Analysis of the Importance of Fresh Air System to Indoor Environment of Green Building and Healthy Building

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Abstract: As an important place for people to live, study and work, the building indoor environment has gradually become the focus of people's attention. The fresh air system plays an important role in improving indoor environmental health problems. This paper discusses the control requirements of green buildings and healthy buildings on the indoor environment. Through the real-time detection of the indoor environment temperature, relative humidity, CO₂ concentration, PM2.5 concentration, air flow speed and fresh air volume of the building, the operation process of the fresh air system is analyzed. The impact on the indoor environment, expounds the importance of the fresh air system to the indoor environment, and provides a reference for the improvement of the indoor environment of green buildings and healthy buildings.

1. Introduction

According to relevant statistics, the construction industry material consumption accounts for 15% of the total material consumption, and building energy consumption accounts for 28%. The core concept of green building is "four sections and one environment" (energy saving, land saving, water saving, material saving), protecting the environment, reducing pollution, and providing people with a healthy and comfortable living and working environment[1]. Green buildings are more focused on the relationship between buildings and the environment, and the requirements for indoor environmental health are not comprehensive. It is the most effective way to improve the indoor environment through the fresh air system and create a healthy, comfortable and livable environment for people.

2. Green building & Healthy building

2.1. Green building indoor environmental control requirements

Green buildings not only require energy-saving and emission-reducing buildings, and realize the harmonious coexistence of man and nature, but also make clear requirements for indoor environmental quality[1]. The US LEED evaluation standard requires that the monitoring capability of the indoor ventilation system be improved, and CO₂ concentration testing should be carried out in densely populated areas to ensure that the fresh air volume meets the requirements of the indoor environment, improve indoor air quality, and improve the environmental comfort[2]. The British BREEAM standard health and comfort evaluation regulations require that the fresh air vents of the fresh air system should
be away from pollution sources, and the open area of the building facade windows should be no less than 5% of the building area to meet the needs of indoor natural ventilation to achieve energy saving and high efficiency[3].

In large public buildings, about 30%-40% of air-conditioning energy consumption is used to deal with the consumption of fresh air[4]. Xiao Dan[5] pointed out that in order to create a healthy and comfortable office environment and meet the air quality requirements of indoor staff in the office buildings, the demand for fresh air is greater, which increases the power load of the air conditioning system.

Through investigation and combing of 50 green buildings across the country, including 35 public buildings and 15 residential buildings. It is found that the current IEQ monitoring of green office buildings meets the requirements of the green building evaluation standard for indoor air quality control. The project's fresh air system uses the detected CO₂ concentration of the indoor return air to automatically regulate the fresh air volume of the air conditioning system. To ensure the freshness of indoor air, the indoor CO₂ concentration is less than 0.07%[6].

2.2. Healthy building indoor environmental control requirements

The indoor environment of the building will affect people's physical function, living habits, sleep quality, etc. and then affect people's physical health[7]. Both the US WELL standard and China's health building evaluation standards take indoor air as the first-level evaluation index, of which the air weight ratio in the US WELL standard is 20%, China is 24%, indoor air Evaluation indicators play an important role in evaluating and improving indoor air quality.

China pay more attention to adopting relevant measures to block the spread of pollutants from the air transmission path, while the WELL standard in the United States is more inclined to exclude and reduce pollution sources from the source to ensure indoor air quality[8].

China's health building evaluation standard air item evaluation indicators are divided into two parts: control items and scoring items. The scoring items evaluate the indoor air quality from four aspects: pollution source, concentration limit, purification and monitoring. The realization of healthy building does not come at the cost of high energy consumption. Starting from the concept of people-oriented, energy saving, health and comfort are as much as possible[9].

3. Fresh air system is important for improving indoor environment

3.1. Measurement and analysis of indoor environmental parameters

Taking a green office building in Beijing as an example, the indoor environmental parameters of the summer fresh air system during long-term and high-frequency real-time detection were used to analyze the impact of the summer fresh air system on the indoor environment during the operation. The office building air-conditioning system runs for 10 hours a day, and the fresh air system runs for 4 hours a day. They are opened at 9:00-11:00 in the morning and 14:00-16:00 in the afternoon.

Figure 1. The measured change of indoor air temperature

Figure 2. The measured change of indoor air relative humidity
Except that the air temperature exceeds the standard value stipulated in the standard for some time periods, the indoor air temperature mainly changes in the range of 22℃-26℃. According to the actual measurement results of the indoor air temperature, it can be known that the indoor air temperature can be maintained within a relatively comfortable range for the human body during the operation of the summer fresh air system, the indoor air relative humidity is comfortable, and the measured relative humidity is in accordance with the design value of relative humidity specified in the standard.

Figure 3. The measured changes of indoor air CO₂ concentration

Figure 4. The measured change of indoor air PM2.5 concentration

It can be seen that the indoor CO₂ concentration on each test working day mainly changes within the range of 500ppm-800ppm, and the indoor CO₂ concentration in compliance with the standard does not exceed 1000ppm. From the analysis of the figure, it can be seen that the indoor CO₂ concentration is relatively low during the operation of the summer fresh air system, and the indoor air quality is relatively good.

According to the measured change graph of indoor air PM2.5 concentration, "Indoor Air Quality Evaluation Standards" of China, the indoor PM2.5 concentration does not exceed 35µg/m³, except for some measured values of PM2.5 concentration exceeding 35µg/m³. The current status of PM2.5 concentration in the test office is relatively good. According to the indoor PM2.5 concentration prescribed by the WHO Air Quality Guidelines, the 24-hour concentration does not exceed 75µg/m³. It can be seen that the median value of PM2.5 concentration at each measurement point is less than 75µg/m³.

Figure 5. The measured changes in indoor air flow speed

Figure 6. The measured change of indoor fresh air volume

The standard stipulates that the indoor air flow speed of the office is less than or equal to 0.3m/s to meet the design requirements of the indoor air flow speed of the summer air-conditioned office building. According to the measured values of the air flow speed in the figure, it can be known that the design requirements of the indoor air flow speed of Class I comfort and Class II comfort under summer cooling conditions are met. The analysis found that the detection value of the indoor fresh air volume basically met the design requirements, and the error between the per capita fresh air volume and the standard's 30m³/h specified within the allowable range met the design requirements.
3.2. Measures to improve indoor air quality
The indoor environmental pollution mainly comes from the natural ventilation of outdoor air and the PM2.5 and PM10 pollutants that enter the room through the doors and windows, the CO₂ generated by indoor personnel, and the release of benzene, formaldehyde and TVOC from paint adhesives used in decoration and furniture. Pollutants [10]. Air pollution is happening every moment, from the main construction of the building, the decoration to the check-in and use of every link. In recent years, cities in northern China have been continuously affected by large-scale fog and haze, and air quality has been heavily polluted. The continuous haze weather has caused an explosive increase in patients with respiratory diseases[11].

![Figure 7. 2013-2018 China Air Purifier Production Statistics](image)
![Figure 8. 2013-2018 Chian Air Purifier Sales Statistics](image)

Note: The data comes from China Business Intelligence Network

According to a survey conducted by the China Business Research Institute [12], the output of air purifiers in China was 19.8 million units in 2016, and it is expected to exceed 30 million units by 2018. With the increasing outdoor air pollution, China’s air purification has started from 2013. The retail volume of the air cleaner market is increasing year by year, and the retail sales are also increasing. The air purifier market shows strong development potential. Air purification technologies currently mainly include photocatalyst, UV-C, negative ion, HEPA filter, high-voltage electrostatic and activated carbon purification, etc. Different purification technologies have different effects on air purification[13]. The disadvantage is that the air purifier is only the purification and recycling of indoor air, unlike the fresh air system that can provide fresh outdoor air to the indoor to increase the oxygen content of indoor air.

3.3. Problems faced by the development of fresh air system
The technical development of China’s fresh air system is relatively weak compared to foreign countries. There is no uniform standard for the standard particles used in the fresh air treatment test, so the test results may not meet the actual requirements. When the fresh air treatment filter material is replaced, whether it will produce secondary pollution of accumulated pollutants and how harmful the pollutants are to the human body are all problems that the fresh air system needs to solve[14].

The impact of the fresh air system on the indoor environment is affected by many factors such as system design, installation and operation and maintenance management. The accuracy, reasonableness and standardization of the fresh air system in the design stage are the prerequisites for ensuring the normal operation of the fresh air system. Liu Chao [15] found through investigation and research that the calculation of the fresh air volume in the fresh air system design process is often directly calculated according to the fresh air volume that meets the personnel hygiene requirements. During the installation of the fresh air system, the installation position of the air outlet is sometimes different due to the difference in building structure, which causes the installation and design deviations to cause changes in the pressure and resistance of the return air duct. It is difficult to expel objects in a timely and effective manner. After the fresh air system is put into formal operation, the later operation management can not be ignored, and the system should be regulated and operated in strict accordance with the operation management regulations.
4. Conclusion
Healthy building is the improvement of the health concept based on the green building. Indoor air quality was evaluated by selecting indoor pollutants with high public attention. Through the actual test of the indoor environmental parameters during the summer fresh air system operation of the green office building, we can see that all the parameters during the summer fresh air system operation basically meet the design requirements stipulated by the standard, except for some of the data. The fresh air system is an effective measure to improve the indoor air quality. At present, the development of fresh air system technology is still facing many problems that need to be solved. In the future, China's construction fresh air market has broad development prospects. Solving the existing problems of fresh air system technology will definitely enter a new stage in the development of green buildings and healthy buildings in China.

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