on(Fan speed was high).

7. Test bacteria

Staphylococcus aureus NBRC 12732

8. Reagents, devices, and materials

1) Main reagents

- Tryptic Soy Ager (Difco, TSA medium)
- Sodium chloride (Wako, special grade)
- Sodium thiosulfate (Wako, 1st grade)

2) Main devices and equipments

- Test chamber (25 m^3: 3.3×3.5×2.2 m, Amenity Technology)
- Circulation fan (Yamazen, BS-B-25)
- Laser particle counter (Kanomax Japan, MODEL 3886)
- Thermo-hygrometer (T&D, TR-72Ui)
- Nebulizer (Collison Nebulizer、BGI、CN-31I)
- Glass impinger (specially ordered)
- Membrane filter (A045R047A, Advantec)
- Incubator (MIR-153, MIR-553, Sanyo)

9. Method

1) Test system

The test system was shown on Figs A , B and Photo B . The test device, the circulation fan, the laser particle counter and the thermo-hygrometer were put in the test chamber. Two holes were made at the side panel of the test chamber. The nebulizer for spraying bacterial suspension was connected to the one hole and the glass midget impinger for collecting airborne bacteria was connected to the other hole.

According to the test procedure described on Table A and B. The test device was put in a 25 m^3 test chamber and the bacterial suspension was sprayed with nebulizer for 10 minutes into the chamber while the circulation fan was operated. After 2 minutes circulation of the air, the bacterial aerosol was collected into the impinger (time 0) and then the fan was turned off. Immediately after turning off the fan, the test device was turned on and the aerosol was collected after 60, 120 and 180 minutes.

As a control (natural reduction of airborne bacteria), the same test was performed under the condition that the test device was turned off.

2) Test bacterium

Cryopreserved test bacteria were pre-cultured and then sub-cultured at 36±2 ℃ for 22 hours on TSA. Colonies formed on TSA were scraped off and suspended in sterilized ion-exchange water. Bacterial count of the suspension was adjusted to about 10^9 CFU/mL by Spectrophotometer

3) Spray of bacterial suspension

The test bacterial suspension (10^9 CFU/mL) was sprayed into the test chamber by the glass nebulizer for 10 minutes at a liquid rate of 0.2 mL/min. The pressure of the air discharged from the compressor was set at 1.0 kg/cm^2 and the air flow rate was set to 6.5 L/min.

4) Collection of airborne bacteria

The air in the chamber was sampled at 10 L/min for 2 minutes (total 20 L) to the midget glass impinger containing 20 mL of sterilized saline with 0.015 % sodium thiosulfate to collect the airborne bacteria (bacterial aerosol).

5) Bacterial count

Decimal dilutions of the each collected bacterial suspension were prepared with saline. One mL of the each dilution or the original suspension was mixed with TSA medium to make an agar plate. Ten mL the collected bacterial suspension in the impinger were filtered through the membrane filter. The remainder of the suspension was also filtrated. Each resultant filter was transferred onto the surface of TSA medium. These medium were incubated at 36±2 ℃ for 48 hours. After the incubation, colonies were counted and the number of bacteria in 20 L of air was calculated.

6) Evaluation method for the removal efficiency

This test was carried out using Annex D of JEM 1467 as a reference. In JEM 1467, achieving 2.0-digit reduction in 90 minutes is required to conclude that the test sample is effective.

The evaluation of a removal efficacy was carried out using the method described below, because this test device is not correspond to household air purifier and bacteria was used instead of virus in this test.

The approximate equation was calculated based on the time-dependent changes of airborne bacteria (logarithmic representation) and the inclination of the approximate equation was obtained. This inclination represents an amount of change in the number of bacteria per minute. Net inclination※1 was calculated by subtracting the inclination of control from that of "Test device". Net LRV was calculated from the value of net inclination,※2 and the removal efficacy of airborne bacteria was judged based on net LRV.

The test sample's efficacy was evaluated using the following formulae.

※1 Net inclination = Inclination of "Test device" − Inclination of control

※2 Net LRV = −{ Net inclination × Test time (min) }

※3 $$\text{Reduction rate}(\%) = \left(1 - \frac{1}{10^{(\text{Net LRV})}} \right) \times 100\ (\%)$$

Test samples with 2.0 or higher net LRV for airborne bacteria were judged to be efficient in this test (Reffering to the removal efficiency of Annex D in the JEM 1467).

10. Results

Bacterial count of the sprayed suspension was 2.3×10^9 CFU/mL.

Bacterial counts of the collected samples were shown on Table 1 and Fig 1.

LRV and Net LRV (reduction rate) were calculated from the airborne virus number at each time, and shown in Table 2 and Fig 2.

In this test, Net LRV (reduction rate) of the test device for airborne bacteria was 2.22 (99.39%) at 180 minutes.

11. Reference data

In addition, the number of particle, temperature and humidity in the test chamber were shown as a reference data.

12. Comment

In this test, the net LRV calculated by subtracting a control value was more than 2.0 that is judged to have a removed efficacy of the device on airborne bacteria at 162 minutes. Therefore, the removal efficacy of this device was recognized.

Table1. Removal performance on airborne bacteria (CFU/20 L-air)

Test condition	Time(min)			
	0	60	120	180
① Natural reduction (Control)	180,000	230,000	260,000	170,000
② Test device	450,000	87,000	13,000	2,800

※Test device : "Air conditioner with disinfecting function"
(Model number : MSZ-LN series, Mode : High operation, Air flow rate : 13.5 m^3/min, Disinfecting function : ON)

※Test bacteria : *Staphylococcus aureus* NBRC 12732

※Test space : 25 m^3

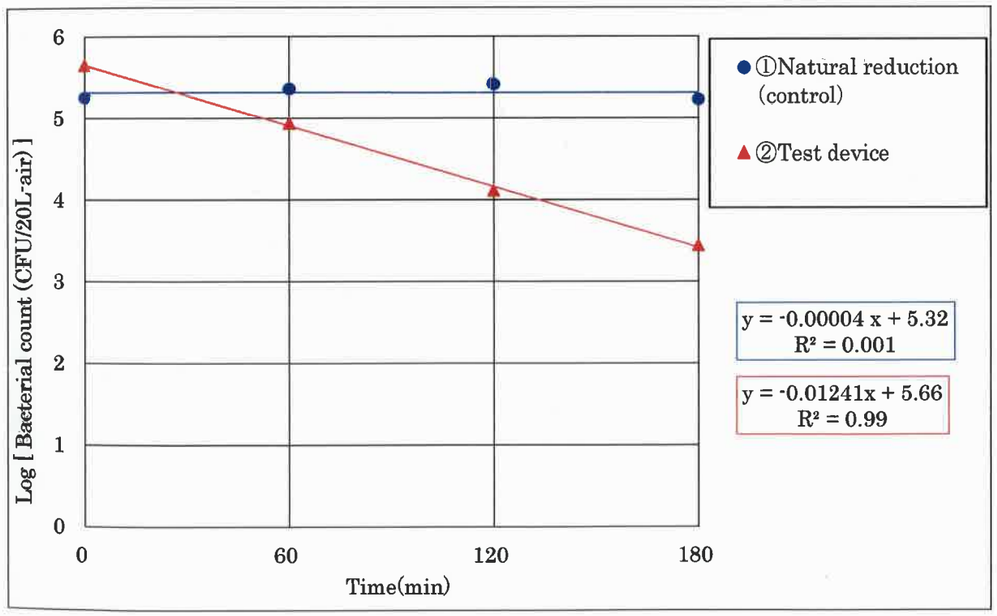


Figure1. Removal performance on airborne bacteria

Table 2. LRV and Net LRV (reduction rate) at each time

Test condition	Inclination	Net Inclination	Time(min)			
			0	60	120	180
①Natural reduction (Control)	-0.00004					
②Test device	-0.01241	-0.01237	0.00	0.74	1.48	2.22
			(0%)	(81%)	(96.6%)	(99.39%)

Net inclination = Inclination of "Test device" − Inclination of control

Net LRV = −{ Net inclination × Test time (min) }

$$\text{Reduction rate}(\%) = \left(1 - \frac{1}{10^{(\text{Net LRV})}}\right) \times 100\ (\%)$$

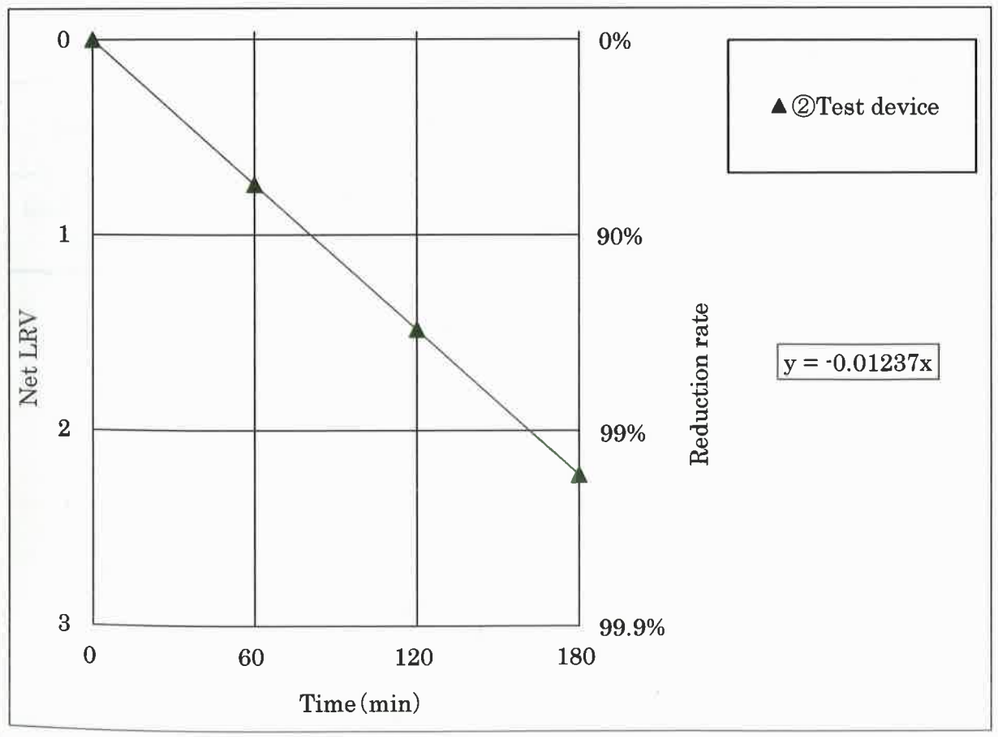


Figure 2. Net LRV and reduction rate at each time

Attached sheet

Table A. Test process (for test condition①)

Test operation	Equipment	Time(min) 0	60	120	180
To make homogeneous air in chamber	Circulation fan	→			
Spray bacteria	Nebulizer	10min 2min stir			
Collect airborne bacteria	Impinger	2min (10L/min)	2min (10L/min)	2min (10L/min)	2min (10L/min)

Table B. Test process (for test condition②)

Test operation	Equipment	Time(min) 0	60	120	180
To make homogeneous air in chamber	Circulation fan	→			
Spray bacteria	Nebulizer	10min 2min stir			
Test device	"Air conditioner with disinfecting function"		→		
Collect airborne bacteria	Impinger	2min (10L/min)	2min (10L/min)	2min (10L/min)	2min (10L/min)

Attached sheet

Photo B. Inside of the 25 m^3 test chamber

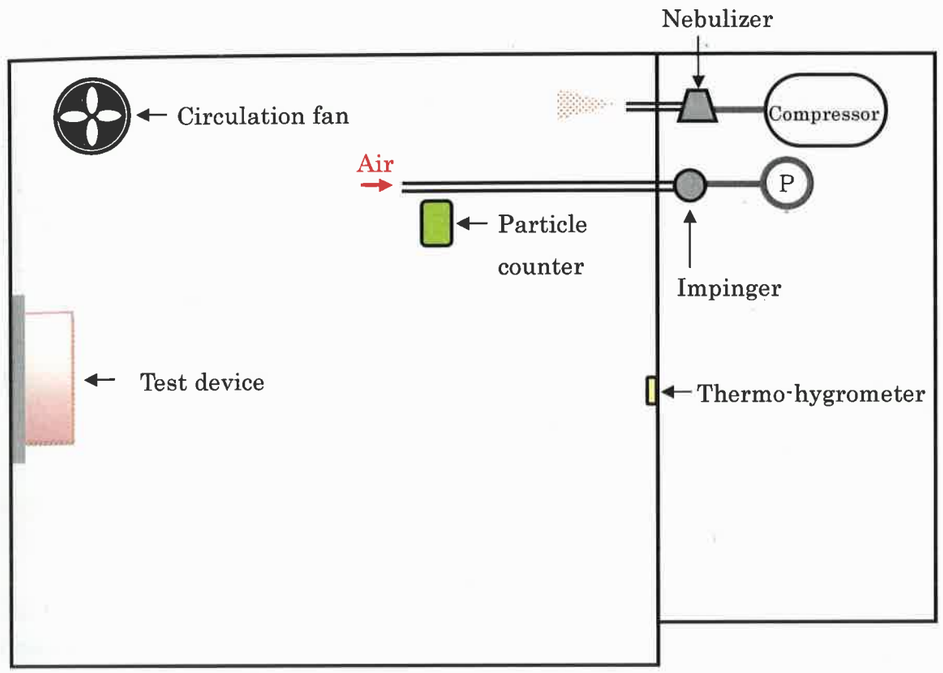


Figure A. 25 m³ Test chamber (top view)

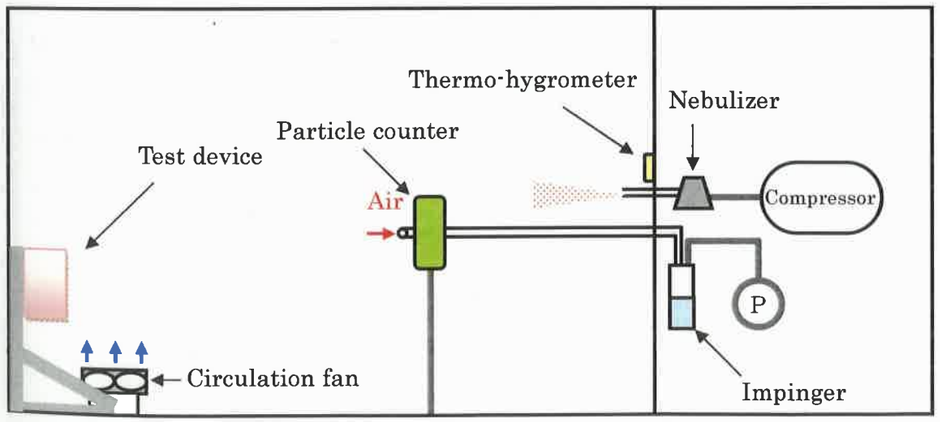
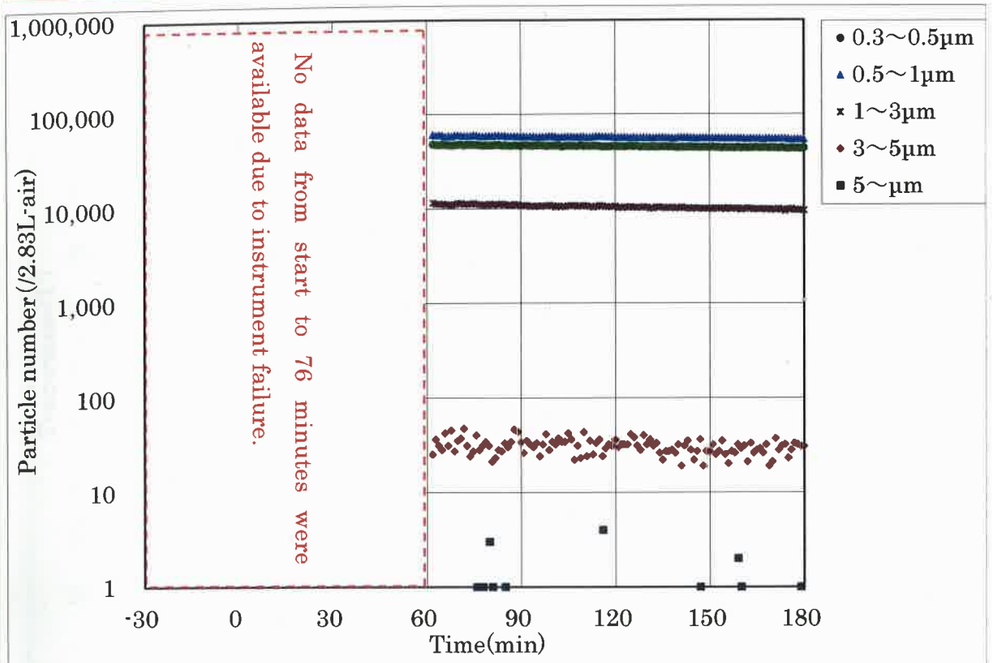
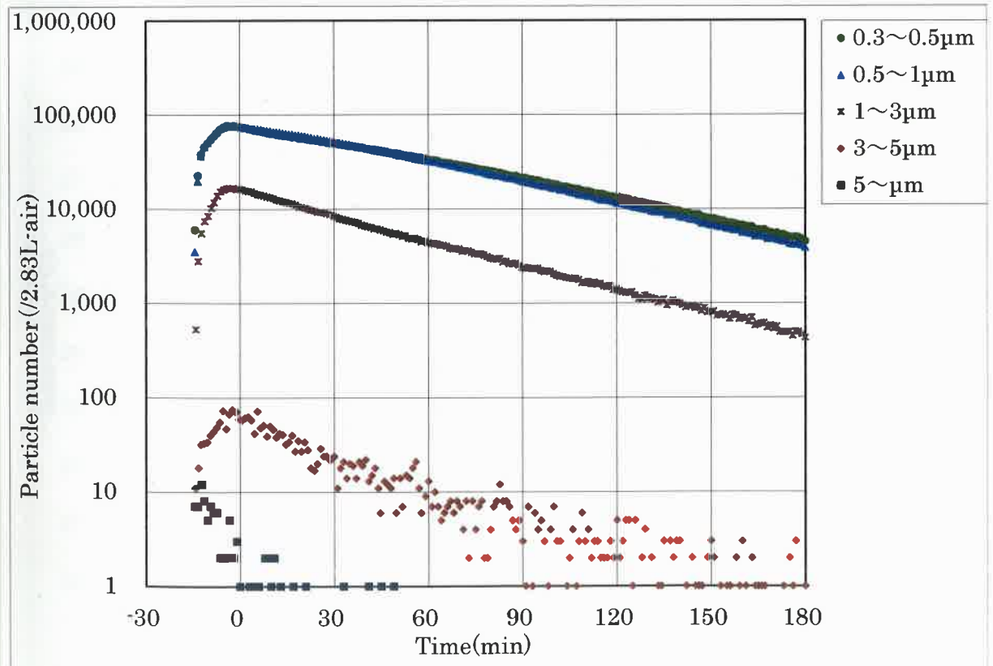


Figure B. 25 m³ Test chamber (side view)

reference data



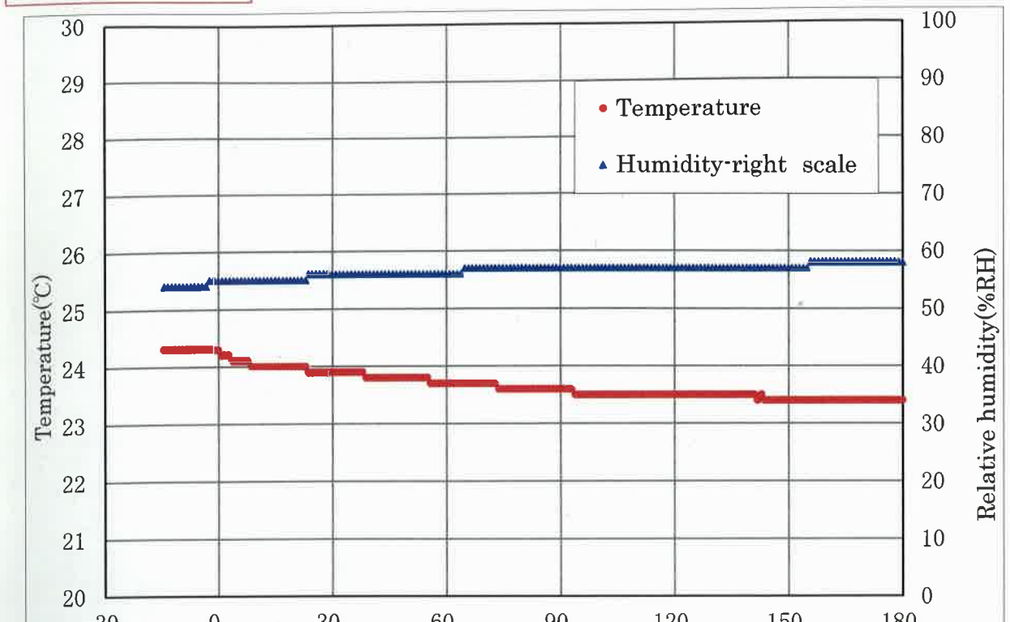
①The particle number in the chamber, Natural reduction



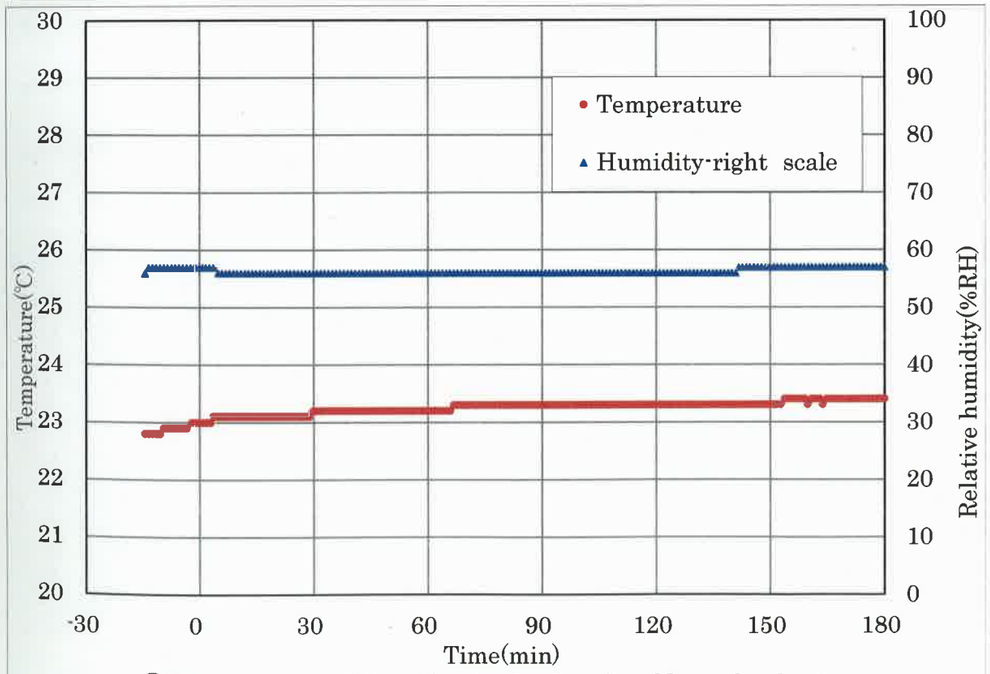
②The particle number in the chamber, "Test device"

＊Measured with a laser particle counter (Kanomax Japan, MODEL3886)

reference data



②Temperature and humidity in the chamber, "Test device"



①Temperature and humidity in the chamber, Natural reduction.

*

Measured by a thermo-hygrometer (TR-72Ui,T&D)

再生紙を使用しています