HVAC Measures of "Returning to the South" in Guangzhou

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Abstract. The phenomenon of "water-exit" often appears on the indoor surface in Guangzhou in spring, which is called "returning to the South" by the local people, which brings about health and safety risks. By analyzing the causes of "returning to the South", this paper points out that the essence of preventing its harm to indoor environment is how to prevent indoor condensation in a high humidity outdoor environment and a low temperature indoor environment. During the design of operation and maintenance, the relevant measures to reduce the indoor air dew point temperature and improve the indoor surface temperature can be considered to reduce the disaster of returning to the south.

Keywords: high-humidity weather, dehumidification, operation and maintenance

1. Introduction

The phenomenon of "water out" often appears on the indoor surface in spring in Guangdong Province, which is called "returning to the South". As a special weather phenomenon, "returning to the South" has not been clearly defined in meteorology. It appears from January to April every year, and its frequency and duration are different. When returning to the south, the air humidity is high, the temperature is low, and the indoor mildew is wet and slippery, which will bring harm to human body, affect the service life of furniture, building materials, building equipment, etc.

Because "returning to the South" has short duration every year and also different each year, in the traditional HVAC design of hot summer and warm winter area, there is usually no special design for this phenomenon. In the actual operation, the existing air conditioning and ventilation system for "returning to the South" operation is more casual. The result is that the harm caused by "returning to the South" is not paid enough attention to and solved, or the energy consumption of air conditioning system is too high or the human comfort is affected.

The purpose of this paper is to study the HVAC design measures in Guangzhou under the climate conditions of "returning to the South", and provide some suggestions for operation and maintenance, so as to reduce the adverse effects of "returning to the south".

2. Analysis on the Causes of the Harm of “Returning to the South”

The High-humidity weather in Guangzhou is due to the rapid change of warm and humid air after the end of cold air influence in winter. When the dew point of outdoor air is higher than the temperature of indoor objects, the phenomenon of "returning to the South" will occur [1].

It can be seen that the outdoor air parameters show the characteristics of high humidity and high dew point temperature when returning to the south. At this time, the indoor surface temperature is still lower due to the cold air of last season. Therefore, when the outdoor dew point temperature is higher than the indoor object temperature, the water vapor in the air will condense on the surface of the object, resulting in wet, moldy and other phenomena.
Based on meteorological data of Guangzhou from 1986 to 2015 obtained from Study on “Climate Characteristics and Dehumidification Design of Residential Toilet in Guangzhou Area” [2], the outdoor design parameters of "returning to the South" are 19.1℃ and 87.5% relative humidity. According to the above parameters, under the typical outdoor meteorological parameters of Guangzhou in winter, the dew point temperature is 16.8 ℃ and the moisture content is 12g / kg, as shown in figure 1.

Figure 1. Enthalpy and humidity chart of typical outdoor meteorological parameters in winter in Guangzhou.

At the same time, according to the "classification of returning days in Guangdong and its relationship with early low temperature and rain" [3], after the daily average temperature ≤ 12℃ and lasting for 3 days, 80% of the probability will follow the occurrence of moderate or severe "returning to the South"; after the daily average temperature ≤ 15℃ and lasting for 3 days, 58% of the probability will follow the occurrence of mild or moderate "returning to the South". Because there is no indoor heating measures in winter and spring in Guangzhou area, the surface temperature of indoor should be close to that of outdoor temperature after 3 days of outdoor low temperature, especially the surface temperature should be between 12-15℃ when "returning to the south".

It can be seen that the surface temperature of indoor objects is 16.8℃ lower than outdoor dew point temperature when returning to the south, resulting in indoor condensation.

Therefore, the essence of preventing indoor environment harm from returning to the south is how to prevent indoor condensation in a high humidity outdoor condition and a low temperature indoor environment.

3. Measures to Prevent the Harm of “Returning to the South”
As mentioned above, how to prevent indoor condensation, in order to prevent the harm of returning to the south is to be considered as the first problem.

In order to achieve this, we can consider it from two aspects
(1) Reduce indoor air dew point temperature;
(2) Increase the indoor surface temperature.

In this process, it is also necessary to consider the comfort of personnel and the energy saving of system operation.
3.1. Reduce Indoor Air Dew Point Temperature

In order to reduce the dew point temperature of indoor air, the moisture content of indoor air must be reduced. During the period of returning to the south, it is suggested to close the external windows to prevent the high humidity air from invading into the room in an unorganized way, resulting in the increase of indoor humidity. On the premise of closing the external doors and windows, in order to ensure the health needs of indoor activity personnel, fresh air should be supplied indoor. The fresh air should be dehumidified.

Several dehumidification methods are described as follows:

3.1.1. Freeze Dehumidification. The principle of freeze dehumidification is that when the wet air flows through the low temperature surface and the temperature drops below the dew point temperature, the water vapor in the wet air condenses and precipitates. The dew point temperature of outdoor air is 16.8 °C and the indoor surface temperature is about 12-15 °C.

The dew point temperature of indoor air should be reduced to below 12°C. The standard supply and return water temperature provided by conventional chillers is 7 / 12°C. According to code “Design of heating, ventilation and air conditioning of civil buildings”, the outlet dry bulb temperature of air cooler is at least 3.5°C higher than the inlet temperature of refrigerant, so the fresh air temperature after treatment is about 10.5°C, which is considered as 11°C. The dew point temperature of the treated fresh air is 9.3°C and the moisture content is 7.3g/kg, as shown in figure 2.

![Figure 2. Dew point enthalpy and humidity chart of fresh air for refrigeration dehumidification.](image)

It can be seen that the dew point temperature of the air sent into the room can be reduced to below 12°C by using the conventional chiller to process the fresh air under the standard working conditions, and there will be no condensation in the room.

If the dew point temperature of the air sent into the room is reduced to 11°C, the parameters after fresh air treatment are as follows: dry bulb temperature 12.5°C, moisture content 8.1g/kg, as shown in figure 3.
Figure 3. Dew point enthalpy and humidity chart of fresh air for refrigeration dehumidification.

It can be deduced that the inlet temperature of cold water should be 12.5 - 4 = 8.5°C.

Since increasing the temperature of cold water supply is helpful to the energy-saving operation of chillers, it is advisable to increase the water supply temperature of chillers appropriately according to the actual dehumidification amount when returning to the south.

Although the water supply temperature of the chiller can be increased appropriately, in order to ensure the dehumidification capacity, the fresh air temperature after treatment still needs to be less than 12.5°C. The fresh air with such temperature can be directly blown into the room, which will easily cause the human body to feel cold and deviate from the comfort zone.

In order to solve this problem, the fresh air should be reheated in the refrigeration dehumidification system. For example, the central air-conditioning system with four pipes of water pipes is connected to the heating coil in series after the refrigeration coil, or the direct expansion machine is adopted for freezing dehumidification. The condensation heat can be recovered to the rear section of the refrigeration coil, so that the fresh air temperature after treatment can rise to 18 ~ 22°C (thermal comfort level II under heating condition in civil buildings design specification).

In addition, the common small and medium-sized mobile dehumidifiers in the market also adopt the principle of refrigeration dehumidification and condensation heat recovery, which is also suitable for returning to the south. However, it is necessary to consider the condensate discharge channel or set the drainage point in the design. When selecting the equipment, the influence of noise and vibration on the service area should be considered.

3.1.2. Solution Dehumidification. Liquid dehumidification depends on the difference between the partial pressure of water vapor of air and that of saturated vapor on the surface of desiccant solution as the driving force for mass transfer. Water vapor is transferred from gas phase to liquid phase, and the moisture content of air is reduced.

The solution dehumidification air conditioning system can separate the heat and humidity load, avoid the energy loss of reheat, and improve the indoor air quality.

However, the system puts forward higher requirements for initial investment, net height of machine room, and later maintenance management. If the system is only set to solve the problem of energy-saving operation of dehumidification and reheating when returning to the south, its economy needs
further analysis and verification. At the same time, the system also needs to be equipped with a heat source to regenerate and heat it.

3.1.3. Other Dehumidification. Solid dehumidification is the use of capillary effect on the surface of some solid materials or the vapor partial pressure difference during phase change to adsorb or absorb water in the air. When returning to the south, the solid desiccant can also be used and placed near the area where mildew and condensation need to be prevented, so as to reduce the humidity in local areas. Commonly used solid desiccants are: silica gel, zeolite molecular sieve, activated alumina, anhydrous calcium chloride and anhydrous magnesium sulfate [4].

Ventilation dehumidification is a method to reduce indoor humidity by introducing dry outdoor air into the room. When returning to the south, the outdoor air humidity is very high, so this method should not be used.

3.2. Increase Indoor Surface Temperature
If there is heat source in the building, it can be heated when returning to the south to improve the indoor surface temperature, such as the building's boiler, air-cooled heat pump system, etc. In case of split air conditioning and multi-line air conditioning, the heating mode can be used; if radiant heating is installed, it can also be opened.

Under the premise of meeting the needs of production and life, the indoor electrical appliances can provide a certain amount of heat, which is helpful to keep the indoor surface temperature not lower than the dew point temperature.

4. Suggestions on Operation and Maintenance of Guangzhou Area for “Returning to the South”
Guangzhou is hot in summer and warm in winter. The common cold and heat sources of air conditioning are chiller, air-cooled heat pump, multi split air-conditioning, etc. Hot water boiler is rarely used, only in some hotel buildings. In addition to residential buildings, the common terminals are fan coil units and all air handling units [5].

As mentioned above, the probability of "returning to the south" is uncertain, and its duration is generally not long. If a system is specially set up for it, the economy of the whole year may be poor. Generally, the appropriate HVAC system should be selected according to the building positioning and annual operation requirements. After the system is selected, the "returning to the South" should be dealt with.

For shopping malls with high lighting load and office buildings with intensive computer power, when going back to the south, under the premise of closing the gaps such as the external windows and doors and isolating the outdoor warm and humid air flow, due to the indoor heat generation, generally there will be no condensation phenomenon in the southern sky. However, in order to ensure the health of personnel, the fresh air system should be opened and the fresh air should be sent to the room after dehumidification. When the fresh air fan is not opened, the regulating valve on the fresh air pipe should be closed to prevent the outdoor air flow from penetrating into the room through the air duct.

For hotels, wards and other areas, the internal heat is not big, and the occupancy situation is relatively random, it is necessary to do a good job of checking the sealing of doors and windows outside each room before returning to the south. For superior hotel rooms, it can operate fan coil refrigeration for 24 hours to prevent indoor condensation. For the project with four pipes, when the guests or patients check in, the heating system should be operated at the same time of refrigeration to improve the comfort of the use area.

For residential areas with split air conditioning, the cooling and heating modes can be alternately operated according to the user's comfort requirements. It is suggested that when the personnel are not in the room, under the premise of closed room, the split air conditioning refrigeration mode can be turned on in advance for dehumidification. When the personnel return to the room, they can switch to the heating mode to improve the comfort.

In addition, other small and mobile measures can be provided to help solve the problem of "return-
ing to the South", such as mobile dehumidifier and solid hygroscopic agent. However, it is necessary to consider the discharge of condensate and the timely replacement of hygroscopic agent.

For areas without HVAC facilities, such as semi outdoor walkways and balconies, or areas where the entrance and exit of the building lobby cannot be strictly closed, dew will also form on the wall and ground when returning to the south. The hazards should be estimated in advance, and relevant anti-skid and warning measures should be taken.

5. Summary
"Returning to the South" is a kind of meteorological phenomenon in spring in Guangzhou, which is easy to cause serious indoor condensation and mildew. Because of its uncertain probability and short duration, it is not paid enough attention in design and operation.

In this paper, through the analysis of the causes of returning to the south, the essence of preventing indoor environmental harm is how to prevent indoor condensation in a high humidity outdoor condition and a low temperature indoor environment. In the design of operation and maintenance, the relevant measures to reduce the indoor air dew point temperature and improve the indoor surface temperature can be considered.

During the actual operation, the operation and maintenance personnel should pay more attention to the hazards of "returning to the South", make full use of the existing HVAC measures of the building, supplemented by temporary and decentralized dehumidification measures, so as to reduce the harm of returning to the south.

Reference
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