Air-conditioning system individually controlled temperature and humidity

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1. Background

Air-conditioning systems utilizing vapor compression heat pump cycles have seen energy efficiency improvements through reductions in required compressor operation; mainly by decreasing the difference between high and low pressures.

Efficiency improvement in this manner requires dispersing temperature rise, which greatly decreases the latent capacity as shown in Fig.1.

In air-conditioning systems there is generally a compromise between efficiency and latent capacity and the efficiency improvement maintaining comfort is limited.

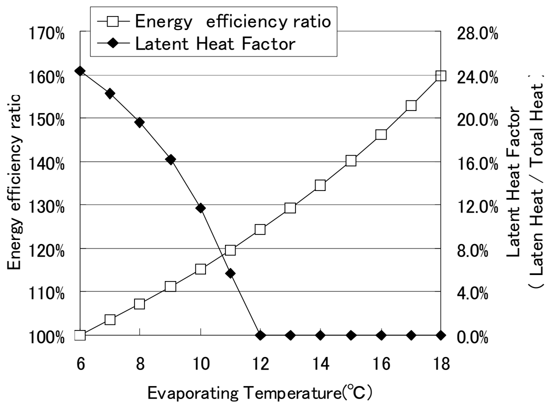

Fig.1 Relationship between Energy Efficiency Ratio and Latent Heat Factor

2 Individual Control System for Latent and Sensible Capacity

2・1 System Description

By combining the "DESICA" humidity controlling heat recovery ventilation system and "Higher sensible heat capacity VRV" temperature controlling, the controls for humidity and temperature are separated thereby allowing both 'energy reduction' and 'comfort' to be satisfied via individual control with these high efficiency systems.

The combination of these two systems showed system energy efficiency for cooling as 4.71 and that for heating as 4.61. This is approximately 34% higher than the Top Runner Criteria for air-conditioning systems defined in the Law Regarding the Rationalization of Energy Use, which shows an average of 3.07 cooling and heating energy efficiencies.

2・2 High Efficiency Humidity Controlling Heat Recovery Ventilation System ("DESICA")

The desiccant system dehumidifies by water adsorption and was applied to separate 'temperature' and 'humidity' to achieve higher energy reduction.

The common desiccant system dehumidifies by rotating the desiccant material coated rotor with humid air passing through one half of the rotor, while the rotor's other half is regenerated by heated air.

The above method offers limited water adsorption due to the heat of adsorption; i.e. to dehumidify 33 deg-C and 22.0g/kg air to 9.0g/kg, high temperature air above 80deg-C is required for regeneration.

In our system, to greatly improve efficiency by regenerating the desiccant with the condensing heat from the heat pump, 'HB DESICA Element' in Fig.2 was developed by combining desiccant material with the heat exchanger. As a result, regeneration by direct heating is enabled.

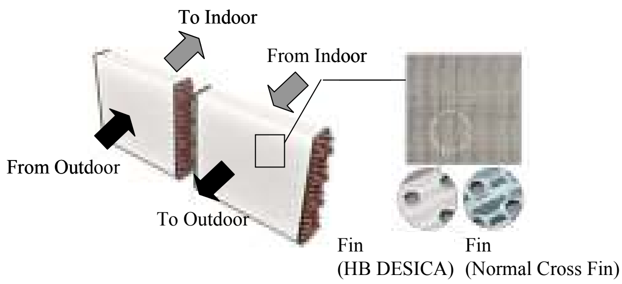

Fig. 2 HB DESICA Element

Because high latent capacity with low regeneration temperature (40deg-C) was achieved by using an 'HB DESICA Element', the exhaust heat (condensing heat) from the vapor compression heat pump can be utilized for regeneration and the power consumption was greatly reduced. As a result, not only achieving the criteria in the Building Sanitation Law but also achieving about 2.5 times higher efficiency compared to normal desiccant dehumidifiers. Also, the reduction in the number of components by combining the desiccant material and heat exchanger and the reduction of heat loss by direct heating of desiccant material reduced the system volume to about 1/3 of the normal desiccant dehumidifiers.

The system does not require water drainage nor supply pipes because the water is released to and provided by air. This also means a reduction in not only the effort required for installation, but also the periodical maintenance and cleaning for the drain pan and/or humidifying element compared to a normal desiccant system.

3 Summary

The "DESICA" humidity controlling heat recovery ventilation system and "Higher sensible heat capacity VRV" combination enables air-conditioning systems to offer improved comfort while lowering power consumption for the first time. Popularization and wide-spread use of this system will further reduce world energy consumption and significantly intensify the fight against global warming.

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