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A study on Energy Consumption and Reduction Technology in Buildings' HVAC

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Abstract: With the continuous progress and development of the construction industry, architects and engineers have introduced the concept of energy-saving and green building designs that utilizes less energy and electricity. This advancement in the construction industry has made green buildings more attractive, thanks to their low energy consumption also compliance with environmental and ecological requirements. This paper examines the principles and advantages of energy-reduction technologies for building heating, ventilation, and air-conditioning (HVAC) applications, and discusses the technical optimization measures for the technology for reference.

Keywords: *Building, HVAC, energy-saving, principle, measures*

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1 Introduction

Heating, ventilation and air-conditioning (HVAC) system is one of the main components in nearly every modern building. The HVAC system, however, consumes a large amount of energy. In order to reduce the carbon footprint and increase the green energy development in the construction industry, it is imperative to optimize the energy consumption of the HVAC system and optimize the technical aspect of the system. This paper analyses the application process of energy saving and reduction technology for building HVAC.

2 The basic principles of HVAC energy reduction

In the application of energy saving technology in building HVAC, it is imperative to combine main application points, management standards while also enhance corresponding control work. An energy-efficient HVAC system is the result of an efficient management of the three basic principles listed above: economic principle, compatibility and environmental-friendliness.

2.1 Economic principle

In the process of building auxiliary facilities for construction project, cost control remains an important consideration for developers. Subsequently, cost reduction should also be applied in the setup of the HVAC system[1]. An economical HVAC system that comes with adequate operating capacity should be considered. It is worth noting that the installation of HVAC system also comes with substantial operating cost and maintenance cost. Developers should therefore incorporate all these factors into the equation to optimize and maximize the economic return of HVAC energy reduction strategy[2].

2.2 Compatibility

The main consideration in the implementation of energy-saving in HVAC is the influence of external factors such as climate and weather fluctuations. In order to compensate the natural fluctuation of weather, the HVAC system should contain adequate adjustment capability to efficiently reduce energy consumption[3]. The present technology relies heavily on automation technique that, apart from reducing the cost of energy, also reduces labour cost.

2.3 Environmental-friendly

The most fundamental driver behind the implementation of energy-saving strategy in HVAC is to create an environmental-friendly edifice with reduced carbon footprint and saves costs. The objective of HVAC is the efficient manipulation of heat energy. Therefore, comprehensive study of energy cycle of a target building should be conducted to better design an efficient, energy-saving HVAC plan[4]. In addition, the green energy movement has taken great strides in recent years and has now become a new trend in the society. Consumer market now prioritises green energy products that emphasis on energy and cost-saving.

3 The application of energy-saving and consumption-reduction technology of building HVAC

In the application of energy saving technology in building HVAC, it is imperative to combine the detailed inspection of the engineering details of the project. It is also important to establish a complete technical application management procedure, in addition to standardized system to allow for technical management that accentuates the advantages of the technology[5].

3.1 The water pump frequency conversion energy-saving technology

In this section, the basic working mechanism of water pump frequency conversion will be discussed as described by Figure 1.

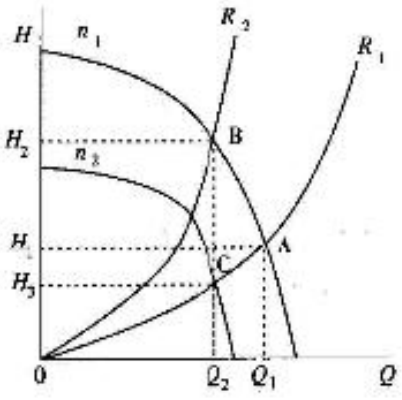

Figure 1. The basic principle of water pump conversion energy-saving strategy

The main idea behind the principle is the manipulation of HVAC pressure using valves. By referring to Figure 1, we can see that by reducing the flow rate of the HVAC from Q1 to Q2 on the x-axis, the operating condition will shift to point B from point A. The corresponding increase in valve pressure means the corresponding pipe network characteristic curve also shifts from R1 to R2. Subsequently, the hydraulic head also increases from H1 to H2 on the y-axis. This automatic regulation can help to control fluid resources and achieve the desired reduction in energy consumption[6], as shown by the changes of point C to point B in Figure 1.

Another important advancement achieved in recent years is the treatment of water pump under cold condition. This is implemented by applying temperature difference control method to gauge and supervise the system to ensure a reduction in motor speed, which subsequently manage the actual flow of the pump. A schematic diagram describing the temperature difference control method is shown in Figure 2.

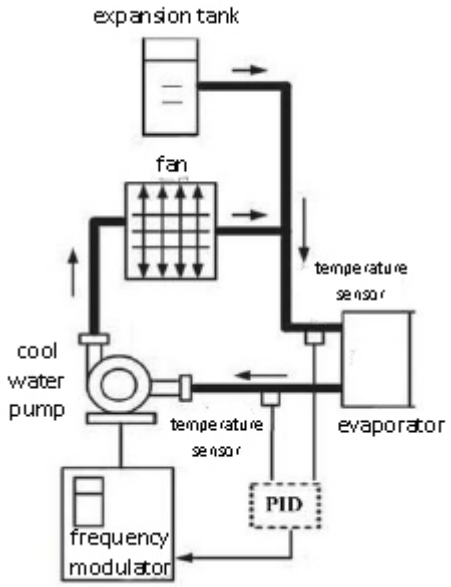

Figure 2. The mechanism for temperature difference control method

3.2 Natural ventilation technology

The Natural Ventilation Technology is one of the most commonly applied technique for an efficient HVAC system. The main techniques in the natural ventilation technology are the wind pressure and heat pressure techniques. The technique exploits the natural tendency of wind pressure and heat pressure to effectively enhance the indoor air quality without the use of electricity[7]. This can help to reduce energy consumption for a building. In addition, the use of natural ventilation is a cost-effective method that meets the practical requirements for green environmental protection.

3.3 Solar power

The use of renewable energy is an important strategy within the green energy movement framework. Among the different types of renewable energy currently available in the market, solar energy presents a clean, cost-effective, and renewable solution[8]. By using solar power as an alternative to replace conventional electric-generation method, designers and engineers can maximize the potential of solar power to help reduce the cost of electricity. For HVAC system specifically, the use of solar power to generate heat within a building through a central system that distributes the heat throughout the building efficiently can significantly reduce the need for heat generated via electricity.

Besides, installing climate compensator can also help to improve the overall operation of the HVAC system. The climate compensation system itself has a relatively dynamic energy-saving rate, and hence can complement the existing HVAC system. A simple climate compensation system is described in Figure 3.

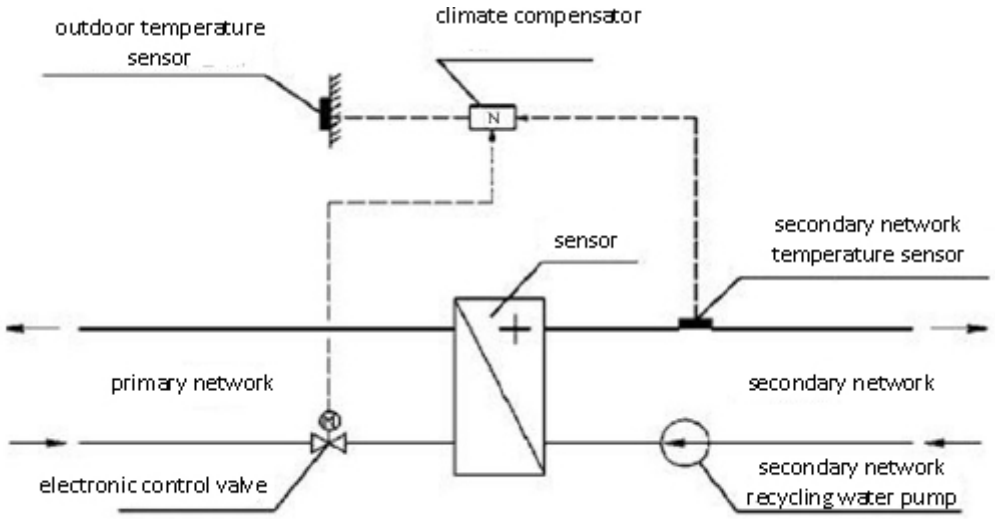

Figure 3. Schematic diagram of the installation of climate compensator in heat exchange station

The application of climate compensator should be used in tandem with external inputs such as temperature and wind reports from weather forecasts. By referring to these inputs, building management can effectively manipulate the supply of water, heat, ventilation and electricity to create a comfortable, cost-saving indoor environment[9].

3.4 Geothermal technology

Geothermal technology has gradually become one of the most popular energy sources in recent years. It has the potential for cost saving and energy saving and may help in establishing a more comprehensive building HVAC model. Most importantly, geothermal technology has a minimal impact on the environment, and produces no pollutant.

The technology is more commonly used in the northern regions of China, where sources of geothermal energy exist in the form of geothermal fields and hot springs. The heat from the geothermal sources is used to increase the heating auxiliary equipment and to be used in tandem with solar energy in series or parallel connection for temperature regulation. In the warmer regions in southern China, geothermal energy is generally used for cooling purposes[10].

4 Enhancing the energy-saving application of HVAC

It is imperative to understand regional characteristics and the engineering demands to increase the operational efficiency of energy-saving technologies in building HVAC. Moreover, establishing a complete technical supervision and management platform can maximize the comprehensive effect of energy-saving technology in building HVAC.

4.1 Improve the technical design of the HVAC system.

HVAC system is a highly technical system that requires considerable technical and science knowledge. It is imperative to have a deep knowledge of the technical facets of the system to enable a full and complete utilization of the system's capacity.

The first step in improving the technical design of

building HVAC is to upgrade technical management model of HVAC system. Due to its nature, HVAC system usually experiences high load criterion, engineers and architects should analyse and examine ways to balance the load evenly to improve the productivity measurement of the system while reducing the energy-consumption.

On the other hand, it is critical for designers to consider the balance between the load criterion of each model and the demand of running the HVAC system on a cost and energy-saving mode. For this to happen, technicians should be equipped with sufficient knowledge of the design scheme, hands-on knowledge and on-the-scene considerations to modify and improve on the design model that can ensure optimum performance of the energy-saving technology of building HVAC.

4.2 Optimize control level

For the application management of building HVAC energy saving technology, it is very important to establish a complete control module and processing mechanism. It is also necessary to supervise the overall function in combination with the control level to ensure efficient energy consumption with reduce wastage, and that the actual heat output meets the standardized application system. To achieve this goal, there are three main factors to consider:

Firstly, it is imperative to monitor the carbon output from building HVAC. The emission of carbon from building HVAC system is on important factor to consider. It is therefore necessary to implement a reasonable control module that can be automated to track and analyse of the output of the HVAC system. This aims to establish an early warning system to keeps the carbon emissions within specified environmental requirements.

Secondly, it is necessary to control the power consumption of the pump to ensure that the goal of energy saving can be met and that the comprehensive effect of application management and operation and maintenance is improved. With the advancement of information technology, it is not possible to automate the monitoring of temperature, humidity and cold heat output using computer or even mobile applications. The advantage of the automation control technology should be exploited to track and adjust the corresponding parameters and optimize the stability of the HVAC control system.

Thirdly, it is necessary to supervise the operation, maintenance and management of HVAC equipment to ensure that the air conditioner operates in the optimal mode to achieve the goal of energy saving and consumption reduction. Mismanagement and poor supervisor could significant affect the energy-saving model of the HVAC system, and hence should be avoided to maximise the advantages of energy-saving technology in building HVAC.

5 Conclusion

Driven by the concept of energy-saving and environmental protection, energy-saving in HVAC can gradually become a major trend in the construction industry. The successful application of energy-saving strategy relies on proper exploitation of the main technical points and factors, including the consideration of external influence such as weather fluctuation. Lastly, efficient management provides the important drive to compel the green energy revolution and to create a win-win situation for the environment and economy.

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