About new coronavirus infectious disease measures by air conditioning

1. INTRODUCTION

With the spread of new coronavirus infection, the importance of "ventilation" has been pointed out as one of the measures to prevent infectious diseases. The Ministry of Health, Labour and Welfare recommends method to avoid the risk of cluster infection as: “Encourage ventilation: implement proper operation and inspection of ventilation equipment so as not to create a closed space with poor ventilation.” (Ministry of Health, Labour and Welfare "Ventilation to improve" closed space with poor ventilation "in commercial facilities")
Ventilation is effective as a countermeasure against infectious diseases, but on the other hand, ventilation takes outside air into the room, which makes it difficult to control indoor humidity and raises concerns about hygiene and comfort. The new coronavirus may repeat seasonal epidemics like other viruses, so we propose measures to reduce infection risk by air conditioning from the perspective of ventilation and humidity control.

2. CLASSIFICATION OF INFECTION RISK AND MEASURES TO REDUCE IT THROUGH AIR CONDITIONING

A. Classification of infection risk

i. **Droplet nucleus infection：**Infection by inhaling a dry, airborne virus
ii. **Droplet infections：**Infection by inhaling a virus (aerosol) that holds a certain amount of moisture
iii. **Contact infection：**Infection through direct (human-to-human) or indirect (contact with object) viral contact

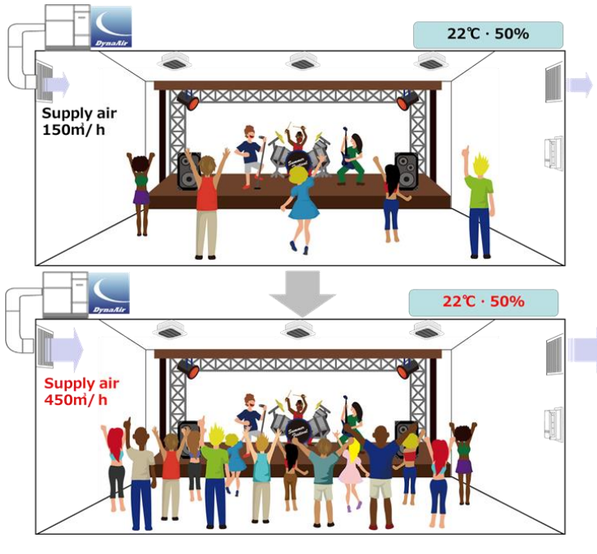
B. Measures to reduce the risk of infection

The following measures can be taken to reduce the risk of infection other than through direct contact between people.

i. **Maintenance of human immunity：**Prevent low temperatures and dryness to prevent immune deficiencies during the cold season
ii. **Reduction of flotsam：**Reduces the chance of infection by reducing the amount of virus floating in the air
iii. **Reduction of residual time：**Decrease the chance of infection by reducing the time for the virus to survive on the surface of an object

C. Specific measures by air conditioning

i. Securing the right amount of ventilation for the number of people in the room

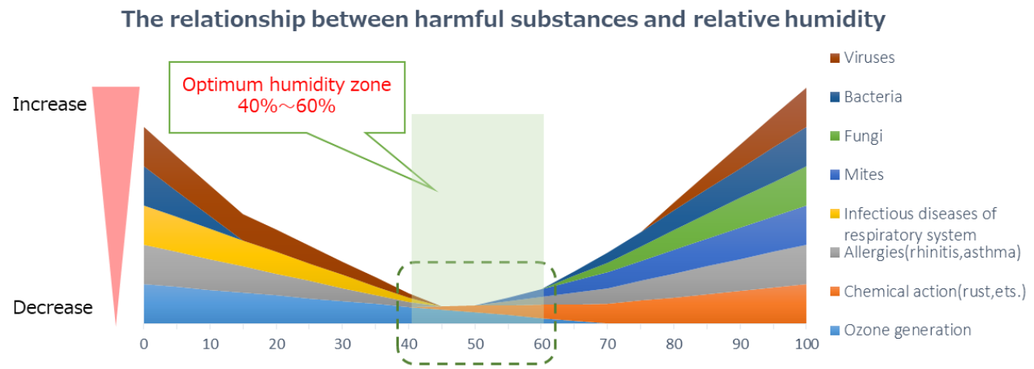


Appropriate ventilation according of the number of people is expected to further reduce the amount of virus floating and the floating time, and it is thought that the contact time with the virus and the amount of inhalation can be reduced.
In general, the amount of ventilation in a given space is fixed to a value specified at the time of design.
Also, in many spaces, the ventilation system does not maintain the performance it was designed for.
Therefore, we use a device that changes the amount of ventilation according to the change in the number of people in the room as shown in the left figure.
The number of people in the room and the amount of heat generated are detected by sensors, and the amount of outside air supplied and its temperature and humidity are dynamically controlled.
As a result, the appropriate amount of ventilation can be ensured while maintaining the temperature and humidity of the specified room.
This type of air conditioning can reduce the amount of floating viruses per person.

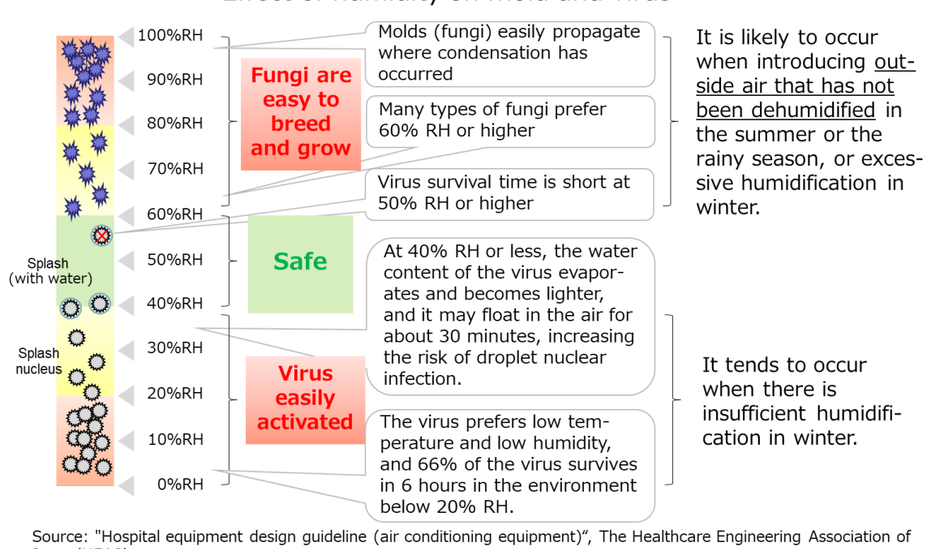
ii. Maintain a relative humidity of 40% to 60% suitable for occupants

Maintaining a relative humidity of 40% to 60% has been known to provide the following benefits

① It can prevent the decline of human immunity.
② It can reduce the amount and activity of many harmful substances.
③ Reduce the airborne time of the virus.



Source.：American Society of Heating, Refrigerating and Air-Conditioning Engineers, ASHRAE



Source: "Hospital equipment design guideline (air conditioning equipment)“, The Healthcare Engineering Association of Japan(HEAS)

iii. Purification in unused time periods

Viruses are classified as summer viruses, winter viruses and year-round viruses depending on the epidemic season, each of which is known to have a combination of temperature and humidity that is unsuitable for survival. Ventilation by creating a combination of temperature and humidity (e.g., low temperature and low humidity or high temperature and high humidity) that is disliked

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by the virus during the hours when there are no people in the room can shorten the survival time of the virus attached to the object.
If the combination of temperature and humidity disliked by new coronavirus can be determined, it will be possible to purify the room by using an air conditioning system.

3. USE OF DYNA AIR SYSTEM

Until now, air conditioning has been mainly about temperature control, and the main theme of air conditioning has been energy conservation by positioning ventilation (outside air intake) as part of the air circulation.
However, since the risk of virus infection cannot be avoided with such air conditioning systems, a paradigm shift is needed to fundamentally change the point of view, and Dyna Air System is seen as a promising means of realization.

A. What is the paradigm shift in air conditioning with a view to trans-COVID?

i. From temperature to humidity

Modern air conditioning is built around efficient temperature control and only minimally regulates humidity. Without accurate control of humidity, the risk of viral infection cannot be reduced.
It is necessary to have a device that can return to the target value even if humidity changes due to opening and closing doors or changes in the number of people in the room.

ii. From returning to ventilation

Returned air is air that has been used in a room after adjusting the temperature and humidity, but the mainstream air conditioning system is to reuse the energy of the temperature and humidity of this air to save energy, discard some of it and mix it with outside air instead.
However, there is a contamination risk in the use of returned air, and the energy-saving effect is reduced by the power of air transport and pressure loss, so a highly efficient air supply using all outside air is desirable.

iii. From design to operation

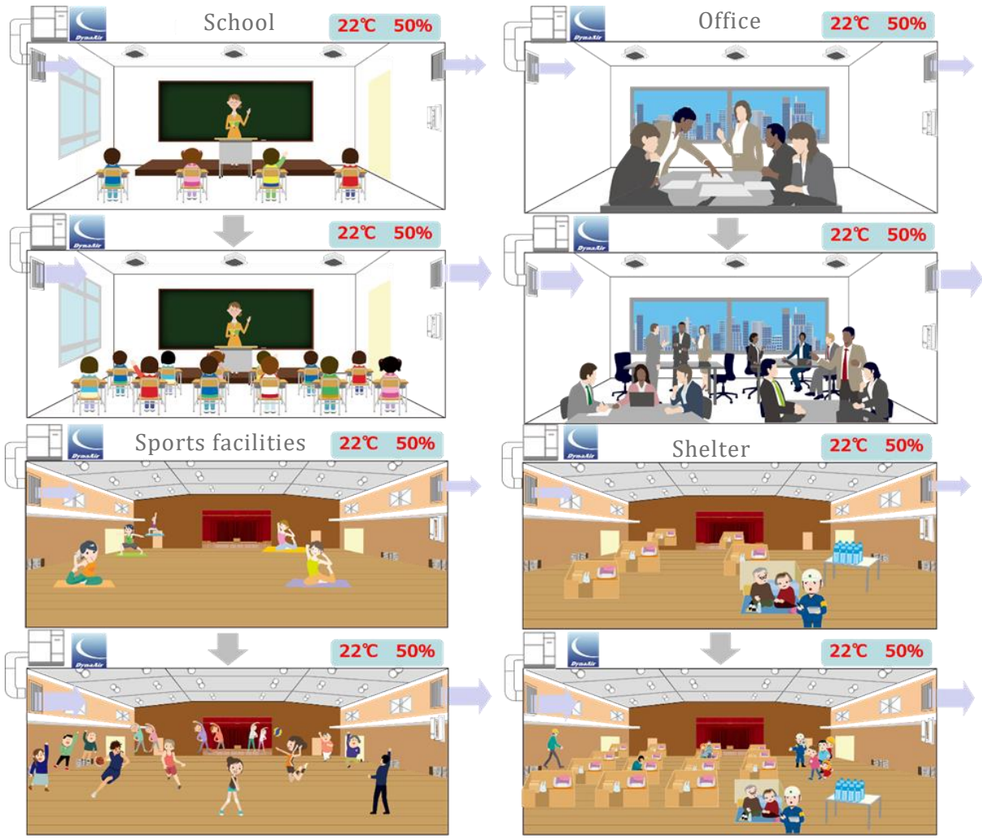
Although many facilities are equipped with air conditioning systems based on design assumptions, it must be confronted that there is a possibility that they will be operated under conditions other than those assumed (outside air environment, number of people in the room, and unexpected usage patterns).
A device that can keep pace with these changes in conditions and dynamically change the amount of outside air introduced, the temperature of the air supply and the humidity of the air supply can reduce the risk of virus infection under real-world operating conditions.

B. What is Dyna Air System

Dyna Air System is a device that regulates the temperature and humidity of air using a humidity control liquid, and is the most energy efficient of all dehumidification and humidification devices, providing a large volume of dehumidification and humidification in a single contact with air and supplying air with accurate humidity.
Liquid control liquid are characterized by their ability to eliminate bacteria, and since they do not evaporate or deteriorate, they require very little maintenance to maintain their performance.

4. AIR CONDITIONING WITH DYNA AIR SYSTEM

Dyna Air System can create any combination of ambient air supply and its temperature and humidity. Therefore, the combination of temperature and humidity that can reduce the risk of virus infection can be maintained even if the number of people in the room changes or the amount of heat (temperature and humidity) generated in the room changes, as shown in the figure below (assuming winter).
Then, once there are no people in the room, we can create a combination of temperature and humidity that the virus dislikes, reducing the amount of virus survival by the time it is used again.



5. CONCLUSION

Rational change in people's behavior is essential for the maintenance and recovery of economic activity in Trans-COVID, and to achieve this, a system is needed for people to know their own environment while implementing state-of-the-art air conditioning.
Since it is difficult to completely avoid the harmful substances represented by viruses, it is necessary to create an environment in which economic activities can be carried out on the premise of their presence. It is necessary to collect and analyze big data such as the number of people in a room, the amount of ventilation, temperature and humidity in various spaces, and make use of cutting-edge technologies such as Dyna Air System to realize a shift from energy-saving air conditioning (cost reduction) to healthier air conditioning (social value improvement).
We believe that the essence of air conditioning is to "maintain health and physical condition and achieve high-quality activities." Therefore, we would like to present a clear solution to society by coordinating air conditioning and IoT.

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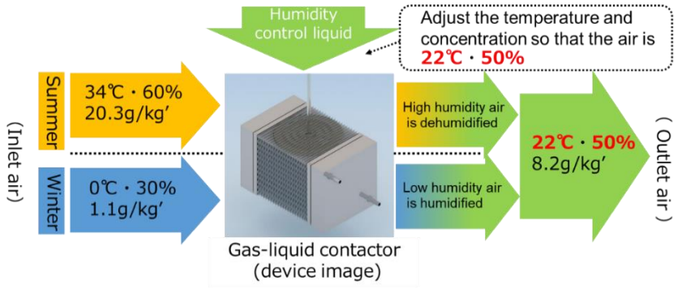
REFERENCES

< Technology for Dyna air systems>

The core technology of the Dyna Air system is the humidity control coil, which brings air into contact with the humidity control liquid.
These humidity control coils can be manufactured in any size and mounted on general-purpose outdoor air handling units.

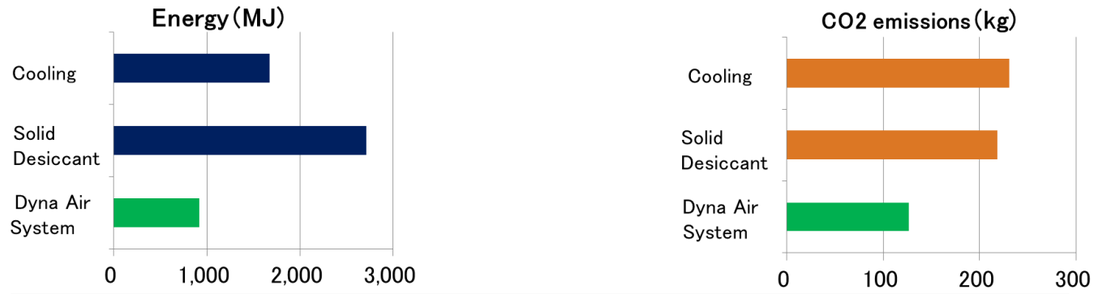


The principle of operation is shown on the left, and this coil can freely dehumidify and humidify using hot and cold heat from heat pumps, and can be adjusted separately for temperature and humidity.
A comparison of energy efficiency is shown in the figure below.

Energy saving and environmental comparison with other dehumidification methods

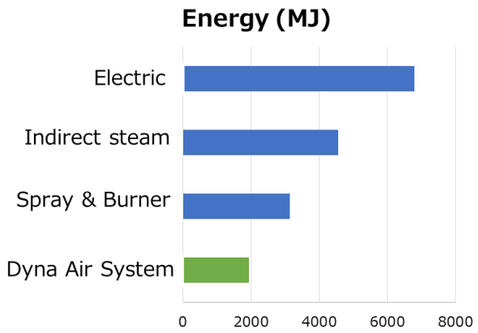
【Outside air】
DB：22.1℃ RH：87.9% AH：14.7g/kg'
Air flow：147,019m³/h

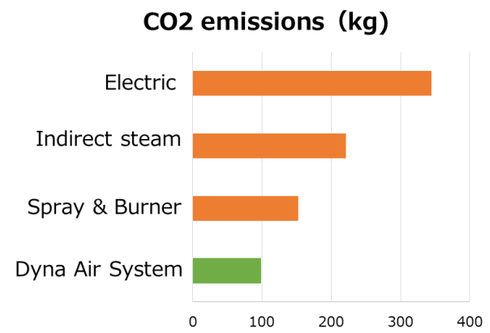
【Supply air】
DB：20.0℃ RH：50% AH：7.36g/kg'



Energy consumption and CO2 emission can be greatly reduced compared to cooling and solid desiccant, when using condenser exhaust heat.

Comparison of required energy and CO2 emission for 1ton of humidification



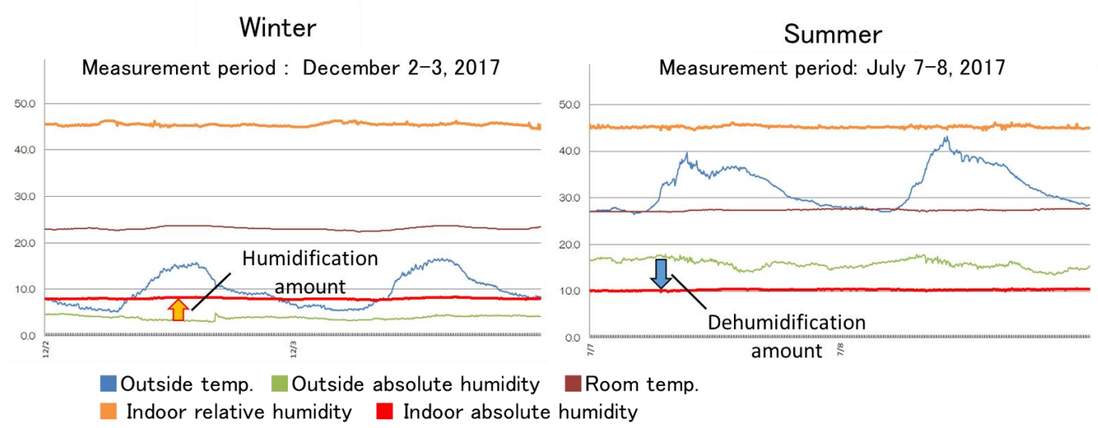


By using a heat pump as a heat source, both energy and CO2 emissions can be significantly reduced.

< Example of Dyna Air system>

Dyna air system has been installed in Japan, mainly in hospitals and nursing homes that require high air quality. All of the facilities that have been installed maintain a steady 40% to 60% relative humidity, which is considered comfortable and safe.

Actual measurements at a certain nursing home



Even if the outside air temperature and humidity change, by controlling the temperature and humidity of the air supply, the indoor relative humidity (set to 45% RH) is accurately maintained in both winter and summer.

Akiko Iwasaki*1,*3,*4 have stated that 'Importantly, there is a sweet spot in relative humidity for indoor environments, the review found. Mice in environments of between 40% and 60% relative humidity show substantially less ability to transmit viruses to non-infected mice than those in environments of low or high relative humidity. Mice kept at 50% relative humidity were also able to clear an inhaled virus and mount robust immune responses.'

In the future, Dyna air system will be able to address the combination of temperature and humidity in each season and region that can reduce the risk of COVID-19 transmission, as more details become available.

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