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Analysis and Optimization of Dynamic Energy Consumption of Intelligent HVAC System

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Abstract: In the traditional HVAC(heating ventilation and air conditioning) system, there are some problems such as poor system stability, unreasonable operation and large energy consumption. For this reason, the analysis and optimization of dynamic energy consumption of intelligent HVAC system are studied in this paper. First of all, the dynamic energy consumption of system operation of air conditioning is analyzed from the both perspective of energy consumption mistakes and energy saving problems. And then, the operating status of air conditioning system is optimized by the method of setting parameters for system structure and simulating operating status. As time goes on, the study of the optimized system improves the work efficiency, thereby reducing the energy consumption.

Keywords: Intelligent HVAC system; Operation; Dynamic energy consumption; Optimization

1. Introduction

With the continuous development of society, people gradually pay attention to the problem of energy consumption. After a long period of analysis, it is found that intelligent HVAC consumed a lot of energy in the operation, which led to the current situation of straining energy supply. A high quality intelligent HVAC requires a reasonable design, which is a key part for the life of the entire air conditioning system. In the traditional HVAC system, there are some problems such as poor system stability, unreasonable operation and large energy consumption, which is difficult to meet people's concept of green life [1].

For the above point of view, this paper analyzes and optimizes the dynamic energy consumption of intelligent HVAC system. First of all, the dynamic energy consumption of system operation of air conditioning is analyzed from the both perspective of energy consumption mistakes and energy saving problems. And then, the operating status of air conditioning system is optimized by the method of setting parameters for system structure and simulating operating status. A reasonable design of air conditioning system can effectively improve the work efficiency, but also can meet the contemporary concept of green life, reduce the pollution of the outdoor environment, which is everyone's pursuit of quality of life. This study provides a scientific basis for the future technology.

2. Analysis of Dynamic Energy Consumption of Intelligent HVAC System

2.1. Mistakes of energy consumption of intelligent HVAC

In the design of HVAC, the functional design is often considered, but the design of energy consumption is ignored. Especially in the energy consumption design, only the limited requirements of the system are considered. This design is only for meeting the guidelines of intelligent HVAC design specifications, and doesn't have a better conversion angle to play the purpose of saving energy consumption of air conditioning.

Therefore, in the design of the intelligent HVAC system time, not only the original design concept should be changed, but also the energy consumption problems of intelligent HVAC system should be paid attention so as to improve the design quality. For example, in a construction project, design the air conditioning with the concept of energy conservation, and focus on it for analysis may get the results: compared with the previous program it saves at least 20.2% in terms of energy consumption [2].

2.2. Energy saving problems in intelligent HVAC

In the designing of intelligent HVAC, experts generally do not take the initiative to consider the limited energy consumption problems, they just meet the standards in the design, so it is difficult to design energy-saving problem into the air conditioning system. If making a little improvement and optimization on the system in the actual design process, it will achieve unexpected results. Therefore, from the perspective of intelligent HVAC designing, while saving energy and further optimizing at the same time is the main purpose to achieve energy conservation.

In the process of intelligent HVAC system design, sensible heat treatment can only meet the national standards about energy conservation, so as to achieve the corresponding parameter specification. If the system is optimized, the efficiency of energy conservation can also be improved, increase up to 29% in energy efficiency. The specific energy-saving situation is shown in Figure 2 [3].

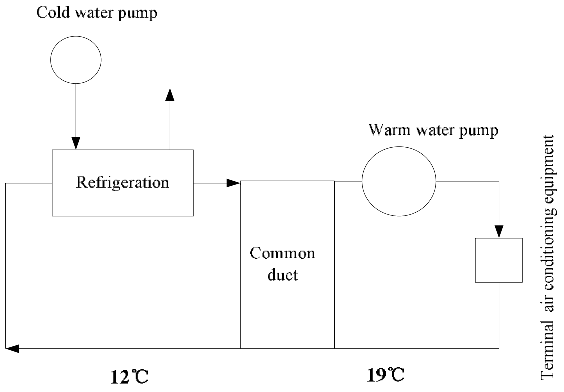

Figure 1. Energy Saving System of Air Conditioning

According to Figure 1, the design structure of HVAC system in the actual operation process, energy consumption can meet the national standards, and the unit used is water-cooled screw chiller. After the optimization of the system, the used unit of terminal air conditioning equipment consumed is efficient high temperature chiller, and with recycling the original consumption greatly reduced. The current system is relatively simple, so in the design of HVAC system, the awareness of energy conservation should be fully improved so as to meet the standards of overall energy-saving and optimization.

3. Optimization of Intelligent HVAC System

In the process of optimization design of intelligent HVAC system, all the equipment constitute a whole system, thus realizing the sharing of information resources, which is conducive to the effective management so that the air conditioning system can play its greatest role. The optimization of the intelligent HVAC system can be done through these two aspects.

Based on the parameters of the intelligent HVAC system, the optimal matching scheme is carried out so as to obtain the optimal design parameters, which can achieve the best operation condition of the intelligent HVAC system optimization, greatly improve the efficiency of intelligent HVAC system, and reduce the cost of the system investment. The purpose of the optimization of intelligent HVAC system is to achieve the system's cooling load and indoor comfort, and to make the energy consumption of all the equipment to a minimum. The mathematical expression [4] is:

$$\min Q = Q_{ch} + Q_{chwp1} + Q_{chwp2} + Q_{fan} + Q_{cw} + Q_{ctf} \quad (1)$$

In formula (1), Q is the total energy consumption of the air conditioning system; Q_{ch} is the energy consumption of the chiller; Q_{chwp1} is the disposable energy consumption of the chilled water; Q_{chwp2} is the secondary energy consumption of the chilled water; Q_{fan} is the energy consumption of terminal air conditioning equipment; Q_{cw} is the energy consumption of cooling tower fan; Q_{ctf} is the energy consumption of cooling water pump.

When the chiller of intelligent HVAC is in the operation, the change of cooling water temperature is often very small [5]. If it can be negligible, the expression of energy consumption for cooling water is:

$$Q_{ch}=W_{nom}COP_{nom}\left(a_0+a_1\frac{W_{ch}}{W_{nom}}+a_2\frac{W^2_{ch}}{W^2_{nom}}\right)\times\left(b_0+b_1P_{chws}+b_2P^2_{chws}\right) \quad (2)$$

chiller, COP_{nom} is the performance coefficient of the chiller under full load, that is the ratio of the cooling capacity to the energy consumed; W_{ch} is the actual cooling capacity; P_{chws} is the return water temperature of cooling water of the chiller; a_i and b_i are the coefficients of unit operation.

The process of optimizing the intelligent HVAC system, the current state should be simulated as much as possible, and the control limit of the intelligent HVAC system should be reduced so as to improve the stability of the intelligent HVAC system and reduce the probability of failure. So that the optimization of intelligent HVAC system can achieve the optimum efficiency.

The experimental test is based on the operation data of one of the large air-conditioning DCS located in an underground shopping mall in Yuexiu District of Guangzhou, combining the different time of the day. The optimized energy consumption statistics of the air conditioning system can be obtained as shown in Table 1.

Table 1. The Optimized Energy Consumption Statistics of the Air Conditioning System

Time /h	Q ch/ K w	Qchwp1 /k w	Qchwp2/ K w	Q fan/ K w	Q cw/ K w
8:00	3.4123	0.4731	0.7328	0.7553	0.7956
9:00	3.5613	0.5289	0.7993	0.8462	0.8214
10:00	4.126	0.5998	0.8269	0.9217	0.8576
11:00	4.981	0.6013	0.8972	0.8542	0.8990
12:00	5.109	0.5873	0.9103	0.7990	0.9123
13:00	4.768	0.5019	0.8970	0.7813	0.8762
14:00	4.192	0.4899	0.7995	0.6910	0.7615
15:00	3.582	0.4630	0.6825	0.6057	0.6637

16:00	3.498	0.4539	0.6672	0.5802	0.6330
17:00	3.252	0.4395	0.6388	0.5537	0.6108
18:00	2.552	0.3570	0.5821	0.5022	0.5277

It can be seen from Table 1 that the energy consumption increased as the time goes from the morning to the afternoon. In the afternoon, as time goes by, the energy consumption is slowly reduced and close to the original value. It shows that the optimization of intelligent HVAC system is necessary.

4 . Conclusions

The problem of dynamic energy consumption of intelligent HVAC system is very important, if the product development of energy consumption is greatly enhanced and the system is optimized, the work efficiency of air conditioning can be effectively improved. On the basis of optimizing the energy consumption, by using advanced design concept of the system, analyzing with computer network technology, and finally choose technology that fit energy consumption for system optimization, this is the only way to ensure the scientificity of the operation of air conditioning system and to provide advanced optimization methods for China's future air conditioning optimization technology.

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