https://www.panasonic.com/global/consumer/clean/qafl.html

First edition: January 2021

Panasonic

Antivirus

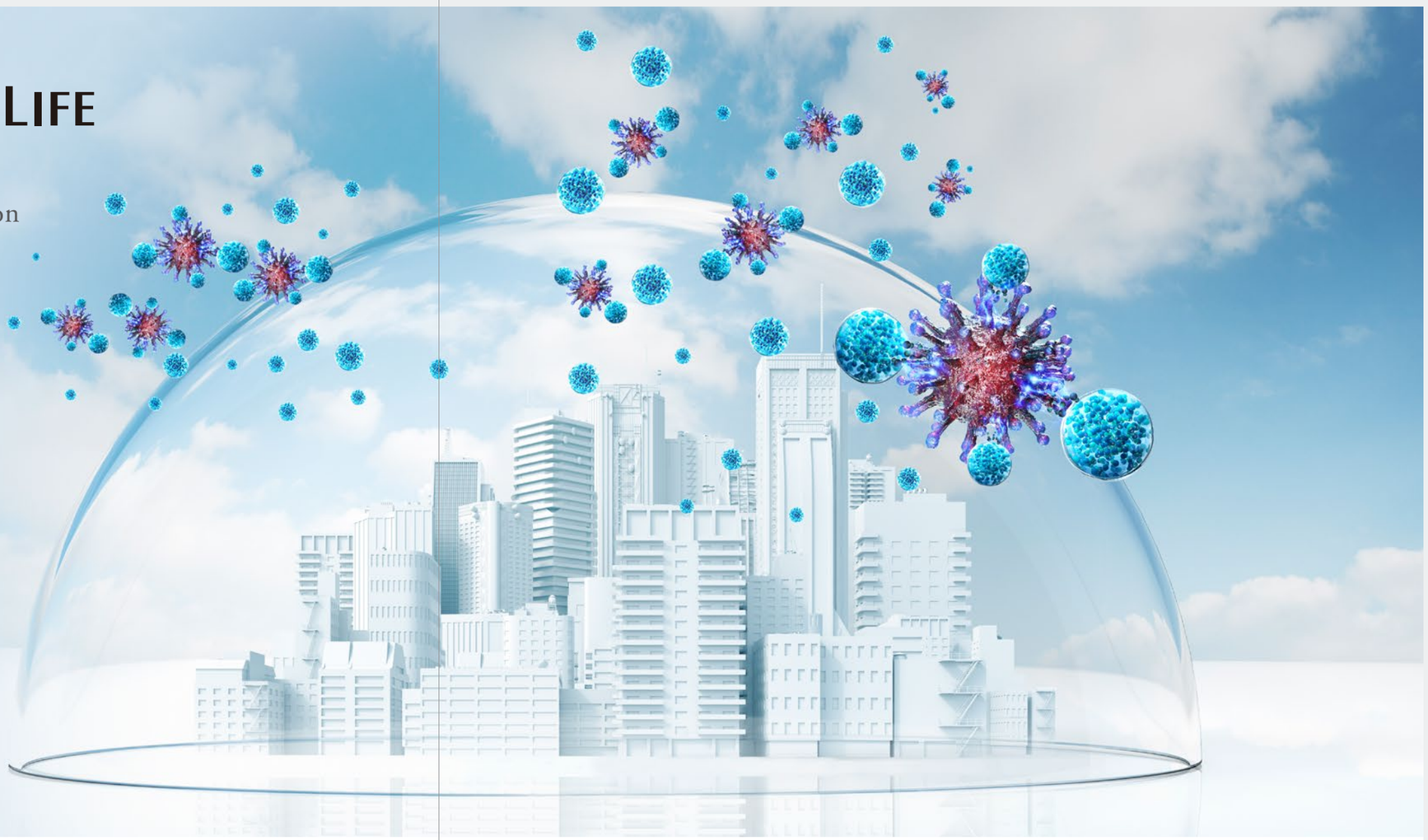
COMPLETE AIR MANAGEMENT SYSTEM

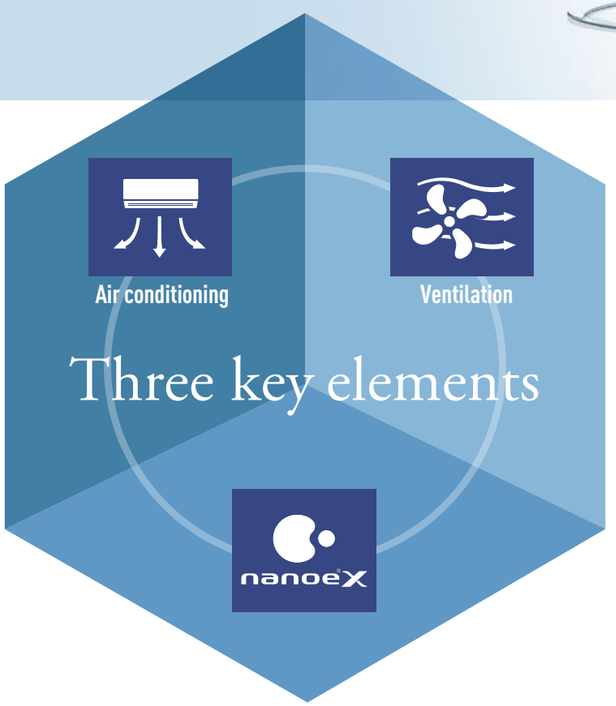
CONCEPT BOOK

QUALITY AIR FOR LIFE

Quality Air For Life

Panasonic solutions for antivirus protection
in all indoor environments





3 solutions

Unoccupied bedroom

Occupied bedroom

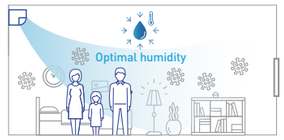
nanoeX Inhibition

When no one is in the room, the air conditioner operates in fan mode and nanoe™ X can inhibit viruses.

When people enter the bedroom, the air conditioner's nanoe™ X inhibits viruses.

Air conditioning Humidity control

Since nobody is in the room to raise the humidity, little humidity control is required.



When people enter the bedroom and humidity rises, the air conditioner controls humidity and inhibits viruses.

Ventilation Ventilation

Since nobody is in the room to introduce viruses, little ventilation is required.

When people enter the bedroom, the supply air fan exchanges air in the bedroom and expels viruses.

Inhibition

nanoe™ X

Test results: novel coronavirus (SARS-CoV-2) activity inhibited

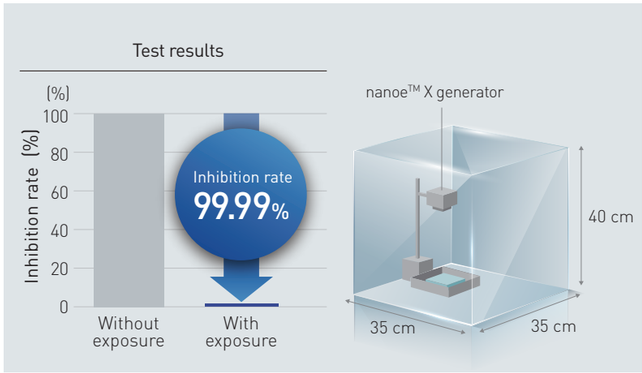
Test of nanoe™ X generator

Overview

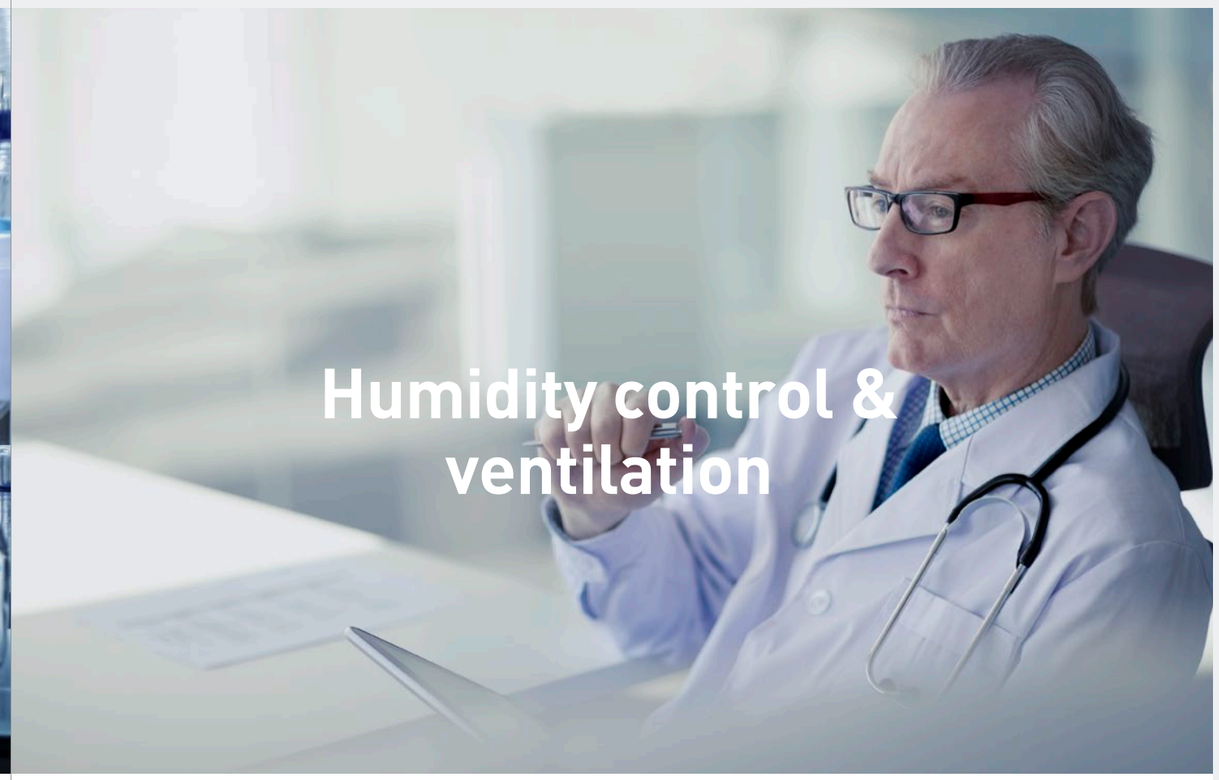
This test verified the inhibitory effect of nanoe™ X on the novel coronavirus (SARS-CoV-2). Gauze saturated with SARS-CoV-2 virus solution was placed in a petri dish and exposed to a nanoe™ X generator from a distance of 15 cm in a 45 L box and nanoe™ X was released for a predetermined period. Over 99% of the activity of the SARS-CoV-2 virus was inhibited in 2 hours.

Details

Testing organisation: TEXCELL. (2) Target substance: novel coronavirus (SARS-CoV-2). (3) Test volume: 45 L enclosed box (400 mm x 350 mm x 350 mm). (4) Exposure time: 2 hours. (5) Exposure distance: 15 cm.



Notes: (1) The virus infectious titer was measured and used to calculate the inhibition rate. (2) This verification was designed to generate basic research data on the effects of nanoe™ X on the novel coronavirus in laboratory conditions. (3) It was not designed to evaluate product performance.



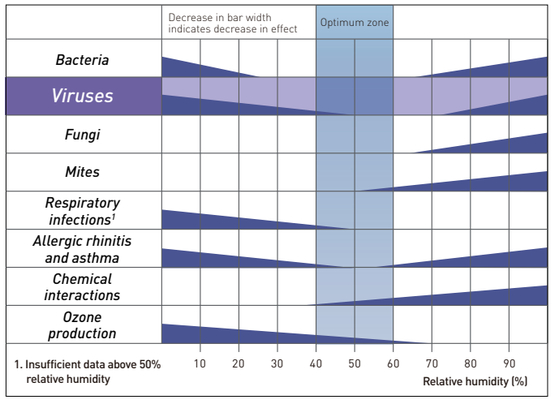
Humidity control & ventilation

Humidity control

Controlling humidity range to inhibit virus activity

When humidity is low, immune function can be suppressed and virus survivability can increase. On the other hand, high humidity can cause mould, mites, and condensation, so the American Society of Heating, Refrigerating, and Air-Conditioning (ASHRAE) recommends humidity be maintained between 40% and 60%.

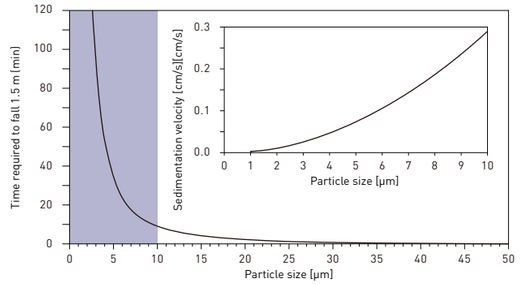
Optimal humidity range for minimizing adverse health effects



Source: Sterling, E.M., et al. "Criteria for human exposure to humidity in occupied buildings." ASHRAE Transactions, 1985, vol. 91, Part 1.

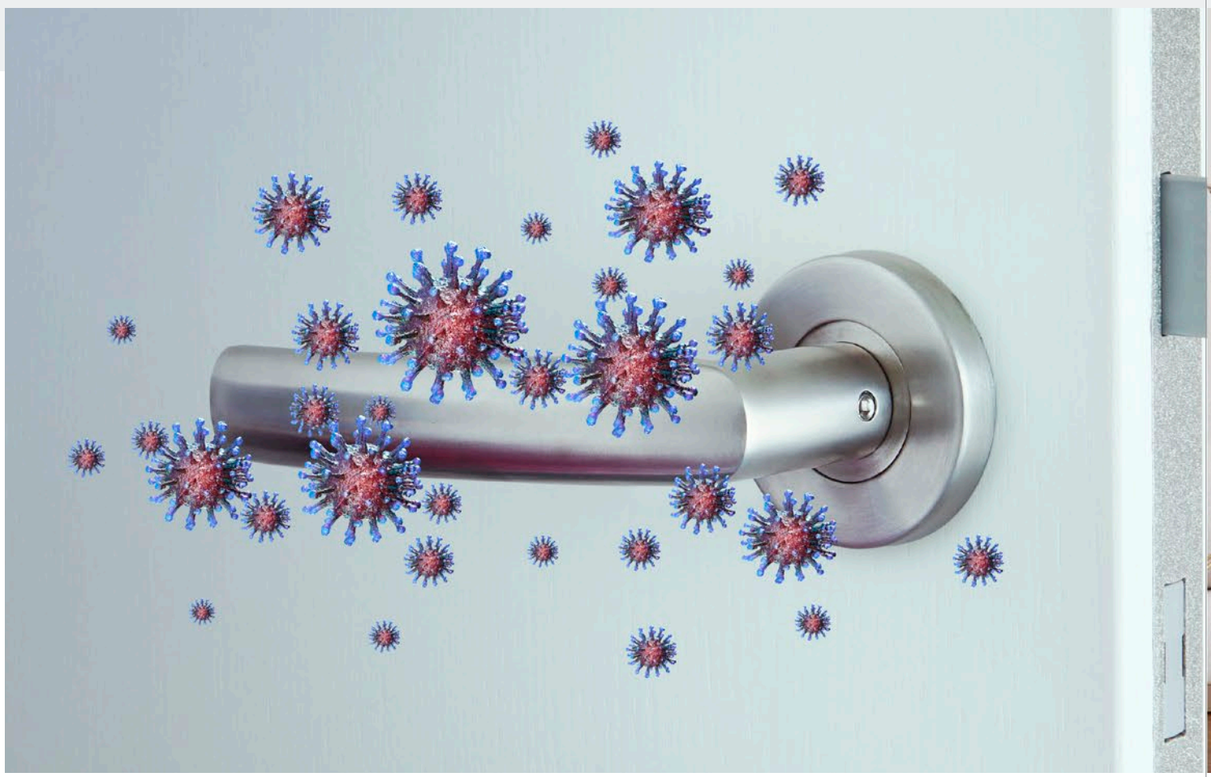
Ventilation

Viruses are released with the sneezing and coughing of an infected person. The smaller the particle size of the droplet expelled, the longer it will float in the air and the farther it will travel. The spread of droplets can be controlled with an appropriate indoor airflow plan. In addition, the greater the ventilation volume and frequency, the lower the risk of infection because the concentration of airborne virus is diluted and the human exposure dose is reduced.



Ventilation frequency (times/hour)		2	4	6	12	15
Time required for removal (minutes)	Removal rate 90%	69	35	23	12	9
	Removal rate 99%	138	69	46	23	18

Sources: Architectural Institute of Japan (AIJ). (2020b). Activity HUB related to COVID-19. Motoya Hayashi, U Yanagi, Kenichi Azuma, et al. Measures against COVID-19 concerning Summer Indoor Environment in Japan. Japan Architectural Review (2020).

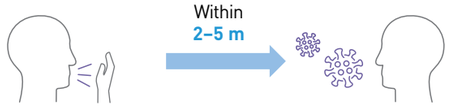


1 How viruses infect humans

- Viruses must hijack human cells to survive because they need a host to replicate.
- Viruses can enter the body and infect it in two ways:
  1. Droplet infection: An infected person's cough or sneeze infects another person directly. (Maximum distance droplets can travel is about 2-5 meters).
  2. Contact infection: An infected person touches an object, transferring the virus to the object. The virus adheres to the object, and another person who touches it is infected.

Droplet infection

Droplets from the cough or sneeze of an infected person enter another person's body.

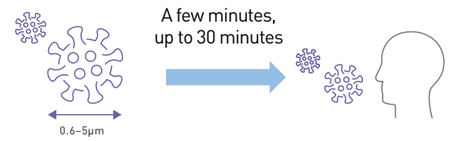


The virus attaches to a mucous membrane.

When a person coughs, thousands of small droplets of 0.6 to 15 μm per cubic centimeter are discharged. The droplet concentration increases with the severity of the cough.

Aerosol infection

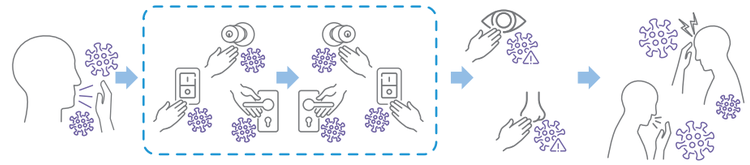
Infection is caused by fine particles containing virus floating in the air and inhaled through the nose or mouth.



Airborne viruses in a closed room with high humidity don't dry out so they can remain infectious for a few minutes and up to 30 minutes, whereas they would normally remain infectious only a second or up to a minute.

Contact infection

Viruses adhering to various surfaces are touched and taken into the body.



If a hand with virus on it touches a doorknob, train strap, light switch, or other object, the virus may adhere to that object.

It can then adhere to another person's hand.

If you touch your nose, your mouth, or your eyes with hands that have virus on them...

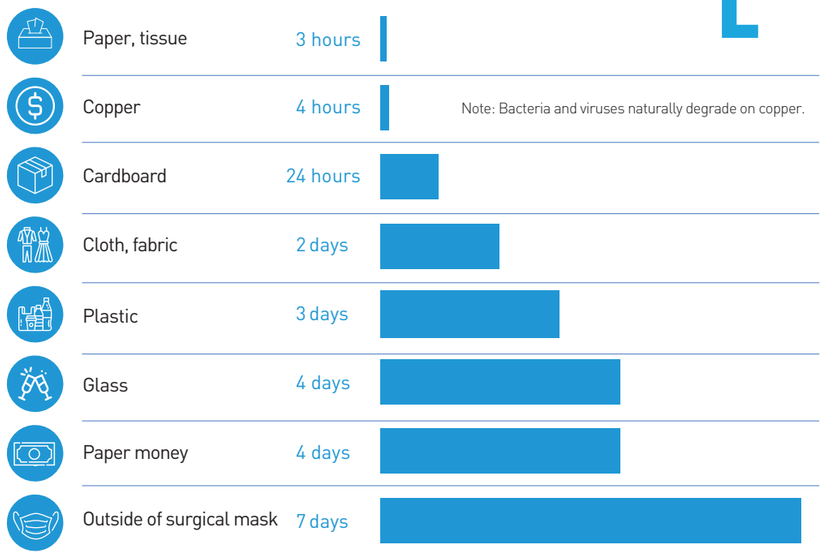
...you can get infected.

2 Survival period of adhered viruses

- The length of time a virus can survive adhering to an object in a living space depends on the object. On average viruses survive from 2-3 days , but can survive as long as 7 days.

> The novel coronavirus survives longer on smooth surfaces than on irregular ones.

How long the novel coronavirus can live on surfaces



Source: https://www.businessinsider.com/coronavirus-lifespan-on-surfaces-graphic-2020-3

Issue

When humidity is too high or too low viruses and microorganisms may remain active, which can lead to infection.

Humidity

Solutions

Air conditioning

Keeping humidity below 60% can inhibit the activity of viruses.

Air conditioner

Equipped with temperature and humidity sensors

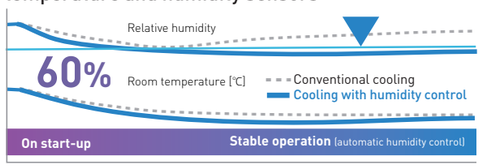
With humidity fluctuating up and down, viruses are active.

Controlling humidity can inhibit the activity of virus caused by high humidity.

Air conditioner operation with humidity control

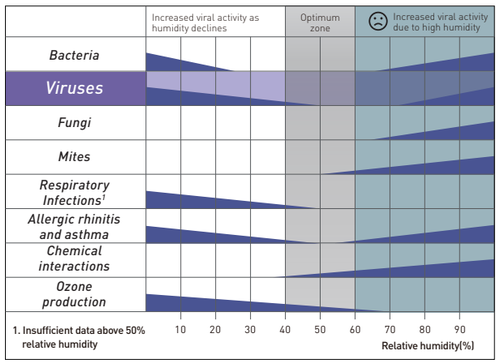
To help prevent illness at home, it is important to maintain relative humidity in the 40-60% range. As humidity declines, virus activity increases and human immunity declines. On the other hand, as humidity increases, virus activity increases, and mould and mites reproduce more rapidly. An air conditioner with dehumidifying function can prevent various adverse effects by preventing a rise in humidity in the environment.

Operation of an air conditioner equipped with temperature and humidity sensors



Note: In case of XU series product in I-AutoX mode

Optimal humidity range for minimizing adverse health effects



Source: Sterling, E.M., et al. "Criteria for human exposure to humidity in occupied buildings." ASHRAE Transactions, 1985, vol. 91, Part 1.

Issue

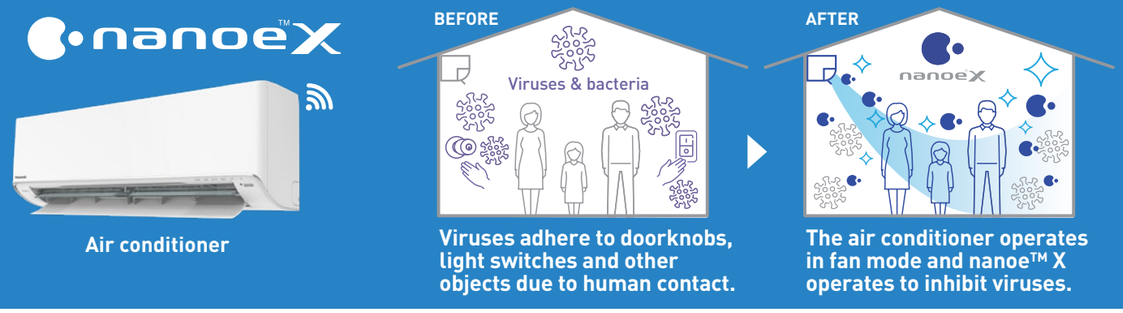
When people touch doorknobs, light switches, smartphones and other objects, viruses can adhere to their hands.

Adhered viruses

Solutions

nanoe™ X technology

nanoe™ X technology inhibits adhered viruses



Air conditioner

Viruses adhere to doorknobs, light switches and other objects due to human contact.

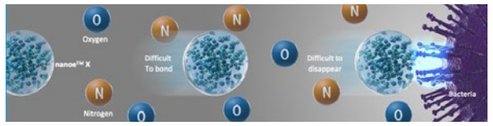
The air conditioner operates in fan mode and nanoe™ X operates to inhibit viruses.

Air conditioner with nanoe™ X technology

Panasonic's unique nanoe™ X technology is very effective against various pollutants. It inhibits bacteria and viruses, mould, allergens, pollen, and other hazardous substances, deodorises, and moisturises hair and skin. nanoe™ X technology makes the air quality in your environment better.

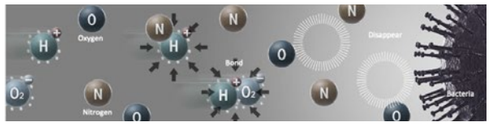
nanoe™ X

Enclosed in a water shield, nanoe™ X particles do not readily bond with other substances.



Ordinary ions

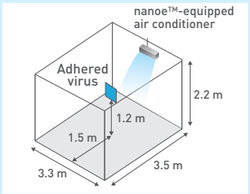
Ordinary ions readily bond with oxygen and nitrogen in the air and are eliminated.



Verified that nanoe™ inhibits activity of adhered bacteriophage ΦX174 over 99.8% in 8 hours.

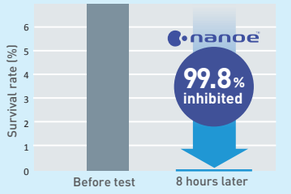
Test environment

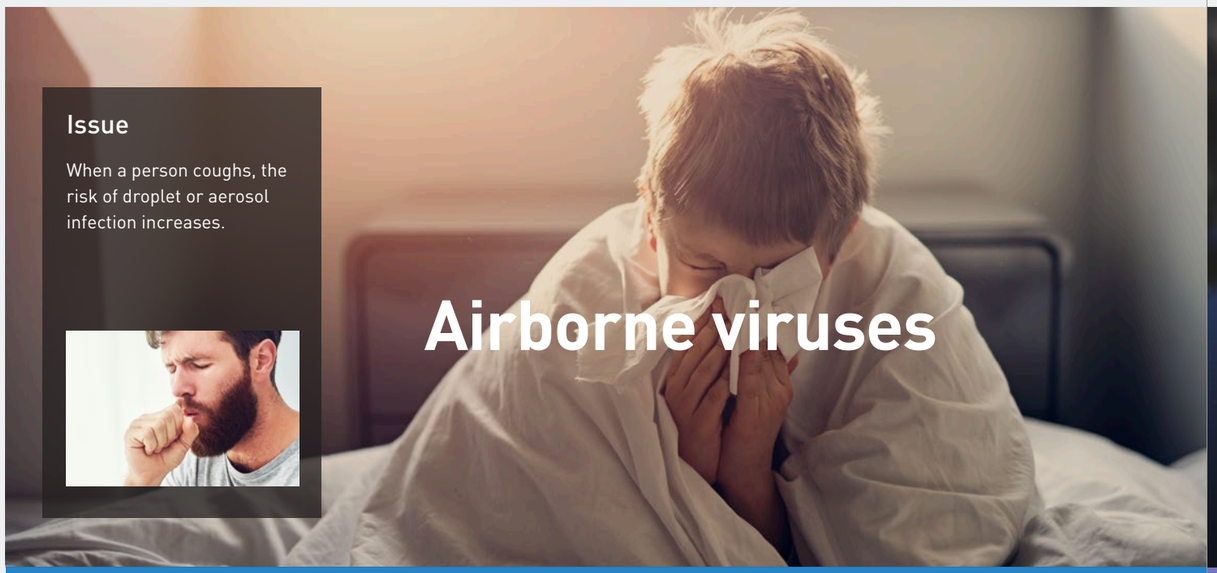
Test room: 25 m³



Test result

Bacteriophage ΦX174





Issue

When a person coughs, the risk of droplet or aerosol infection increases.

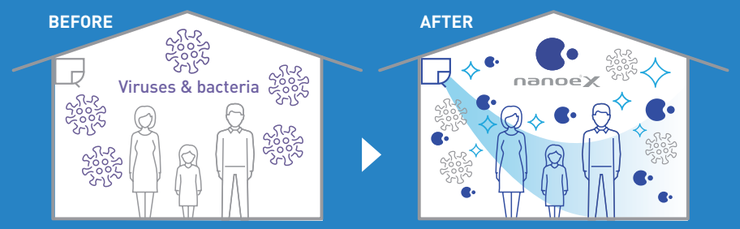
Airborne viruses

Solutions

nanoe™ X technology

nanoe™ X technology inhibits airborne viruses.

Air conditioner



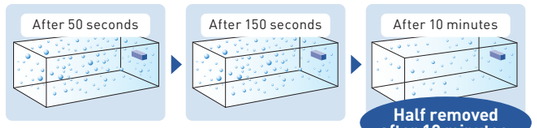
Airborne viruses fill an enclosed room.

The air conditioner operates in fan mode and nanoe™ X can inhibit viruses.

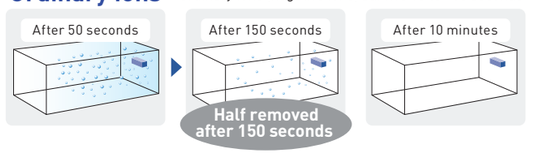
Air conditioner with nanoe™ X technology

Panasonic's unique nanoe™ X technology is very effective against various pollutants. It inhibits bacteria and viruses, molds, allergens, pollen, and other hazardous substances, deodorises, and has a moisturizing effect on hair and skin. nanoe™ X technology makes the air quality in your environment better.

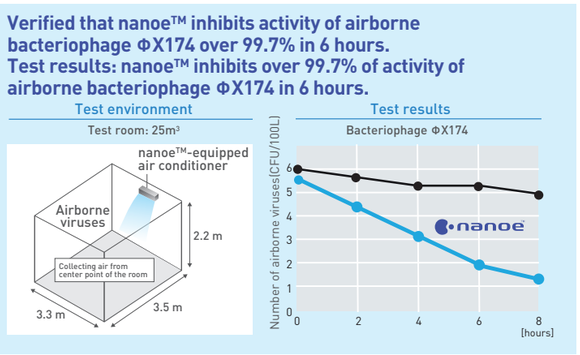
nanoe™ X Surviving over 10 minutes, nanoe™ particles fill the room.



Ordinary ions Ordinary ions (negative ions) survive 10 to 100 seconds



Verified that nanoe™ inhibits activity of airborne bacteriophage ΦX174 over 99.7% in 6 hours.
Test results: nanoe™ inhibits over 99.7% of activity of airborne bacteriophage ΦX174 in 6 hours.

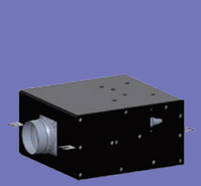


Airborne viruses

Solutions

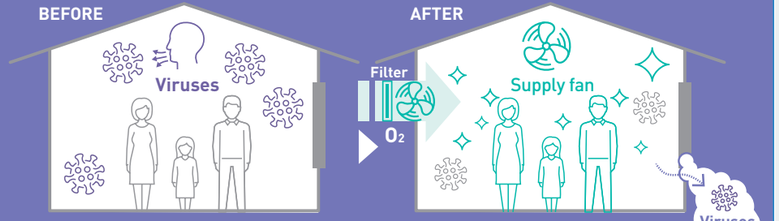
Ventilation

A sensor activates the supply fan and viruses are expelled.



Supply fan

IAQ remote controller



When the number of people in the room increases, the number of viruses increases.

CO_2 sensor activates the supply air fan and viruses are expelled.

Effects of ventilation on viruses

The greater the ventilation volume (the amount of intake of outside air), the lower the concentration of pollutants generated indoors. Adequate ventilation reduces the risk of infection by diluting airborne SARS-CoV-2 levels and reducing human exposure. The higher the ventilation rate, the less time required for removal of viruses.

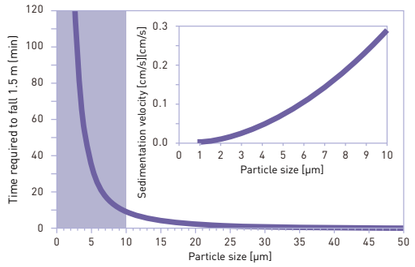
Effective ventilation of an ordinary pipe fan (at 52 m³ per hour)

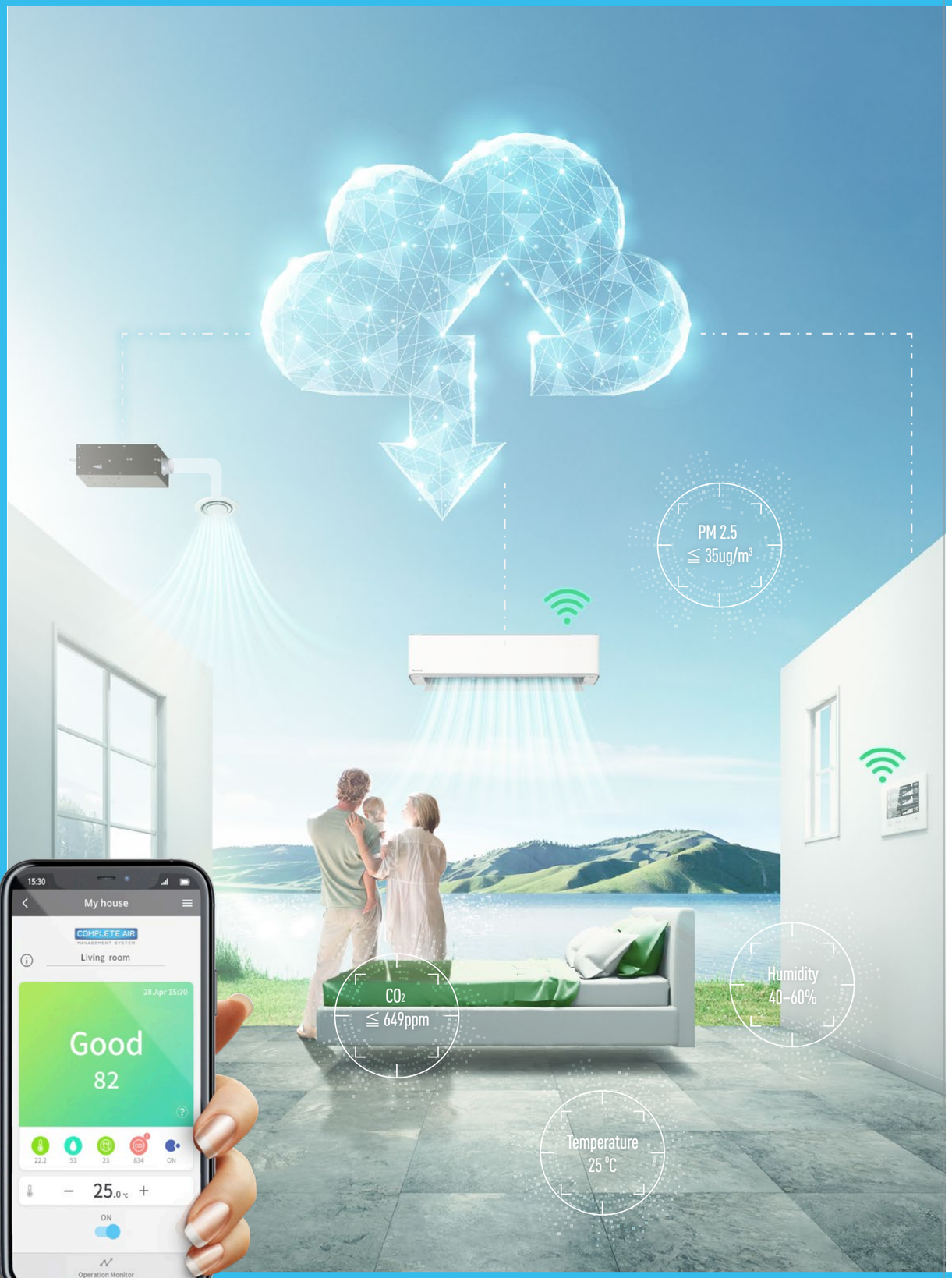
Ventilation frequency (times/hour)		2	4	6	12	15
Time required for removal (minutes)	Removal rate 90%	69	35	23	12	9
	Removal rate 99%	138	69	46	23	18

Sources: Architectural Institute of Japan (AIJ). (2020b). Activity HUB related to COVID-19.
Motoya Hayashi, U Yanagi, Kenichi Azuma, et al. Measures against COVID-19 concerning Summer Indoor Environment in Japan. Japan Architectural Review (2020).

Time required for elimination of viruses: **69** minutes Ventilation rate per hour: **twice** Virus removal rate: **90%**

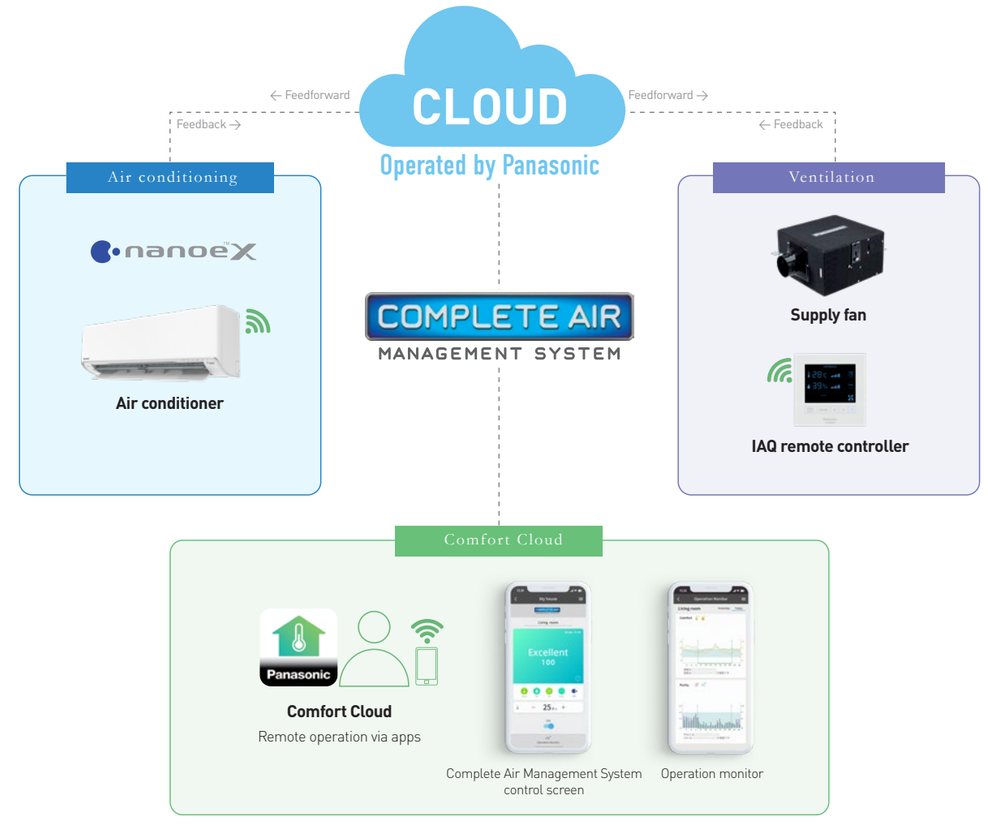
The higher the volume and frequency of ventilation, the lower the concentration of pollutants generated indoors, and the more the airborne SARS-CoV-2 concentration is diluted, reducing the risk of infection.





COMPLETE AIR MANAGEMENT SYSTEM

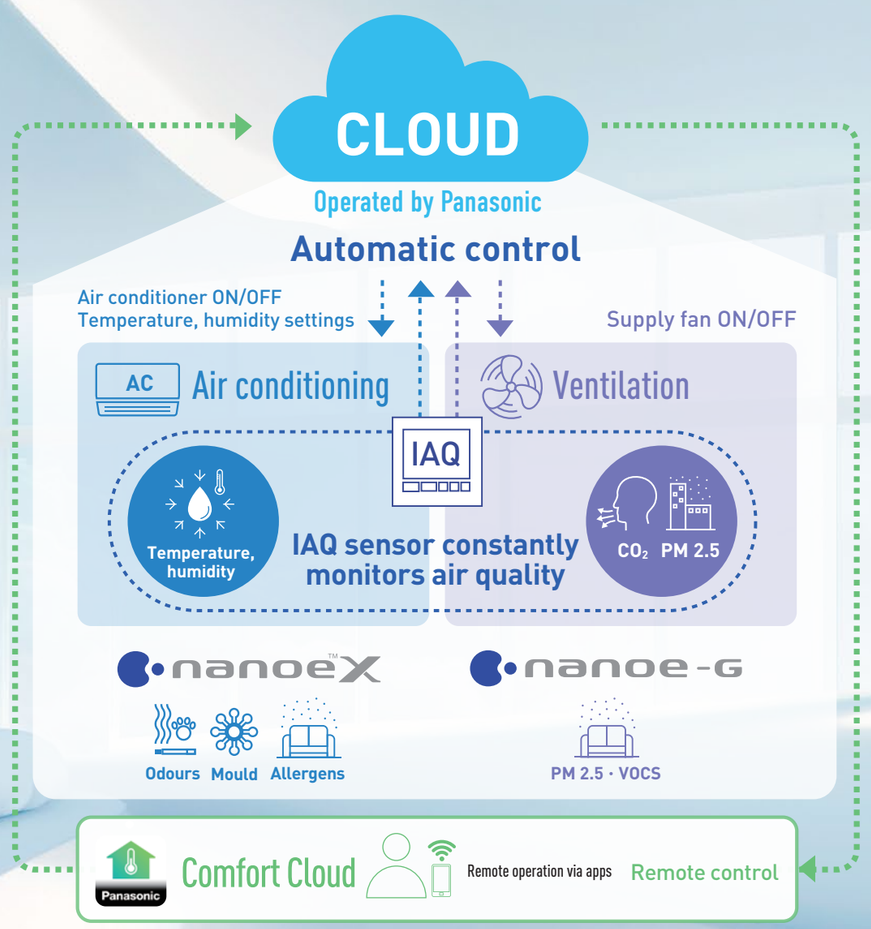
Linked operation of air conditioner + supply fan + IAQ remote controller



Note: Illustrations of screens may differ from actual app screen appearance.

The Complete Air Management System controls temperature, humidity and indoor air quality to ensure comfort automatically.

COMPLETE AIR
MANAGEMENT SYSTEM



About the Complete Air Management System

With the Complete Air Management System, an Indoor Air Quality (IAQ) sensor constantly monitors air quality for automatic control of heating and cooling and ventilation volume. It provides optimally clear air at a comfortable temperature and humidity. It minimizes the time required to purify contaminated air and restore clean air to your environment. It automatically maintains optimum air quality. And it does this at minimal energy cost. This is the promise of the future delivered on by the Complete Air Management System.

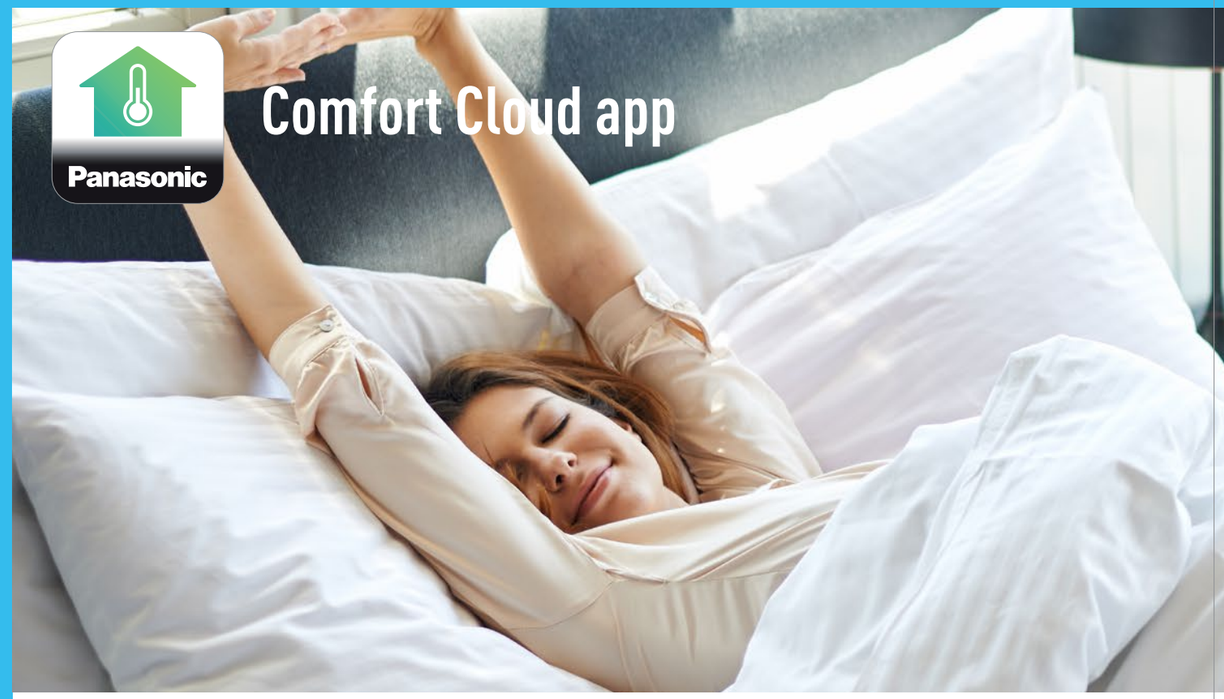
To prevent viral infections, ventilation is conducted in accordance with occupant tracking via CO_2 sensing.

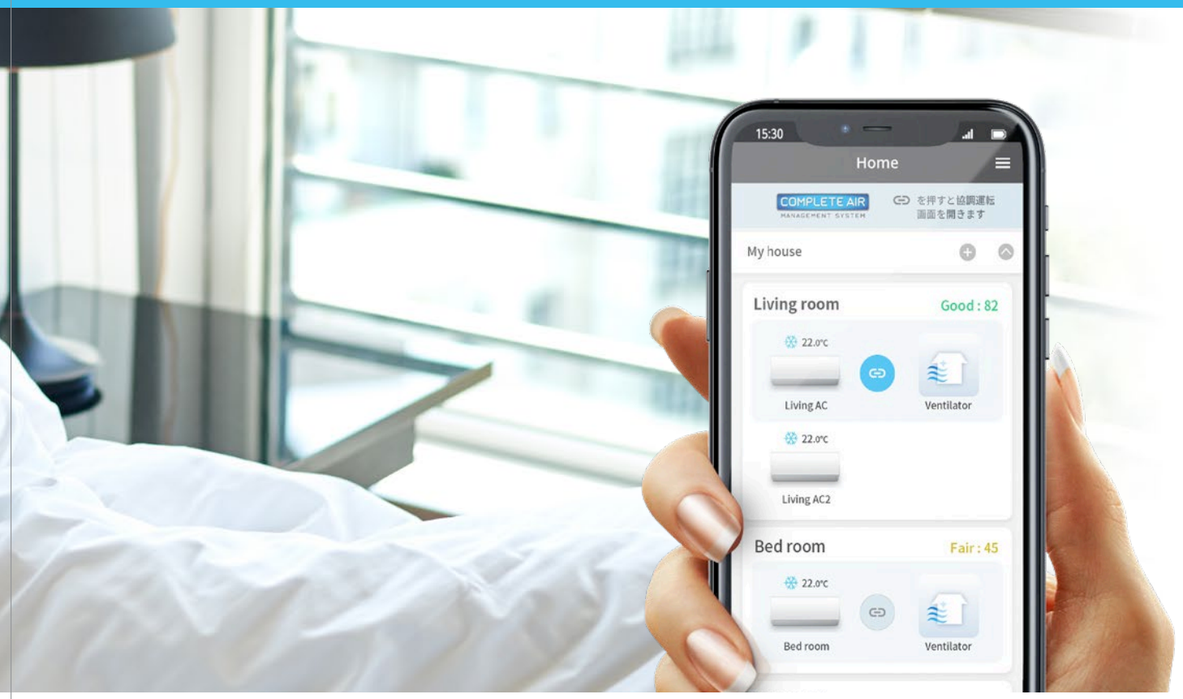
Based on a calculation of carbon dioxide generated by humans, maintaining the indoor CO_2 concentration at 1,000 ppm is equivalent to securing ventilation volume at 30 m^3 per hour per person, and is considered sufficient ventilation. Measuring CO_2 concentrations is an effective way to reveal inadequate ventilation in a shared space*. The Complete Air Management System constantly senses CO_2 concentrations and provides ventilation suitable to the living environment.

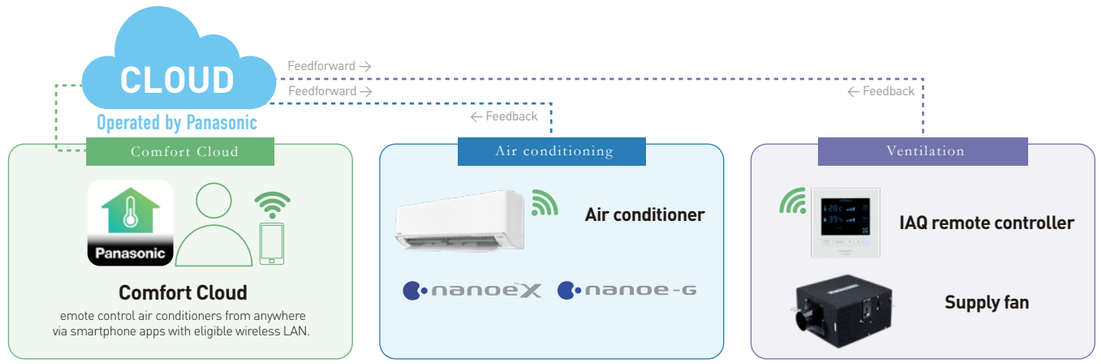
IAQ remote controller with CO_2 sensor

* Source: "How to ensure proper ventilation in poor-ventilated closed spaces in winter," November 27, 2020, Ministry of Health, Labor and Welfare.

Comfort Cloud app

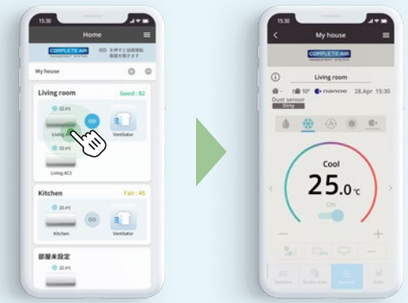






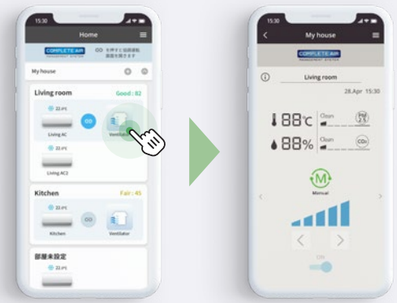
Air conditioning

Air conditioner operation screen



Ventilation

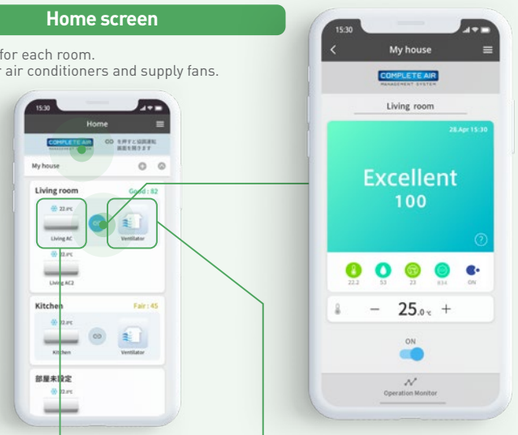
IAQ operation screen



COMPLETE AIR MANAGEMENT SYSTEM

Home screen

- Add units for each room.
- Easily pair air conditioners and supply fans.



Complete Air Management System home screen

- IAQ remote controller shows air quality in each room in four levels.
- Set temperature can be changed.
- Complete Air Management System can be turned ON/OFF.

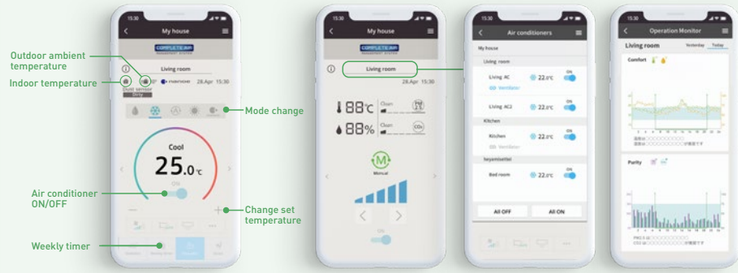
Example air quality condition displays

- Temperature/humidity/PM 2.5/CO_2 sensing evaluated in 4 levels
- Current air quality easily checked

Complete Cooling screen

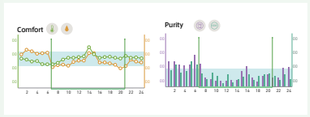
Individual room supply fan screen

Device overview control



Operation monitor

- Yesterday and today's IAQ sensed every hour
- Check whether air quality is optimal.



Note: Illustrations of app screens may differ from actual screen appearance.

The concentration of nanoe™ is maintained at a level which is expected to be effective in inhibiting viruses even with air exchange 3 times per hour.

Note 1: This is an example of the effects of nanoe™ X that can be expected to inhibit activities of viruses in spaces larger than 45 L.
Note 2: Inhibition is not guaranteed in all conditions.

Verification process

Preliminaries

・Viruses are classified into four types. Each type has different physiochemical resistance.
・The most physiochemical resistant are the non-enveloped DNA viruses, and bacteriophage ϕX174 is classified as this type.
・Virus clearance test* verified nanoe™ inhibitory effect on all 4 virus types.
・nanoe™ has the potential to inhibit highly resistant and unknown viruses.

1: Verification of inhibitory effect against airborne and adhered bacteriophage X174 in actual space with nanoe™-equipped air conditioner.

Reference evidence (25m³ room, use of nanoe™-equipped air conditioner)
-Test A: 99.8% of activity of adhered bacteriophage inhibited in 8 hours.
-Test B: 99.7% of activity of airborne bacteriophage inhibited in 6 hours.

2: Verification of inhibitory effect of nanoe™ X-equipped air conditioner in larger space and ventilated conditions. nanoe™ X concentration calculated based on evidence of surrogate viral inhibition. Reference simulation used.

・The concentration at which nanoe™ can inhibit viruses was calculated.
・The concentration of nanoe™ was maintained at or above the level which is expected to be effective in inhibiting viruses, even in a larger space and with air exchange 3 times per hour.

Reference simulations
-Simulation A: The concentration at which nanoe™ can inhibit adhered and airborne viruses were calculated.
-Simulation B: nanoe™ X concentrations with air exchange every 0, 0.5, 1, or 3 times per hour in a 53 m³ space were calculated.
-Comparison of simulation A and B: nanoe™ X can be effective against viruses even in a larger space and with air exchange 3 times per hour.

1: Verification of inhibitory effect against airborne and adhered bacteriophage ϕX174 in actual space with nanoe™-equipped air conditioner.

[Verification of inhibitory effect against airborne and adhered bacteriophage ϕX174 in actual space with a nanoe™-equipped air conditioner — Test A]

Test results

Verified that nanoe™ inhibits over 99.8% of activity of adhered bacteriophage φX174 in 8 hours.

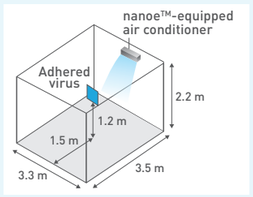
・Gauze saturated with bacteriophage φX174 solution was exposed to a nanoe™-equipped air conditioner from a distance of 1.5 m in a 25 m³ room for 8 hours.
・Over 99% of the activity of the adhered bacteriophage φX174 was inhibited in 8 hours.

Overview

・Testing organisation: Japan Food Research Laboratories (Japan)
・Target substance: bacteriophage φX174
・Test method
-Test volume: 25 m³ room (3.3 m x 3.5 m x 2.2 m)
-Exposure time: 8 hours

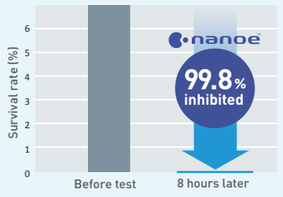
Test environment

Test room: 25m³



Test results

Bacteriophage ΦX174



[Verification of inhibitory effect against airborne and adhered bacteriophage ϕX174 in actual space with nanoe™-equipped air conditioner — Test B]

Test results:

Verified that nanoe™ inhibits over 99.7% of activity of airborne bacteriophage φX174 in 6 hours.

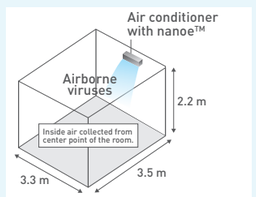
・Airborne bacteriophage φX174 solution was exposed to a nanoe™-equipped air conditioner in a 25m3 room for 6 hours.
・Over 99% of the activity of the airborne bacteriophage φX174 was inhibited in 6 hours.

Overview

・Testing organisation: Kitasato Research Center for Environmental Science (Japan)
・Target substance: bacteriophage φX174
・Test method
-Test volume: 25 m3 room (3.3 m x 3.5 m x 2.2 m)
-Exposure time: 6 hours

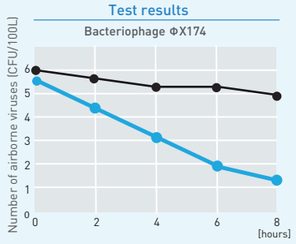
Test environment

Test room: 25m³



Test results

Bacteriophage ΦX174



* Virus clearance test outline
・Testing organisation: Charles River Biopharmaceutical Services Gmbh
・Test period: September to November 2011
・Test method: Test box volume: 45L/ Exposure time: 6 hours/ Exposure distance: 15cm
・4 types of viruses were selected based on the virus clearance test guidelines, and comparison of nanoe™ exposure and non-exposure was carried out in testing according to GLP standards.
・It was confirmed that 99% of the virus infection titer of the 4 types of virus was inhibited in 6 hours.

2: Verification of inhibitory effect of air conditioner equipped with nanoe™ X in a larger space and with air exchange 3 times per hour.

[Verification of inhibitory effect of nanoe™ X-equipped air conditioner in a larger space and ventilated conditions — Simulation A]

Simulated results:

The concentration at which nanoe™ can inhibit a virus was calculated.

・Gauze saturated with SARS-CoV-2 virus solution was exposed to a nanoe™ X-equipped air conditioner from a distance of 15 cm in a 45 L box for 3 hours.
・Over 99% of the activity of the SARS-CoV-2 virus was inhibited in 3 hours.

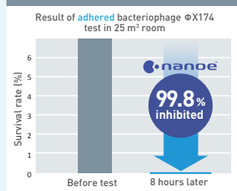
Concentration of nanoe™
= the concentration at which the results of airborne and adhered virus inhibition in actual space are obtained

Conditions of the simulation

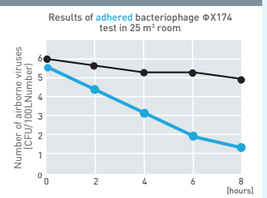
・Room size: 3.3m x 3.5m x 2.2m (25 m³)
・Operation time: concentration at saturation
・Air volume : 10.1 m³/min (606m³/hour)
・nanoe: 480 billion generated per second
・OH radicals reduced by half in 10 minutes

nanoe™ concentration

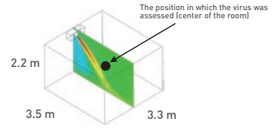
Result of adhered bacteriophage ΦX174 test in 25 m³ room



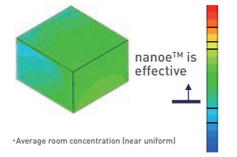
Results of adhered bacteriophage ΦX174 test in 25 m³ room



A — Simulation model



Simulated results



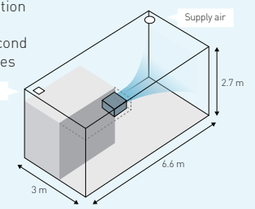
[A decrease in the nanoe™ X concentration can be caused by an increase in the adaptive volume or the effect of ventilation. In this simulation, the volume of the test space was doubled and the ventilation frequency was increased. — Simulation B]

Conditions of the simulation

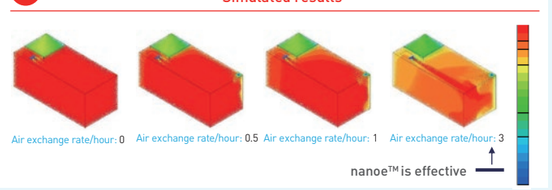
・Room size: 6.6 m x 3 m x 2.7 m (53 m³)
・Operation time: concentration at saturation
・Air volume: 7.5 m³/min (450 m³/hour)
・nanoe™ X: 4.8 trillion generated per second
・OH radicals reduced by half in 10 minutes

Simulation model

[Room size]



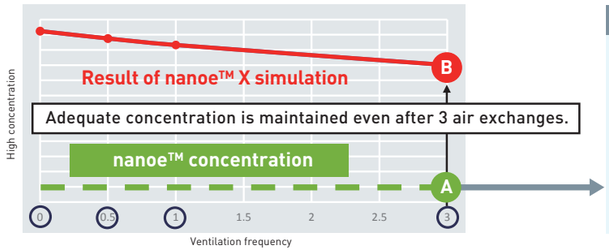
B — Simulated results



[Verification of inhibitory effect of nanoe™ X-equipped air conditioner in a larger space and with ventilated conditionsventilated conditions — Comparison of simulation A and B]

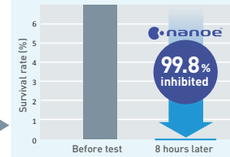
Simulated results

The concentration of nanoe™ is maintained at or above the level which is expected to be effective in inhibiting the virus, even in a larger space and with air exchange 3 times per hour.

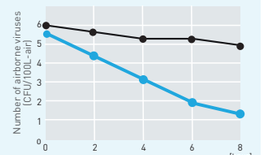


Standard of nanoe™ concentration

Result of adhered bacteriophage ΦX174 test in 25m³ room



Result of adhered bacteriophage ΦX174 test in 25m³ room



Conclusion: Verification of inhibitory effect of nanoe™ X-equipped air conditioner in a larger space and ventilated conditions.
According to nanoe™ X density simulation results, nanoe™ X can be effective against novel coronavirus, even in a larger space and with air exchange 3 times per hour.