Humidification by desiccant air-conditioning

Comparison humidification of desiccant air-conditioning with conventional humidification

Conventional humidification

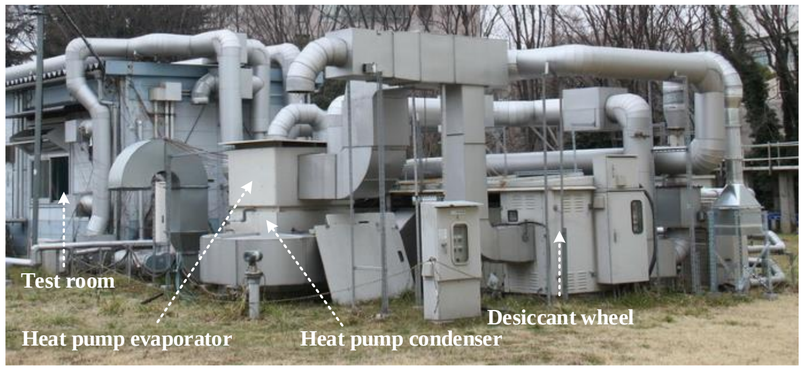
Evaporative humidification:
Evaporative humidification uses unheated water. This may cause the growth of microbes in the humidifier during the summer or non-operating hours at night, as well as unpleasant odors.

Spray humidification:
Spray humidification releases water directly into the air, and thus, any impurities and germs that are contained within the water are released into the air.

Steam humidification:
Facilities where a degraded IAQ is not acceptable, such as hospitals, humidification methods that use unheated water should be avoided. With this method, even though the impurities in the water are not transported by the steam.

→There is still a risk of microbe growth in the drain pan and water tank. It also requires a greater level of maintenance because of the occasional buildup of limescale.
→When water is used as the source of humidity, a method of sterilizing the humidification filter and duct may be necessary, such as potassium chloride, microwaves or ozone, or ultraviolet germicidal irradiation (UVGI).

Humidification by desiccant air-conditioning



Appearance of desiccant air-conditioning system Desiccant wheel

・By adsorbing water vapor from the air and using it as the source of humidity instead of water, a water source and drain pan will not be necessary.
・Peripheral equipment and piping work for heating and humidification, as well as the corresponding maintenance required to treat limescale, will not be necessary.
・The risk of microbial growth inside the drain pan and water tank of the air-conditioning unit will be eliminated, and an improved IAQ is expected.

→ A dew-free environment could be achieved both inside the air-conditioning unit and indoors throughout the year.

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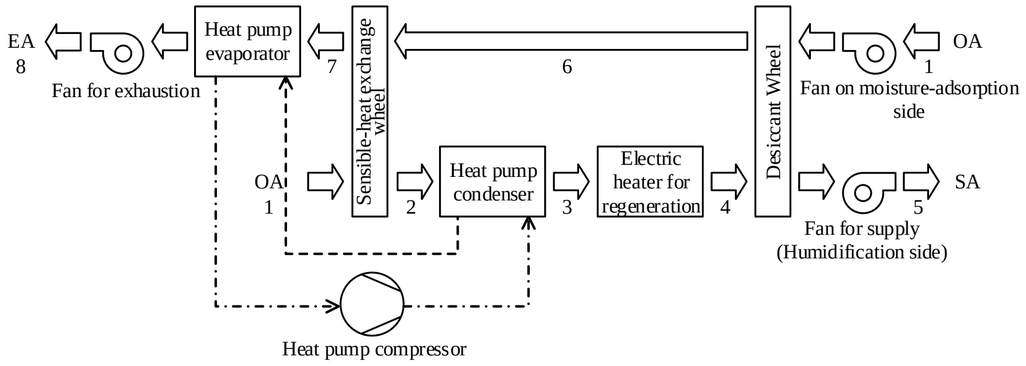
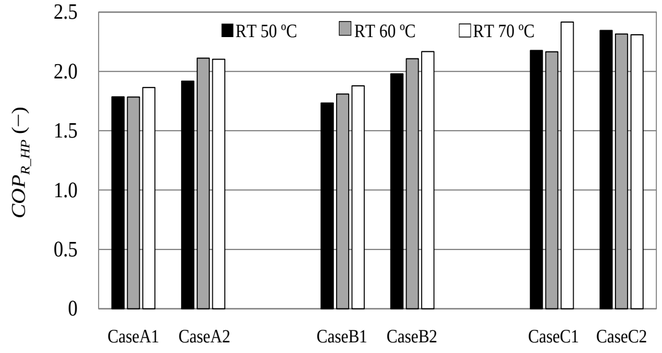
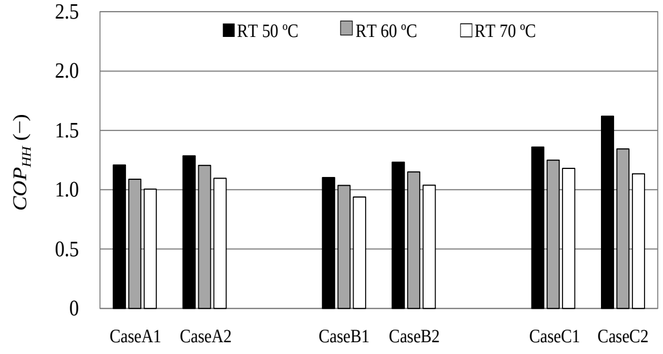
Evaluation of humidification performance



Operational flow of the experimental system for winter humidification. SA:supply air; OA:outdoor air; EA:exhaust air.



Heating efficiency of the heat pump for regeneration (COP_{R_HP}).
RT:regeneration temperature



Humidification-heating efficiency of the heat-source side (COP_{HH}).
RT:regeneration temperature

Evaluation conditions

Outdoor conditions	Temperature (ºC)	7-8				6-11	
	Humidity ratio (g/kgDA)	4.7-5.9				1.8-2.3	
Case		A1	A2	B1	B2	C1	C2
Airflow rate (m^3/h)	Humidification side	500					
	Moisture-adsorption side	500	1000	500	1000	1000	1500
Rotation speed of desiccant wheel (rph)		5		10		5	
Regeneration temperature (ºC)		50/60/70					

※ Sensible-heat exchange wheel was not rotated.

・To ensure a suitable humidification performance, a method was adopted to increase the airflow rate on the moisture-adsorption side compared to that on the humidification side.

→The amount of water vapor adsorbed by the wheel is increased by increasing the amount of water vapor in the OA supplied to the moisture-adsorption side.

→Passing a large volume of low-temperature OA through the moisture-adsorption side quickly cools the wheel on the moisture-adsorption side, which increases the moisture-adsorption efficiency.

Evaluation results：

1. Even under OA conditions that were the equivalent of the outdoor winter conditions for designing an air-conditioning system, a humidity ratio of 5.8 g/kg DA or more was achieved for the SA by selecting the appropriate parameters, such as increasing the airflow rate on the moisture-adsorption side or increasing the regeneration temperature. In addition, it was confirmed that the system satisfied the minimum level of humidification performance required for a DOAS in Japan.
2. It is desirable to keep the sensible-heat exchange wheel stationary because the negative effects, which are due to the transportation of latent heat from the moisture-adsorption side to the humidification side by rotation, are greater than the adsorption heat recovered by the rotation of the sensible-heat exchange wheel.
3. In the case of a desiccant air-conditioning system that is combined with a heat pump for winter humidification, the moisture-adsorption side should be insulated to improve the efficiency of the heat pump for humidification-heating.
4. By increasing the airflow rate of the moisture-adsorption side with respect to the rate on the humidification side, the level of humidification increased approximately in proportion to the increase in the airflow rate on the moisture-adsorption side.
5. The COP_{R_HP}, COP_{HH}(Maximum value : 1.59), and COP_{SYS} values were also improved when the airflow rate on the moisture-adsorption side was increased with respect to the flow on the humidification side.

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