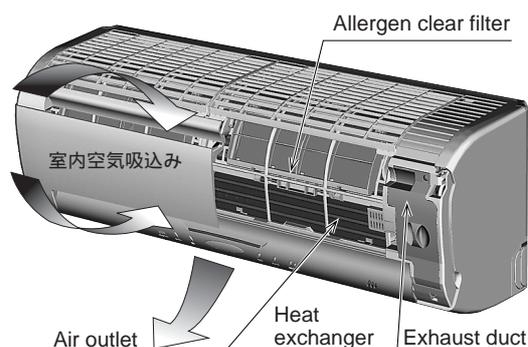


Technology for Improving Indoor Air Quality

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1. Introduction

Atmospheric environment, one of the constituents of living environment, i.e. the Indoor Air Quality (IAQ) that has so far been given little importance is drawing attention in recent years. This is attributed to people's awareness and concern about health impediments caused by air pollution, allergies related to respiratory system caused by house dust, pollen, etc. and other diseases caused by viruses, etc. as well as the easy acquisition of high-level information regarding health and beauty.

The technology that creates an atmospheric environment comfortable to live in is generally called the IAQ improving technology, and has a wide scope ranging from dust arresting, deodorizing, sanitizing, dehumidifying to providing useful constituent, etc. Mitsubishi Heavy Industries, Ltd. (MHI) has developed air-conditioners equipped with filters capable of decomposing and inactivating the airborne allergens and humidifiers that prevent the air from getting dry by means of nano-class waterdrops to contribute to improving the residential IAQ.

2. Allergen inactivation filter⁽¹⁾

2.1 Concept of development

Paying attention to the increase in allergic affection in recent years, MHI commenced development of a technology capable of eliminating the biological airborne allergens likely to cause disease related respiratory system from the residential environment. The biological airborne allergens mainly include mite, pollens and pet which find their way into human respiratory system to cause allergic affections such as sneeze, inflammation, etc.

These allergens so far have been considered difficult to inactivate except by using high-temperature heating or strong chemicals. MHI came up with the idea of an enzyme as a means to inactivate such allergens, and has successfully put it into commercialization.

2.2 Development of filter

The selected enzyme excels in resistance to heat and chemicals, and has long life. Further, because the enzyme has a property of promoting the hydrolytic reaction of protein, it requires moisture. Hence, special fibers with high hygroscopicity were used as the filter material to form a reactive system of liquid phase on the surface of the filter

fiber under an appropriate moist environment, enabling enzyme reaction to take place on the filter. Further, in order to support the enzyme reaction, the urea that temporarily degenerates the allergen protein was jointly used to ensure more authentic inactivation.

2.3 Filter performance

Indoor airborne allergens often found in Japan were used for evaluation of filter performance. The pulverized allergens were adhered to the developed filter to evaluate the inactivation. **Fig. 1** shows the inactivation rates of mite allergens and other allergens. The inactivation of allergens using the enzyme has a wide range of decomposition, and can be applied to various types of allergens existing in the indoor environment.

Since the enzyme is used for decomposing the protein, it can be used for inactivation of viruses and fungi in addition to allergens. For example, it is possible to inactivate 99.9% of the influenza virus in one hour, and the enzyme is confirmed to have antifungal (antibacterial) effect against micrococcus pyogenes.

2.4 Unit configuration

The concept of removing allergens from the indoor air by mounting the newly developed filter on the room air-conditioner is shown in the figure at the upper left. Located before the heat exchanger, the filter sucks in the indoor air containing the airborne allergens through the inlet port during operation to arrest them on the filter, where they get inactivated, so that they can no longer cause allergy even if they get scattered in air again.

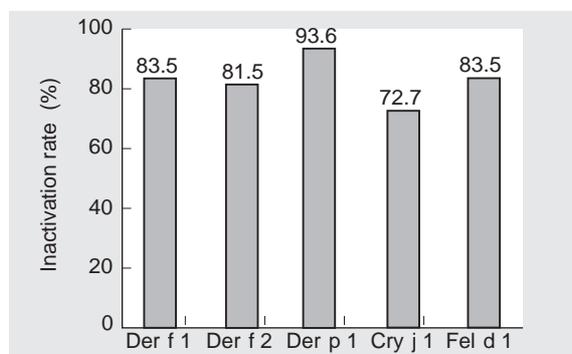


Fig. 1 Inactivation rates of various allergens
 Indicates that the allergen clear filter is applicable to various types of allergens. The Der f1, Der f2 and Der p1 in the figure indicate mite allergens, the Cry j1 cedar pollen allergens and the Fel d1 cat allergens.

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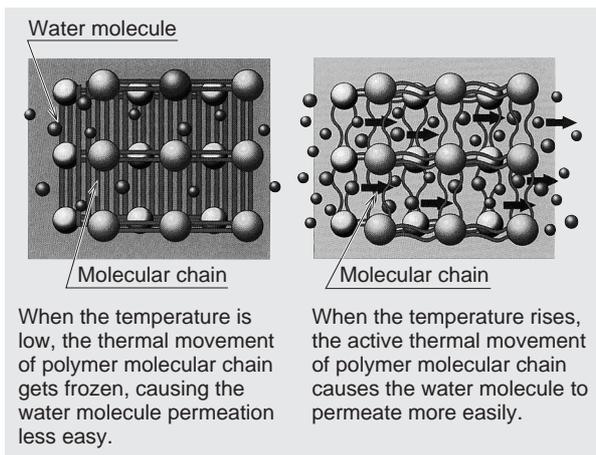


Fig. 2 View showing moisture permeation
The ease of water molecule permeability depends on the temperature of polymer film.

3. New-type humidifier "nanomist[®]" (2)

3.1 Application of shape memory polymer to humidifier

The shape memory polymer known as a moisture-permeating and water-proofing material is a non-porous polyurethane material commercialized as a material for sport wears that controls the moisture content in the clothes to ensure comfortable feeling.

Fig. 2 illustrates the mechanism of water molecule permeation. When water (fluid) contacts with the outer surface of the polymer film, the water proceeds into the film while dissolving and diffusing the micro-space (created on the film due to the thermal motion of molecular chain inside the film) because of the difference in density. By collecting the water in nano-class size from inside the film, the air can be humidified. Thus, by processing the polymer into a tube with thin film, and by passing water through the outer side of the tube and the dry indoor air through the inner side, MHI has been successful in developing a new type of humidifier excelling the conventional one in performance.

3.2 Main features

(1) Top-class energy-saving design in the industry

The humidifier is composed of a water tank, humidifying module, fan and heater. Since the contact of indoor air with the tube influences the moving speed of water, i.e., the humidifying speed, the newly developed small-size, high static-pressure and high-efficiency sirocco fan is used here.

This allows a high-capacity humidification, about 65% of the rated capacity even when the heater is OFF as shown in **Fig. 3**, contributing to the reduction of energy consumption by 62% of the conventional steam fan type Mitsubishi humidifier (saving the annual electricity charge approximately by 5 100 yen).

(2) Maintenance-free

Since the scale of the residual component of water after evaporation does not stick to the film, the performance is confirmed to show no deterioration even when the maintenance is not carried out.

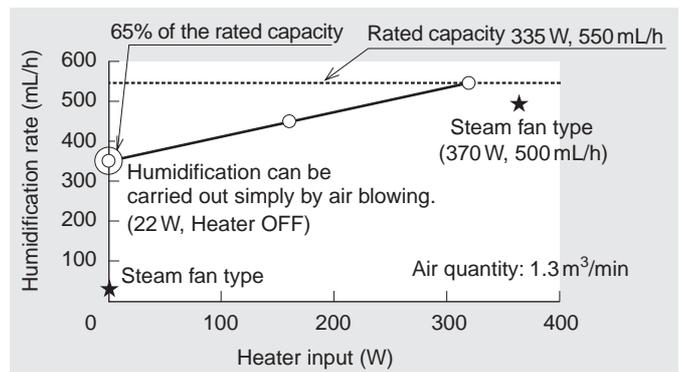


Fig. 3 Humidification rate at heater OFF
Humidification as high as 65% of the rated capacity can be obtained.

(3) Clean humidification

The non-porous film permeates water molecules but blocks the mold, bacteria, virus, etc. larger in size, ensuring clean humidification.

(4) Specification of moisture permeation system

Since the humidified air and the water inside the humidifier do not get heated, there is no danger of the hand getting burned at the air outlet. Further, since the humidified air temperature is almost as high as the room temperature, and the moisture vapor is extremely small in size and has excellent diffusion, the irregularity in the humidity inside the room and the greasiness at the air outlet that had been a problem in the conventional humidifier can be restrained.

4. Conclusions

It is said that Japanese people spend 90% of their time every day somewhere inside the room, with the houses, offices, buildings, hospitals, transportation facilities having more and more airtight indoor environment. This trend is expected to continue, making the improvement in IAQ Technology more and more important. The new type humidification presented in this paper as a countermeasure against allergens is an extremely effective technology for improving the IAQ. We are determined to continue development of MHI products in the future. We are also determined to keep on our engagement in various technologies for IAQ improvement, such as elimination of microbes, VOC, micro-hazardous materials, etc. and imparting of effective components.

References

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