試　験　報　告　書

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試 験 報 告 書

Test Report

エアコンによる浮遊菌の除去性能評価試験（25 m³ 循環式）

Evaluation test of Air Conditioner on removal of airborne micro-organisms using *S.aureus* (25m³)

KRCES－Bio. Test Report No. 23_0371

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Approved by : Toshihiro Itoh

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1. Test objectives

To evaluate the efficacy of air conditioner for removing air borne bacteria (S.aureus) in a 25 m^3 test room.

2. Client

Name: Mitsubishi Electric Corporation Shizuoka Works

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

March 1, 2012～March 5, 2012

5. Test device

Air conditioner integrating inactivation device (Model number : MSZ-FH35)・・・ Photo 1

Test condition

① Device OFF (control)

② Device ON (Air flow;12.6 m^3/min、Inactivation performance ON)

6. Test bacteria

Staphylococcus aureus NBRC 12732

7. Method

Test device was set in a 25 m^3 test chamber and bacterial suspension was sprayed into the chamber. Air sample was collected using an impinger at time 0 (airborne bacterial count at the starting point), and the test device was turned on. Aerosol was collected at each collecting point, and collected bacteria were quantified using standard culturing assays.

7-1. Test system

Fig 2 and 3 show the test system. Test device, a circulation fan (Yamazen, BS-B-25), a laser particle counter (Kanomax Japan, MODEL 3886) and a thermo-hygrometer (T&D, TR-72Ui) were set in the test chamber (25 m^3: 3.3

×3.5×2.2 m, Amenity Technology). Five holes (one for spraying and the others for collecting airborne bacteria) were made at the center of a side panel of the test chamber. A glass nebulizer (specially ordered) and a glass impinger (specially ordered) were connected to each hole. A nebulizer and impingers were used for spraying and collecting test bacteria, respectively.

7-2. Culture of test bacteria

Frozen stock bacteria was precultured , and this was recultured for 24 hours at 35°C with TSA (Tryptic Soy Agar, Difco). Colonies were scraped off and suspended in sterilized ion exchanged water. Bacterial count of the suspension was adjusted to about 10^9 CFU/mL

7-3. Spray of bacterial suspension

Test bacterial suspension was sprayed through a nebulizer by the air from an air-compressor into the test chamber for 15 minutes. Air splaying rate was set at 7.5 L/ min (including 0.2mL of bacterial suspension).

7-4. Collection of airborne bacteria

Airborne bacteria were collected into a glass impinger containing 20 mL of sterilized saline with 0.015 % sodium thiosulfate at 6 L/min for ten minutes (Total volume 60 L) at each collecting time.

7-5. Operation

The test process was shown on Tables 2 and 3. Bacterial suspension was sprayed into the test chamber for 15 minutes while the circulation fan was operated. After 2 minutes, the initial sample of airborne bacteria was collected (time 0). Samples were collected at 180, 240 and 360 minutes after the test device was turned on.

7-6. Bacterial count

After sampling, decimal dilutions of each collected bacterial suspension were prepared with saline. One milliliter of each dilution was mixed with TSA to make an agar plate and incubated at 35℃ for 48 hours. The remaining original sample solution (17 mL) was membrane-filtered. The resultant filters were transferred onto TSA. After incubation at 35°C for 48 hours, the number of colony was counted and bacterial count per 60 L of air was calculated.

8. Results

Bacterial count of the sprayed suspension at ①Device OFF was 2.6×10^9 CFU/mL and Device ON was 3.1×10^9 CFU/mL.

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

Particle number, temperature and humidity in the test chamber were shown in attached Figs as a reference.

The inclinations of the approximation curves of airborne bacterial count (change in airborne bacterial count (log scale) per minute) of ①Device OFF and ②Device ON were -0.0026 and -0.0201 respectively as shown in Fig 1.

Change in the logarithm value can be interpreted as change in digit number of airborne bacterial count. Therefore, decrease in airborne bacterial count of ① Device OFF and ②Device ON after 180 min were 0.46 digit (65 % reduction) and 3.61 digit (99.97% reduction) respectively.

Bacterial count of ②Device ON after 180 min was 3.15 digits (= 99.92 %) lower than that of ①Device OFF (control).

Note : 1 digit decrease is equal to 90 % reduction, and 2 digits decrease is equal to 99 % reduction. The calculating formula is as follows.

$$\text{Reduction rate}(\%) = \left(1 - \frac{1}{10^{(\text{Number of decrease digit})}} \right) \times 100\ (\%)$$

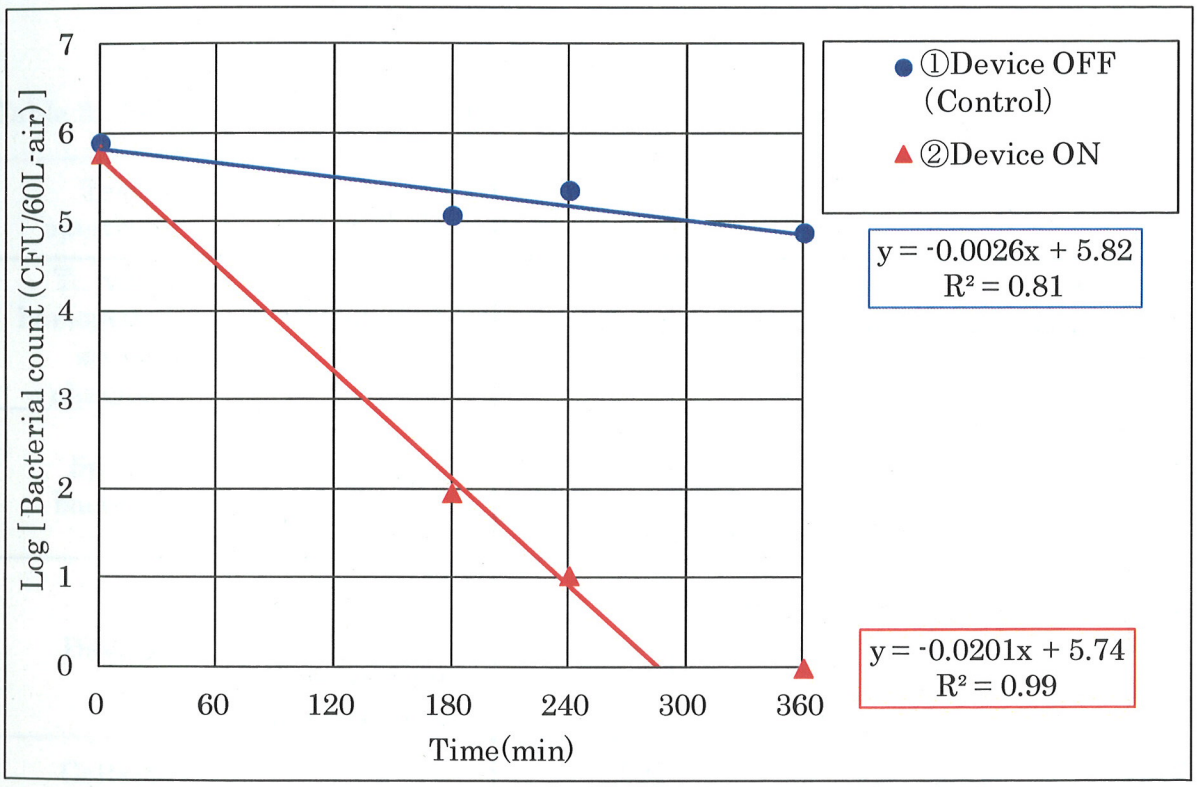
Table 1. Removal effect of the device on airborne bacteria (CFU/60 L-air)

Test condition	Time (min)			
	0	180	240	360
①Device OFF (Control)	790,000	120,000	230,000	77,000
②Device ON	600,000	93	11	1

※Test device : Air conditioner (Model number : MSZ-FH35、Air flow;12.6m³/min、Inactivation performance ON)

※Test bacteria : *Staphylococcus aureus* NBRC 12732

※Test space : 25 m³



*Data of Device ON (from 0 to 240 min) was expressed as an approximation curve

Fig 1. Removal effect of the inactivation device on airborne bacteria

Table 2. Test process (Device OFF)

Test operation	Equipment	Time (min) 0	180	240	360
To make homogeneous air in chamber	Circulation fans	→			
Spray bacteria	Nebulizer	15min 2min stir			
Collect airborne bacteria	Impinger	10min 60L	10min 60L	10min 60L	10min 60L

Table 3. Test process (Device ON)

Test operation	Equipment	Time (min) 0	180	240	360
To make homogeneous air in chamber	Circulation fans	→			
Spray bacteria	Nebulizer	15min 2min stir			
Device	Fan	→			
	Inactivation performance	→			
Collect airborne bacteria	Impinger	10min 60L	10min 60L	10min 60L	10min 60L

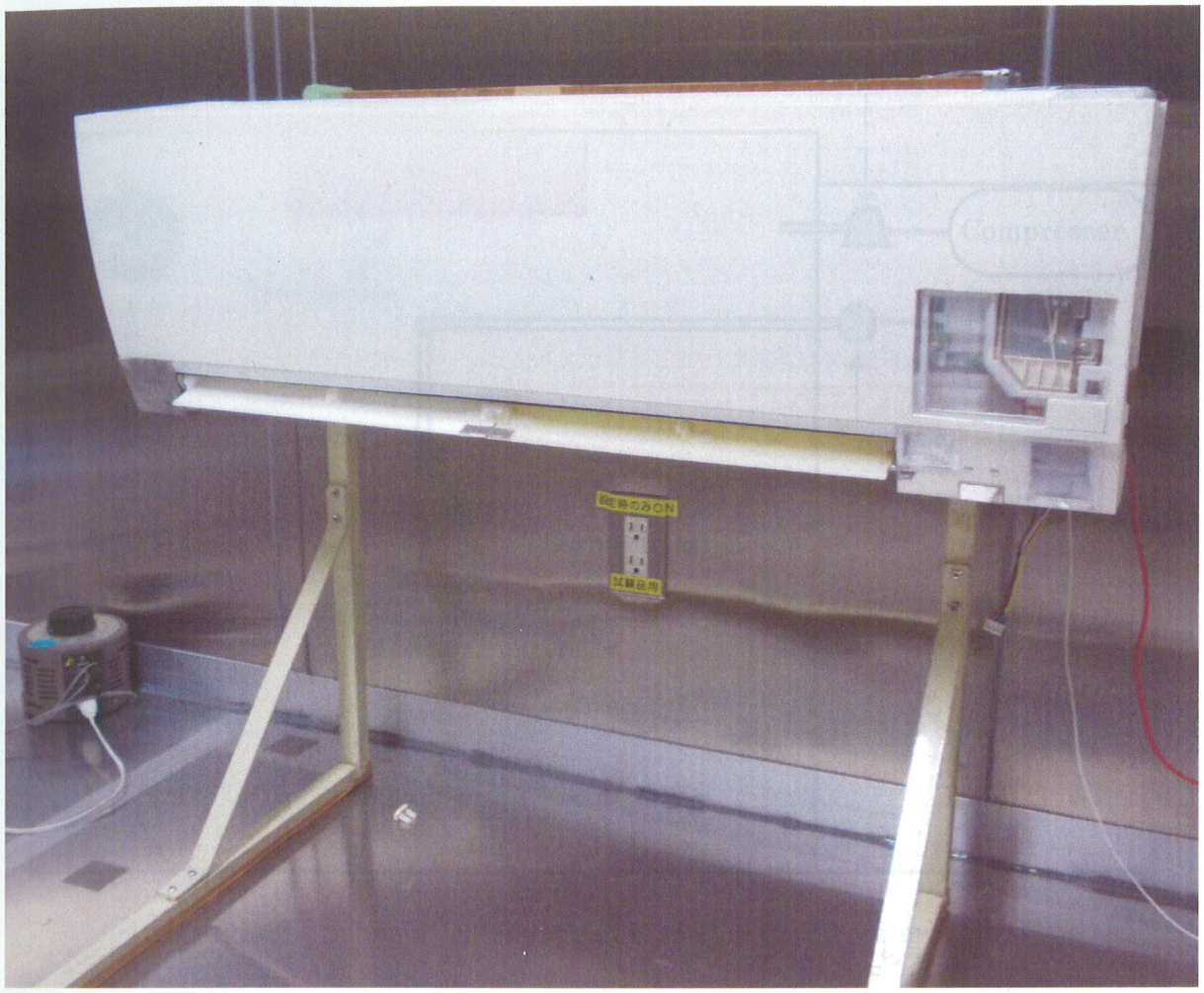


Photo 1.　Air conditioner (Model number : MSZ-FH35)

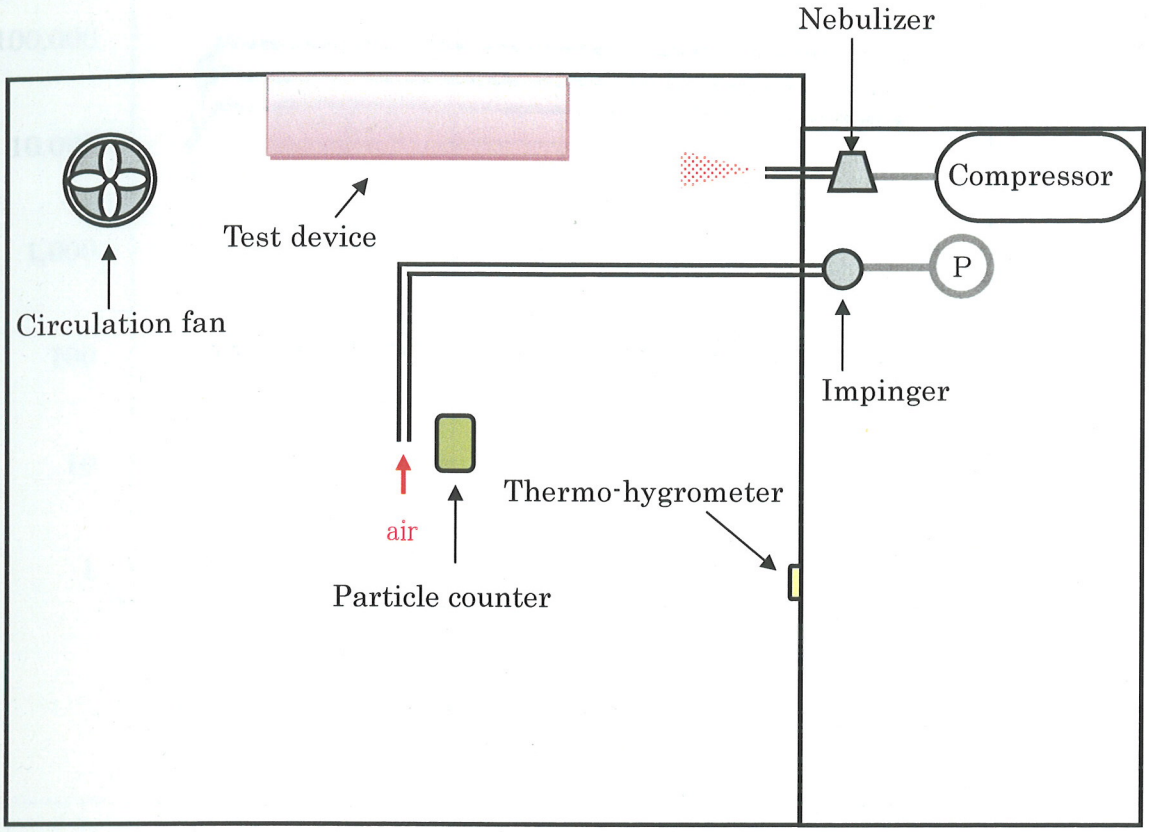


Figure 2. Schematic drawing of test system (Top elevation)

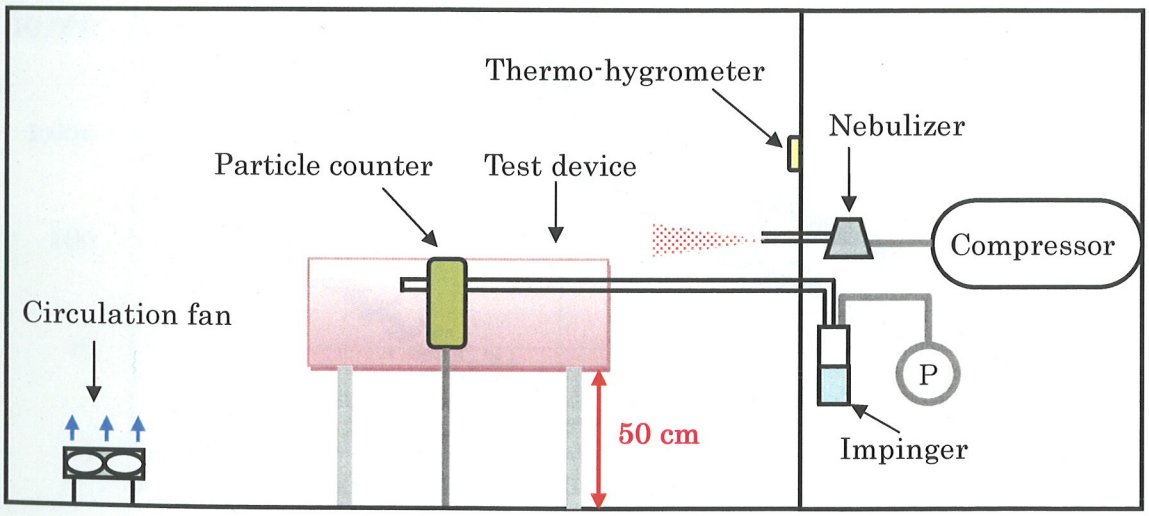
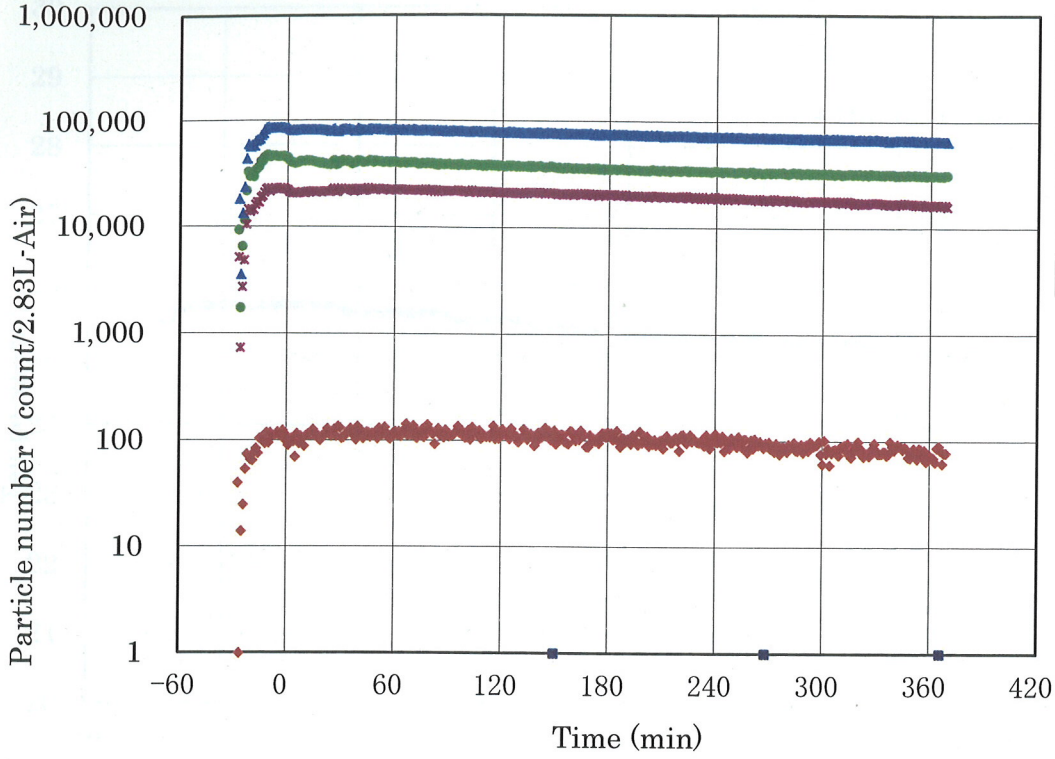
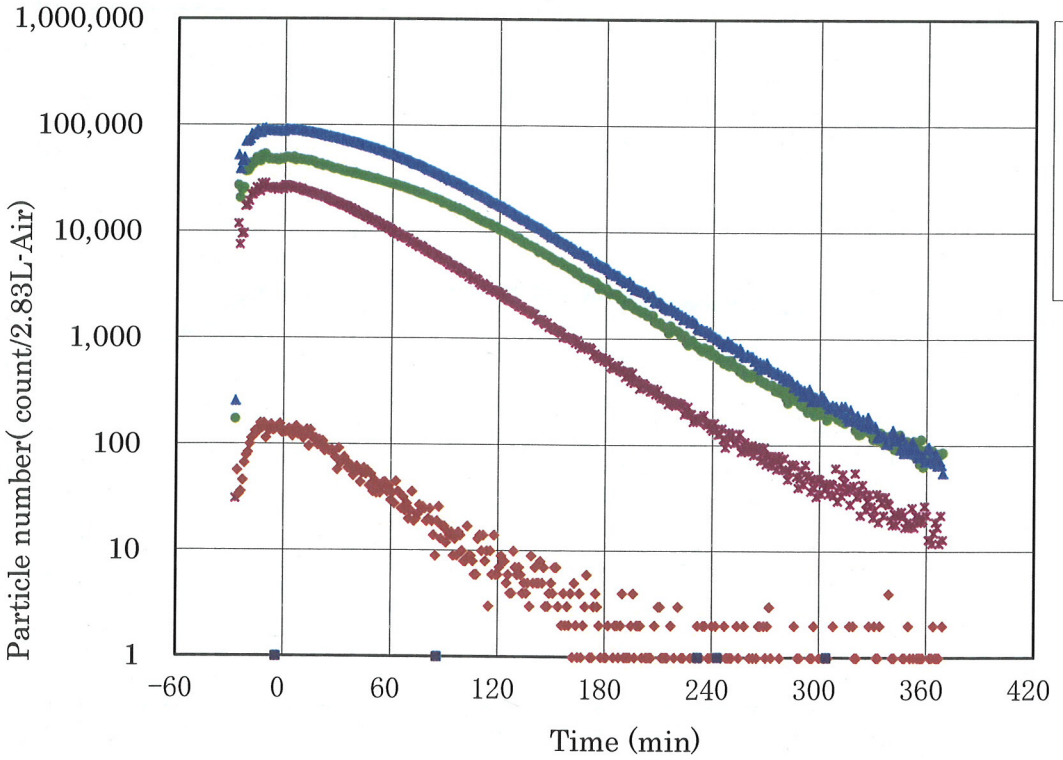


Figure 3. Schematic drawing of test system (Side elevation)

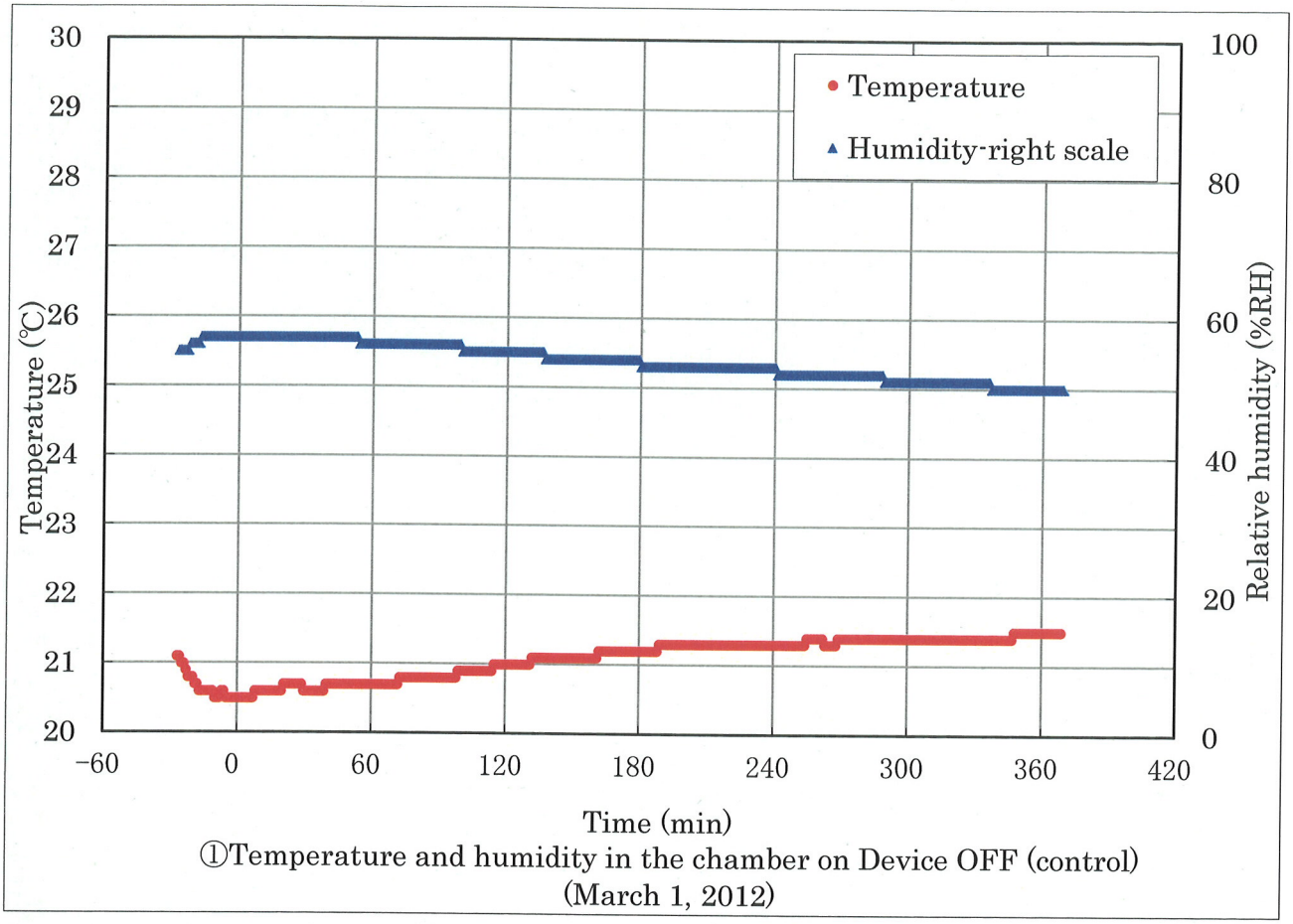


①The particle number in the chamber on Device OFF (control)
(March 1, 2012)

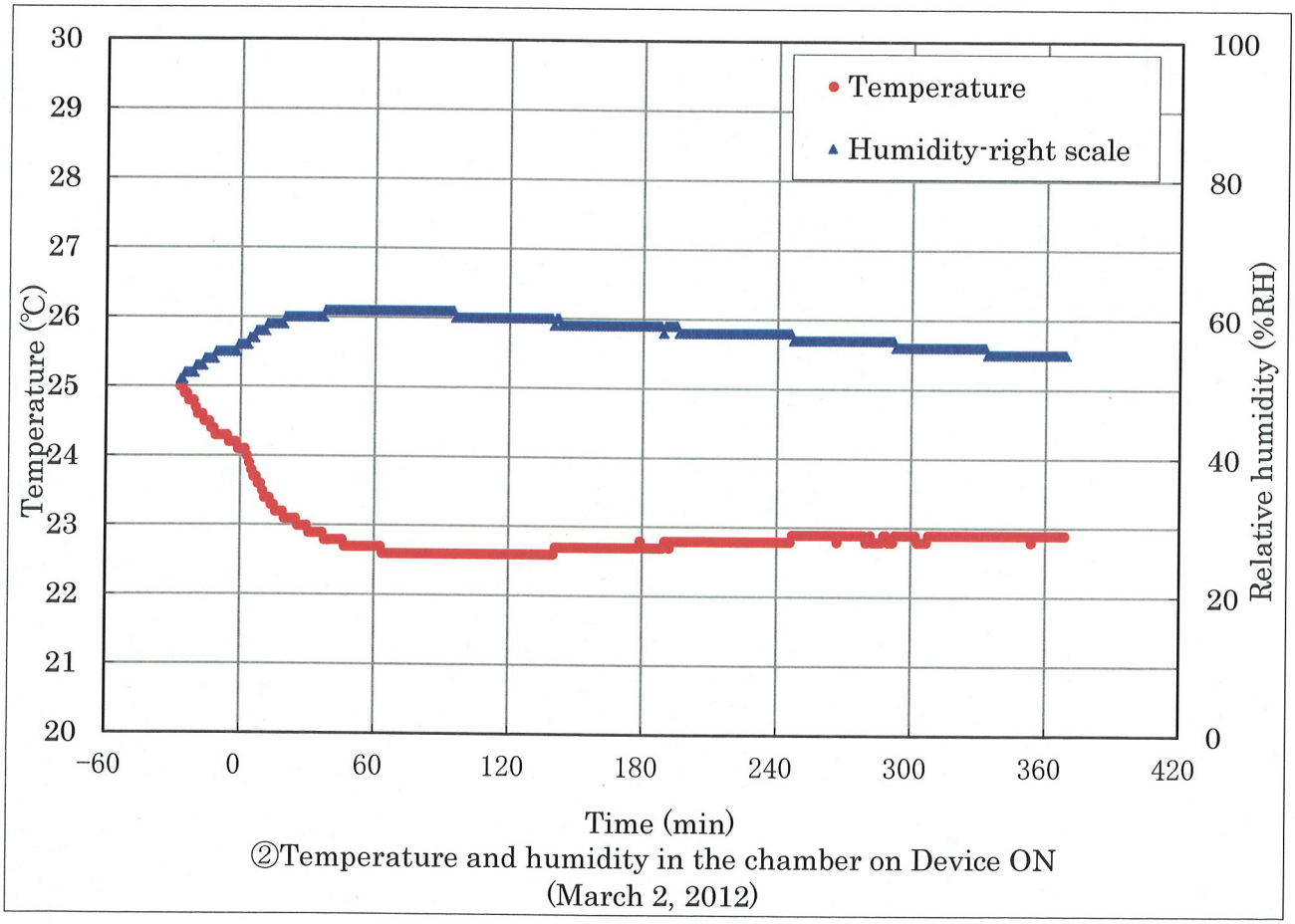


②The particle number in the chamber on Device ON (March 2, 2012)

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



①Temperature and humidity in the chamber on Device OFF (control)
(March 1, 2012)



②Temperature and humidity in the chamber on Device ON
(March 2, 2012)

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