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To cite this article: Daqing Kuang *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **237** 042031

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The Cognition to the Temperature and Humidity Independent Control Air-conditioning System

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Abstract: This thesis introduced the advantages of temperature and humidity independent control air conditioning system compared with traditional air conditioning system and the realization principle of temperature and humidity independent control air conditioning system. Then the thesis introduced the classification of temperature and humidity independent control system and the advantages and disadvantages of each kind of system, and finally summarized the existing problems of temperature and humidity independent control system.

1. The Principle of System

The temperature and humidity independent control is different from the traditional air conditioning system with the method of heat and humidity coupling treatment, temperature and humidity independent control system has two independent systems with temperature and humidity. The humidity control system is used to remove the indoor latent heat load and the CO₂, and the temperature control system is used to remove the sensible heat load. Since the temperature control system only undertakes sensible heat load, The cooling source outlet temperature of the temperature control system does not need 7 °C cold water, and the temperature of 16 °C -18 °C can meet the requirement. This greatly saves energy and provides conditions for the use of natural cold sources ^[1]. In addition, temperature and humidity independent control air conditioning system has a unique advantage in improving indoor air quality and comfort. In recent years, temperature and humidity independent control has been paid more and more attention because of its advantages. Many scholars begin to pay attention to the temperature and humidity independent control.

At present, the temperature control system in the temperature and humidity independent control system mainly adopts the natural cold source, the high-leaving temperature chillers, the evaporative cooling high temperature chillers. Among them, natural cold source mainly includes soil, river water, sea water and so on. According to the different air treatment methods, the humidity control system can be divided into Liquid desiccant dehumidification fresh air handling unit, Desiccant Wheel Dehumidification fresh air handling unit and condensation dehumidification fresh air handling unit. The terminal of indoor sensible heat mainly includes dry fan coils and radiant panels. There is no condensation water in the dry fan coil, which reduces the growth of bacteria and improves indoor air quality. Radiation heat transfer can improve the comfort level of indoor personnel, and the radiant panel can be installed in the roof, which can help the head of indoor personnel to dissipate heat and create a kind of "head cool foot warm" thermal comfortable environment. The radiant panel can lighten the feeling of blowing and make a noiseless indoor environment and be well coordinated in decoration ^[2]. The terminal of humidity control system can use the air supply outlet with displacement



ventilation and personalized ventilation. The fresh air can be sent directly to the air conditioning area, reducing the mixing with the indoor air, improving the quality of the inhaled air, independently controlling the micro-environment of the air conditioning area, and further improving the comfort of the human body in the air conditioning area ^[3]. The advantage of displacement ventilation is mainly reflected in indoor air quality and economy.

Many scholars have done research on the temperature and humidity independent control system. Wang Fei ^[4] in order to analyze the adaptability of double temperature cold source air conditioning system, the energy consumption models of four different types of buildings in Guangzhou area were established, and the dual temperature cold source air conditioning system and the conventional air conditioning system were theoretically analyzed. The simulation results showed that the double temperature cold source air conditioning system can save 16.11% energy compared with the conventional air conditioning system. Zhang Tao ^[5] has studied the system of a high temperature chiller with liquid desiccant dehumidification fresh air unit in Shenzhen. The results showed that compared with the similar office buildings in this area, the energy saving of THIC air conditioning system can reach 35%. Stefano Bergero ^[6] has constructed a LiCl Liquid desiccant dehumidification regeneration system. The comparison between the Liquid desiccant dehumidification system and the steam compression air conditioning system was made by computer simulation, and the conclusion was drawn that the energy consumption can be saved by 50% in summer. Many scholars have also done research on the temperature and humidity independent control, which proved the great energy saving potential of the temperature and humidity independent control system.

2. Classification and characteristics

At present, the temperature and humidity independent control system mainly includes the following four kinds: "high temperature cold source+condensation dehumidification", "high temperature cold source+liquid desiccant dehumidification", "high temperature cold source+desiccant wheel Dehumidification", "high temperature cold source+evaporative cooling".

The following is a comparison of different fresh air handling methods.

Condensation dehumidification: In practical application, the fresh air can be treated with high temperature cold water before condensation dehumidification. If we adopt the temperature and humidity independent control air conditioning system based on double temperature cold source, high temperature cold source can bear 85%-90% of total load of air conditioning system, low temperature cold source can bear 15% of total load of system ^[7]. It has the advantages of stable performance and mature technology, but also has the disadvantages of low air temperature and waste of energy ^[8].

Liquid desiccant dehumidification: Because the solution can adjust the concentration, temperature and gas-liquid ratio, there are many processes of liquid dehumidification, such as isothermal dehumidification, cooling dehumidification, heating humidification, isothermal humidification, etc. The temperature of regeneration is low, so it can be regenerated with low grade heat energy. Advantages: the outdoor fresh air can be directly treated to the air supply state point, the fine particles in the air can be adsorbed, the system structure is relatively simple, the size is relatively small, and the dehumidification efficiency is higher. Disadvantages: some dehumidifiers are corrosive, will corrode pipes, the air may carry solution ions, affecting human comfort, regeneration needs a large amount of energy.

Desiccant Wheel Dehumidification: The material with strong hygroscopicity is added to the wheel and directly in contact with the fresh air so as to achieve the purpose of moisture absorption. The regeneration temperature is about 120 °C, which is higher than that of solution dehumidification. Advantages: This system increases the contact area between water and air, and has higher dehumidification efficiency, which can realize continuous dehumidification and regeneration. Disadvantages: The regeneration part of the system requires huge energy consumption, The wear of wheel is severe, The whole process has significant irreversible losses, low efficiency, and the risk of mixed air ^[9].

Evaporative cooling: Using evaporation of water to make air get cooling quantity, only need to

consume energy consumption of pump and fan, the initial investment of the system is small, but the system is limited by region, and the area is not very extensive^[8].

3. The Problems of Temperature and Humidity Independent Control Systems

3.1. The Problems of High Temperature Cold Sources

(1) In some existing air conditioning systems, the system only provides low temperature cold source, and then mix low temperature cold water with normal temperature water to produce high temperature cold water, thus realizing "double cold source", but this does not fully reflect the advantage of using high temperature cold source^[10].

(2) High temperature cold source can be used as natural cold source, but not all regions have natural cold source. Soil, lake water and other natural cold sources are faced with the problems of heat balance, initial investment and recharge.

(3) The high temperature chillers have some disadvantages, such as high initial investment and high maintenance cost, and the energy consumption is relatively large.

(4) The performance of evaporative cooling high temperature chillers is greatly affected by outdoor meteorological parameters. It has regional limitations and more suitable for northwest dry areas.

3.2 The Problems of Terminal Devices

(1) There is a risk of condensation at the end of sensible heat, either by radiant panels or by dry fan-coil units.

(2) In our country, there are few manufacturers studying the radiation terminal, and the initial investment price of the radiant panel is expensive, and the capillary net with good heat transfer performance can only be imported from abroad, and its price is as high as 350yuan/m². Therefore, when the indoor capillary net air conditioning system is selected, The initial investment of capillary net is about three times that of traditional air conditioning system^[2].

(3) Due to the limitation of water supply temperature, the cooling rate at the radiant terminal is generally less than 60W/m², which limits the application of the radiant panel^[11].

(4) The displacement ventilation system can bear lower indoor load, which has a high demand for the distribution of indoor airflow.

3.3 Other Problems

(1) The temperature and humidity independent control air conditioning system can't use outdoor air to supply cooling freely in the transition season, if it wants to make full use of it, it will increase the complexity of the system^[12].

(2) Domestic HVAC codes, regulations and technical measures have not provided effective criteria such as design method, evaluation method and technical standard for temperature and humidity independent control air-conditioning system, which limits the application and popularization of THIC air conditioning system^[13].

4. Summary

This thesis introduced the principle of the temperature and humidity independent control system, explained the great potential of the temperature and humidity independent control system in the aspect of energy saving, and explained the components of the temperature and humidity independent control system. The classification of temperature and humidity independent control system and the advantages and disadvantages of each kind of temperature and humidity independent control system were introduced. Finally, the existing problems of the temperature and humidity independent control system were summarized.

Acknowledgments

This research has been supported by 'National Key R&D Program of China'(Grant

No.2016YFC0700100); This research has been supported by ‘Promotion of the connotation development quota project of colleges and universities’ - Outstanding Youth of Architectural University(No.21082718003).

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