Journal of Applied Science and Engineering Innovation, Vol.8, No.2, 2021, pp. 41-46
ISSN (Print): 2331-9062
ISSN (Online): 2331-9070

Introduction of Energy Saving Technology of Air Conditioning Water Storage

Shao Shifen [1, *], Zhao Mengdi [2]

[1] Shanxi University of Science and Technology Shanxi Xi'an, China.
[2] Qingdao University, Qingdao, Shandong 266071, China.
[*] Corresponding author. E-mail address: 138286331@qq.com (Jipeng Zhao).

Abstract: The cold storage air conditioning is a technology that starts the refrigerator system in the low power period at night, stores the power in the form of cold storage equipment in the form of cold quantity, while in the peak period of day power, the cold quantity saved in the night period is released into the air conditioning system. This paper introduces the water storage and energy saving technology of air conditioning, including brief introduction of water storage technology, working principle, benefits brought, technology improvement methods and its application prospect.

Keywords Air conditioning; Water storage; Energy saving technology; Application

INTRODUCTION

My country's economy is in a stage of rapid growth, so there is a shortage of power supply, and it is urgent to strengthen power construction. In summer, during the peak period of air-conditioning use, in northern cities such as Beijing, air-conditioning power consumption has reached 15-19% of the city's total consumption; southern cities such as Shenzhen, air-conditioning power consumption is even higher.

As the electricity consumption of air conditioners increases, electricity costs are increasing, and it is necessary to figure out ways to reduce energy consumption under certain workload conditions. Therefore, air-conditioning water and cold storage technology is increasingly favored by people. This technology is mainly used for electricity. Air-conditioning and cold storage are carried out when there is less electricity, and the accumulated energy is released when electricity is used. From this point of view, the water cold storage technology has extremely important strategic significance for peak shaving, valley filling, load adjustment and power saving.

AIR CONDITIONING COLD STORAGE TECHNOLOGY

In the air-conditioning system, the water-storage energy-saving technology can be regarded as one of the important measures to solve the extreme imbalance between the minimum and maximum usage during operation. The basic concept of air-conditioning water storage is: when the power consumption is low at night, it will accumulate The cold capacity is stored for use by Baitian when the electricity peak is used to obtain the effect of balancing the running time of the refrigeration equipment. In addition, the air-conditioning water cold storage technology reduces the installed capacity of the chiller and reduces the auxiliary equipment (such as The installed capacity of water pumps, cooling towers, transformers, etc., enables the refrigeration equipment to operate at full load and with high efficiency, and can also balance the grid load.

The cold storage technology of air conditioner mainly includes two kinds, one is water cold storage, the other is ice cold storage, we mainly discuss the water cold storage energy-saving technology.

BASIC CHARACTERISTICS OF WATER STORAGE TECHNOLOGY

The composition of the cold water storage system and their respective functions

Refrigeration units, circulating water pumps, pipes, terminal equipment, cooling towers, etc. form a water cold storage system. The chilled water temperature is generally 7 ℃/12 ℃, which is the same as the summer cooling of household air conditioners. The outdoor unit is a condenser to provide outside air. Heat dissipation, the room is an evaporator, used to absorb the excess heat in the room, and is realized by the evaporation and condensation of the refrigerant. In the chilled water system (generally the load is relatively large), chilled water is used as a medium and sent to the end air pan (including the coil and the fan). The fan makes the indoor air circulate through the coil and exchange heat with the chilled water to achieve the cooling effect. After the heat exchange, the temperature of the chilled water rises from 7 ℃ to 12 ℃, and the temperature at the evaporator side of the refrigeration unit drops to 7 ℃ to reach the cycle. The condenser side of the refrigeration unit releases heat. Generally, the cooling tower is used to release the heat. Water is also required as a medium to take away the heat. Here, the water is called cooling water. Disperse to the air, cool down, and then return to the condenser. The transfer of heat and cold of the refrigeration unit depends on the refrigerant.

Cooling method

There are two cooling methods, one is that the refrigerator operates in the original way, and the other is the cold storage tank. The two cooling modes can be used in combination. During the day, part of the cooling capacity is provided by the refrigerator and part of the cooling capacity is provided by the cold storage tank.

Characteristics of water storage technology

1. The total number of boot hours per year is less than that of conventional systems;

2. When storing cold at night, the temperature will decrease, and the cooling effect will be improved to a certain extent. The unit is in an efficient operation state, and the efficiency can be increased by nearly 5-7%. The total power saving rate of the air-conditioning system is not less than 11%.

3. The electricity price difference of the time-sharing power supply policy is obtained from this. "Sell high and buy low", which can also save a lot of electricity bills and save electricity.

Principles and design principles of water storage technology

The energy-saving design principle of air-conditioning water and cold storage is to use the equipment unit to work when the power consumption is low at night to cool the water into chilled water, and then release it during the day for the cooling of the air-conditioning water and cold storage system, so that peak-shaving and valley-filling can be achieved the goal of. It can be simplified to charge cold at night and let it cool during the day.

The schematic diagrams of charging cold at night and releasing cold during the day are shown in Figure 1 and Figure 2, and the schematic diagram of the cold water storage system is shown in Figure 3 [2].

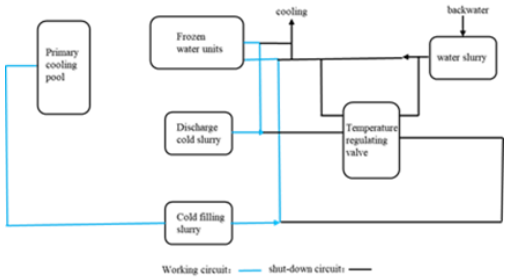

Figure 1 Schematic diagram of charging and cooling at night

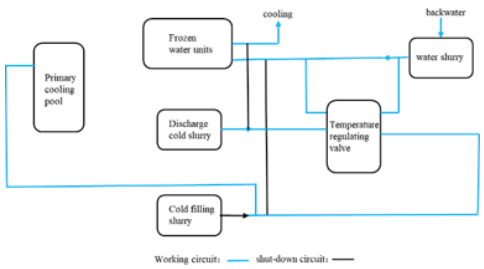

Figure 2 Schematic diagram of cooling down during the day

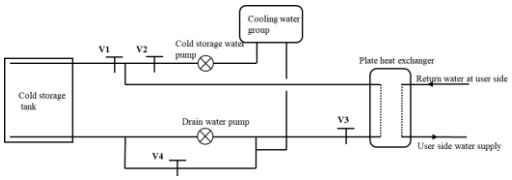

Figure 3 Schematic diagram of water storage system

Design principles

There are many factors to be considered in the design of cold storage water, including various factors that affect the initial investment and operating costs. Study the relationship between electricity consumption, electricity price and total electricity fee as much as possible, and the peak and low electricity consumption. Factors such as the electricity price structure, thereby achieving the most satisfactory economic benefits, reducing the initial investment while reducing electricity consumption, in order to achieve the effect of reducing electricity bills.

If the energy-saving design of water storage is carried out, accurate analysis of the characteristics of building air-conditioning load is an indispensable step. We need to understand the changes in the electricity consumption of electricity-consuming buildings over time. With reference to this relationship function, we can select the system type more accurately and know how to control the system. This is to better design the space occupied by the object, ensure the efficiency of the host and reduce energy consumption on the basis of meeting the work requirements.

When we design an air-conditioning system using water-storage energy-saving technology, we must consider many factors, such as the matching performance and operating conditions of the equipment units. When designing with mathematical modeling, it is ensured that the work task can be completed, the electricity consumption is the least, and the consumption is the least.

THE FORM OF COLD WATER STORAGE

The partition method

Water storage tanks are not unfamiliar to everyone. The interior of the cold water storage tank is composed of a movable flexible membrane or a hard board. This partition can be used to separate water with different temperatures. Most of this partition or membrane is The horizontal direction, so you can not use the diffuser, thereby reducing costs. However, both the flexible membrane and the partition require costly maintenance, and it does not show its own advantages in terms of operation and maintenance compared to the diffuser.

Natural layered water storage

Natural layered water storage is the simplest and most effective and most affordable method of water

storage. Compared with the labyrinth method we will introduce below, this method will not cause the problem of water flow. Compared with the partition method described above In other words, there is no need to worry about the economic burden caused by maintenance.

Why is this method the most effective? Because the rationally designed natural stratified water storage efficiency can reach 87%-96%. This method must use a diffuser. Diffuser, as the name suggests, is a tool for drainage. Because different liquids have different densities, gravity flow is generated by using such a difference, and then a smaller limit is produced that does not mix hot and cold water, and the thickness is also as thin as possible Clinique.

In addition, on the basis of generating gravity flow, we need to control the flow rate of the water flow to make it rational, and we also need to reduce the disturbance of the clinoline to avoid damage. An upright flat-bottomed cylinder is the most reasonable natural layered water storage form.

Labyrinth method

Through the effect of the partition, the water tank is divided into multiple small unit bodies, so that the water flow can cross each unit body in turn according to the designed route (Figure 4 shows the route direction of the water flow in the labyrinth-type livestock water tank).

The best way to prevent the mixing of hot and cold water is the maze method. In the process of cold storage and cooling, it can be known that hot water enters from the bottom inlet and cold water enters from the top inlet. This operation will easily cause mixing under the action of buoyancy, and if the water flow rate is too high, the consequence is that the mixing speed of hot and cold water exceeds our expectations, and it will cause the water flow to be blocked, which will result in the consequence of the capacity of the cold storage system being reduced.

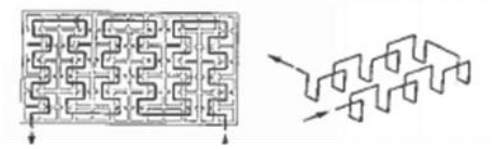

Figure 4 Road map of water flow in labyrinth cold storage tank

TYPES OF WATER STORAGE

Centralized energy storage is a commonly used method in energy-saving technologies for cold storage and air conditioning. Under normal circumstances, the total cold storage capacity is 25500RT. On the basis of making full use of peak and valley electricity prices and saving operating costs, water storage cold storage can play the role of "cutting peaks and filling valleys", thereby solving the problem of power shortage to a certain extent. Studies have shown that the water storage cold storage is expected to save 2% of operating costs, which can save 345 million yuan per year compared with traditional refrigeration technology.

Labyrinth type

Generally speaking, if the cold storage space is too small, the labyrinth type will be used. Countries like Japan with many earthquakes and small area often adopt cold storage technology with a small space when designing buildings, that is, using this labyrinth-type water storage technology. Generally not often used in earth buildings.

Single slot, multi slot type

Different from the labyrinth type, the limitation of this type is that the height is limited, and the single groove type is not easy to control and difficult to be reliable. Rigid partitions are often installed to assist in use.

Multi-slots are connected in series. Rigid baffles are required to be set just like single-slots, but several should be set according to the number.

Naturally layered type

Its core feature is that the natural gravitational stratification is formed by water of different densities and different temperatures, and the thermocline formed by the mixture of hot and cold water is the separation layer between the hot and cold water areas.

Design elements of cold storage tank

The calculation formula for the volume V of the cold storage tank is:

$$V = 3600 \times (\frac{Q}{Q_t}) \times \rho \times C \times \mathrm{FOM} \times a \quad (1)$$

Constant: ρ= (1000kg/m3);

C= Specific heat capacity of cold water (4.18kJ/kg* ℃);

Variable: Q= Cold storage capacity (RT);

Q_t = The temperature difference between cooling and storage;

FOM= Insulation efficiency of cold storage tank;

a= The volumetric efficiency of the cold storage tank.

According to the data and calculation formula, it can be known that the flat-bottomed cylinder is the most economical.

Calculation of cold storage capacity and maximum cooling rate of water-storage air-conditioning

The practicability and working efficiency of the water-storage air-conditioning system are what we must guarantee and improve. Therefore, if we use water-storage air-conditioning technology, we need to determine the maximum cold storage capacity and the

maximum cooling rate of the water-storage air conditioning system.

Assuming that the rated cooling capacity is $q_1(KW)$, the energy supply time is $t_1(h)$, R is the proportional factor between the cold storage time and the working time, and the cold storage time $t_x(h)$, then:

$$S_1 = S - S_1 = S_2 + S_x = q_1 t_1 + Rq_1 t_x = q_1(t_1 + Rt_x) \quad (2)$$

where $S_1 =$ Design circuitous cooling capacity after deducting the cooling capacity of the basic equipment;

$S =$ Objects are cold loaded for 24 hours;

$S_1 =$ Basic equipment provides cold load;

$S_2 =$ Cooling load capacity of the refrigeration unit;

$S_x =$ Device releases cooling capacity.

The rated cooling capacity of the available refrigerator air conditioner:

$$S_1 = S_2 t_1 - Rt_x \quad (3)$$

Among them: the cold storage capacity of the refrigerator $\geq q_1$.

Assumed system cold storage rate $a = \frac{S_x}{S} = S_x / (S_1 + S)$, From the formula (3), it can be seen that $S \geq 0$, the maximum cold storage rate of the air conditioner can be determined as:

$$a = S_{\max} = S_x S_1 = Rq_1 t_x q_1(t_1 + Rt_x) = Rt_x t_1 + Rf_{x'} \quad (4)$$

It can be seen from formula (4) that a is related to $t_1(h)$, R, and cold storage time $t_x(h)$. The larger R, the smaller the capacity, and the greater the maximum cold storage rate.

COMPARISON OF AIR-CONDITIONING COLD STORAGE TECHNOLOGY

Ice storage

The ice storage system uses electric refrigeration and water-cooled air-conditioning as the main mechanism ice, and uses preferential electricity prices to store ice in the ice storage equipment during low power consumption and low load power consumption periods. During the day when the power load is high, avoid peak electricity prices, stop or intermittently operate the electric refrigeration host and water-cooled air conditioner, and release the ice storage capacity storage device to meet the needs of the water-cooled air conditioner load.

Comparison of water storage and ice storage

In terms of power consumption, ice-storage air-conditioning consumes more power than water-storage air-conditioning; in terms of investment, ice-storage air-conditioning has higher investment than water-storage air-conditioning; in terms of energy storage form, water-storage air-conditioning is not the same as ice-storage air-conditioning. Comparable; from the comparison of after-sales maintenance costs, ice storage is 6-10 times higher than water storage.

Comparison of the two

Table 1: Performance comparison between ice storage system and water storage system

project	Ice storage system	Water storage system
Cold storage tank volume	Small (only 10%-35% of the water storage system)	Big
Cold machine chilled water outlet temperature	1-3℃	4-6℃
Cooling machine power consumption	Higher	Lower
Investment in cold storage system	Higher	Lower
Cold storage cold source	Need to be able to operate independently of the ice machine to form a dual working condition cooler	Can use existing system cold source
Design and operation	High technical requirements and high operating costs	Low technical requirements and low operating costs
Coefficient of refrigeration performance COP	Low (10%-20% lower than water storage)	Higher
Other uses	without	Can be used in conjunction with existing building spaces such, and can be used as a heat storage system in winter

BENEFITS FROM THE ENERGY-SAVING TECHNOLOGY OF AIR-CONDITIONING WATER AND COLD STORAGE

Speaking of benefits, we can understand that the water-storage energy-saving technology can not only make good use of the large gap between the day and night due to the time of electricity use for cold storage and energy storage, and then achieve the purpose of saving electricity, but also can continue to promote technological innovation. For China with its rapid economic growth, it is undoubtedly a great project. It is true that this kind of technology is not perfect enough, and it needs to be improved and improved. This requires more and more technical talents. Therefore, vigorously developing education is the most correct choice.

Benefits can also be divided into individual benefits and social benefits, no matter which, they have brought great benefits to social development.

Individual benefits

After the host equipment uses the water-storage energy-saving technology, its cooling efficiency can be increased by 6% to 8% during energy storage operation, and the total power saving rate of the air-conditioning system is about 10% [5]. When individual users are expanding the volume or want to install a new refrigeration and air-conditioning system, they can choose the water-storage air conditioner. The water-storage air conditioner is designed by taking advantage of the difference in electricity time. This step is the most critical step to freeze the water at night. In the daytime, most users will turn on the air conditioner during the day. In such a peak electricity consumption situation, the water storage air conditioner can release the stored chilled water to relieve electricity consumption. In this way, the peak electricity consumption brings The deficiencies can be compensated to a certain extent, which not only reduces users' electricity consumption and electricity bills, but also relieves the pressure on the national grid. Water-storage air conditioners, in short, store cold energy when there are few electricity users, and reduce air conditioning electricity when there are many electricity users. If this method is well used, the benefits can be imagined.

Social benefits (take Sichuan Province as an example)[3]

For individuals, we pursue benefits, and for a province, we must pursue overall benefits. At the end of 2007, Sichuan's electricity usage was 30.32 million kW, of which thermal power used 10 million kW, accounting for about 33% of Sichuan's total electricity consumption [4]. The initial investment is increased by 1,500 yuan for every 1 kW peak load transferred using water storage technology. This shows how important the application of water storage technology.

METHODS FOR IMPROVING AIR-CONDITIONING WATER AND COLD STORAGE TECHNOLOGY

We know that there will be a layer of clinoline between water at different temperatures. The lower the thickness of the clinoline, the better the application of water storage technology. Therefore, we need to find a way to reduce its thickness and ensure work efficiency.

The design of the cold water storage process system can meet the requirements of the mutual conversion of five operating modes and two operating strategies as required.

The five operating modes include a cold storage mode, three cooling modes and a hybrid mode. One of the cold storage modes refers to the cold storage mode of the chiller, and the three cooling modes include the independent cooling mode of the cold storage device, the chiller and the The combined cooling mode of the cold storage device and the independent cooling mode of the chiller. A mixed mode refers to the mode of cooling the chiller while storing the cold.

In the combined cooling mode, it should be possible to realize the two operating strategies of chiller priority or cold storage tank priority to meet energy-saving operation under different cooling loads.

APPLICATION PROSPECTS AND DIRECTIONS

The relevant electric power departments of the Chinese government have proposed and implemented various policies to reduce the economic losses caused by the difference in time difference in electricity use. Among them, the most strongly advocated technology is the use of water-storage energy-saving technology. The application of this technology can not only alleviate the time difference in power consumption, but also ease the contradiction between power construction and new power consumption to a certain extent. It is one of the effective means to solve this contradiction [6]. In addition, various policies on promoting the vigorous development of energy-saving water-storage air-conditioning technology have also been issued in various provinces and cities, and the development and application of water-storage air-conditioning technology has been promoted forward. Not only new projects are suitable for the application of water storage technology, but also renovation projects are suitable for the application of this energy-saving technology.

In our country, the water tank volume can be reduced by increasing the working temperature difference of the water storage air conditioner, thereby reducing the cost and heat loss, and the energy consumption of liquid transmission will also be reduced. The water storage capacity exceeds a

certain limit, and the establishment of water storage tanks in the open space or the full use of existing pools can bring great benefits. In addition, if the water-storage energy-saving technology is used in an area with a suitable latitude and a heat pump system, it can be used for heat storage in winter and cold storage in summer. In this way, the utilization efficiency of cold storage tanks can be improved, and to a certain extent Say it is more economical. Once, in some areas of our country, when installing air conditioners in some gymnasiums, the water-storage energy-saving technology was adopted, because the inlet temperature of conventional air conditioners is 7℃, and the outlet temperature is 12℃. Under such constraints, the cooling body works. The temperature has only increased by 5℃, which makes the cold storage pool larger, and the floor space, cost, and cold loss during the cold storage process are correspondingly increased, so this technology will be difficult to popularize. In recent years, many researchers in my country have conducted a lot of exploration and research on the improvement of air-conditioning water cold storage technology. After a series of case studies, the working temperature difference of the cold carrier has been extended to 8~10℃, or even beyond this range. , The cold storage density has also increased from the original 5000 kcal/m3 to 10000 kcal/m[7]. In this way, the volume of the cold storage tank will be reduced to a large extent, and the engineering cost, heat transfer loss and power consumption of the cold carrier transportation will be reduced to a certain extent.

SUMMARY AND LOOK FORWARD TO THE FUTURE

Through the above introduction, we understand the composition, design principles, working methods, etc. of the water storage system from different levels. Compared with ice storage technology, we understand the advantages and disadvantages of water storage technology, and realize the user benefits and benefits it brings. Social benefits, mastered how to improve the water-storage energy-saving technology, and learned that the water-storage technology has a broad application prospect, but at the same time it also needs to be continuously improved, and more applications are found.

We must know that the world is constantly developing, the country is constantly developing, and the society is constantly developing. Therefore, we must continue to develop. We must not only read more books and improve our self-cultivation, but also stimulate our own creativity, continue to innovate, and add ourselves to the improvement of technology within our own capabilities, so that more and more scientific and technological forces are combined with nature. Going back to the water-storage energy-saving technology introduced in our article, we know that energy is limited, and we need to make full use of it and save it. This is the long-term development plan. The water-storage energy-saving technology saves natural energy very well. Of course, if we can use this technology more efficiently and continue to innovate and develop, I believe we will find more magical existences.

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