LAY-OUT OF AIR SOURCE HEAT PUMP HEATING SYSTEM IN LUGANG LOGISTICS PARK

by

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In order to understand the process of using the heat pump heat organization, the author proposes to conduct a study based on the concept of heat pump air heating system in "Land Port Logistics Park". The author first analyzed the heating characteristics of the ground transportation fleet according to the actual situation, optimized the design of the heat pump, and proposed the same plan. Second, taking some provincial underground parks as examples, the actual performance of the park's air source heat pump heating system was tested. According to the test, the temperature difference between the supply and return water is 3-4 °C, and the average COP of the entire heating season is only 2.1. Based on the analysis and analysis, the meaning of the problem in the actual operation of the heat pump is explained, the cause of the problem is the determination of the pressure and the design plan. After installation, energy consumption can be further reduced, and it advises on the progress and use of the ventilation system. By using electric equipment to heat the docks in the port, it is possible to meet the heating needs of the park and reduce energy consumption and air pollution. Good this is a green and low carbon promise.

Key words: *air source, heat pump, heating system*

Introduction

With the rapid development of mankind, energy consumption and environmental pollution have become serious, and clean heating in winter has gradually become the priority of care. In recent years, with the rapid development of low temperature heating, its use for heating in cities in the northern region is expanding. Air heaters use air as a low temperature heat source, drive an electric motor, run on low electricity, extract heat from the outside air, and produce enough hot water to meet heating needs. It has the advantages of saving energy and protecting the environment. In order to verify the actual performance of the air source heat pump during the application process, the relevant researchers conducted a lot of on-site evaluations and measurements. Research shows that the air source heat pump heat pump has problems such as uneven work space and poor work space, and the system is energy efficient and has good electricity. In order to reduce the energy consumption of the air source heat pump system, the heat demand can be met by installing a generator in combination with a temperature controller and a steam controller to achieve energy saving goals. In addition, the parameters such as the working class can be adjusted directly to improve the work performance to reduce the effort. For the air conditioning system, the performance of the system depends on many factors, and the energy consumption is greatly affected by the temperature of the room and the return water. Work and heat process of making the fence model of the logistics park. Finally, calculate the thermal load

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of the logistics station. Play as a temperature control room and logistics station. Second, based on the performance evaluation of the selected heat pump and local air conditioning equipment, determine the heating capacity of the room, and then determine the product use of heat. Then, the flow rate and the head of the pump are determined according to the temperature difference of 6 °C between the supply and return water of the thermal load of the logistics station, with the resistance of pipes, steam and steam. Finally, the combination of the heat pump equipment, the circulating pump, the continuous pump and the control system will produce the hot water pump.

The working principle of the heat pump is shown in fig. 1. A heat pump consists of a compressor, a condenser, an expansion valve, and an evaporator. To create a closed system, they are connected by pipes, and the heat pump acts as a medium that continues to circulate in the system. The low and low medium heat in the evaporator absorbs heat from the air and becomes a low and low gas state, which, when it enters the condenser, is first compressed by the compressor to increase the pressure and temperature. In the condenser, heat is released and converted into high pressure fluid and high pressure fluid. After the pressure is reduced by the throttle valve, it becomes a low voltage, low pressure liquid, enters the evaporator, continues to absorb heat from the air, and continuously circulates, transferring heat from the air to the high pressure side. The heat released by the air source heat pump on the warm side not only consumes electricity, but also absorbs heat from the heat source. A lower voltage results in a higher COP. This is also the reason for high energy consumption and low efficiency of heat pumps.

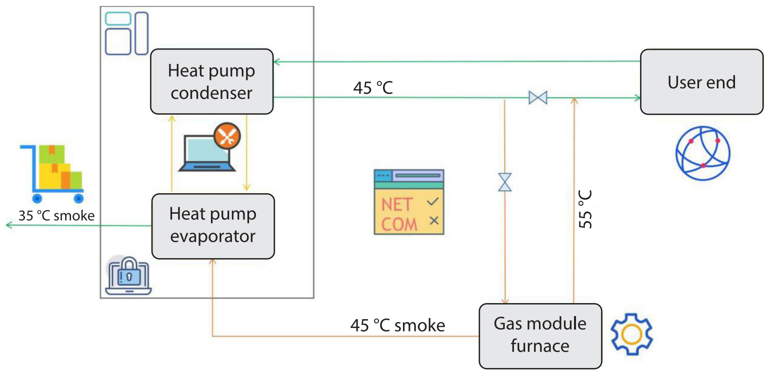

Figure 1. Air source heat pump heating system lay-out

The heat exchanger gathers energy from the air outside the evaporator, compresses it, heats it with the compressor, and then releases the heat in the condenser for heating. The outlet hot water temperature is between 45 °C and 65 °C, which can meet the needs of floor heating and electricity. Although the air conditioners in the house always have a heating function, they are designed for summer. In the winter, when the temperature outside is low, electric heating is turned on, making the operating costs. The heat pump is designed to work in the winter and can absorb heat from the air at low temperatures. The heat produced by the heater includes not only heat from electricity but also heat from the air. In addition, the heat pump is used by the cavity to reduce the grid. Overall analysis shows that air source heat pump is a good energy saving for heating [1, 2].

Literature review

Heat pump heat pump mainly consists of heat pump, water circulation pump, auxiliary water tank, constant pressure device and control system. The main points of the design are the determination of the number of heat pump components, the parameters of the pump movement and the corresponding control strategy. With the rapid development of the country's economy, the construction of land port logistics park also shows rapid improvement. By 2023, the number of dry ports in China will reach 1250, including 32 national dry ports. Socially, the development of the port in the port has also made progress, but in reality there have been some problems, mainly the following: First, to improve the planning and justification of the existing heating system. The second is how to make energy-efficient changes to existing heating to reduce energy consumption and consumption. Third, how to use all existing RES to create green and low carbon development. The fourth is how to optimize the thermal design of air source heat pumps. In recent years, domestic researchers have done a lot of research in the field of heat pumps. Zhang *et al.* [3] in addition the latest heat generators used in rural bungalows, testing and measuring heat pumps, the system is stable, the indoor temperature in the season is about 15 °C, the heat efficiency index is up to 2.75, heat. efficiency. Wu *et al.* [4], in the cold season, tried to heat the two-oxidized carbon heat pump, evaluated the performance of the heat pump in the hot season, and the temperature of the distribution station reached 22 °C. The utilization rate of the heating system can reach 2.25, the energy efficiency is higher than that of gas heaters, and the CO_2 of CO is 22 times lower than that of CO. The author takes the Land Port Logistics Park of an international port district in a certain province as an example, analyzes its winter heating problem based on its specific situation, and conducts optimization design and lay-out research on its air source heat pump heating system. A system lay-out plan for the air source heat pump heating system is proposed. Through the research and exploration of the aforementioned issues, the aim is to find a suitable heating method for the inland port logistics park.

Methods

Taking a provincial land port logistics park as an example, the planned land port logistics park covers an area of approximately 2550 acres, with a total logistics park area of approximately 250000 m^2. The park mainly includes four parts: railway station, international logistics park, bonded logistics center, and comprehensive office building. Among them, the railway station consists of three individual buildings, the international logistics park consists of six individual buildings, the bonded logistics center consists of one individual building, and the comprehensive office building consists of two individual buildings. The maximum heating in this area is 550000 m^2 in winter, and the maximum cooling in summer is about 200000 m^2. The park uses a heat pump for heating and air temperature from 22-25 °C in the winter and 25-27 °C in the summer. Considering the actual temperature in the winter and the ambient temperature in the summer, the ambient temperature is set to 22~27 °C when creating the system, and condensing and evaporative air heat pump used for cooling and heating, respectively.

System operation test analysis

Test content and instruments

Check the flow of main water supply pipes, temperature of supply and return water, energy consumption of units and water pumps (separate measurements), calculate energy efficiency of all heating plants. When testing partial load operation, calculate the heat consumption of circulating water from the non-working unit by closing the water flow and returning hot water to some extent. Check supply and return water temperatures at various heat sink ends. The measurement tools are presented in tab. 1.

Table 1. Test equipment parameters

Test parameters	Test equipment name	Measurement accuracy	Measuring range
Supply and return water temperature	Temperature recorder	±0.4 °C	–55 °C/120 °C
Air temperature and humidity	Temperature and humidity recorder	±0.4 °C	–38 °C/160 °C 0/100% RH
Discharge	Ultrasonic flowmeter	±4% RH	0
Power	Power measurement meter	±1%	0
Power consumption	DCZ power comprehensive tester	±1%	50-760 V 0.6-650 A

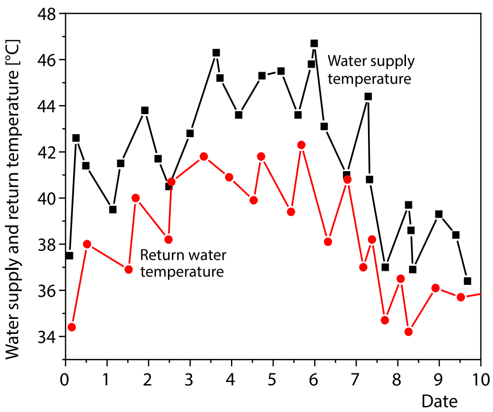

Figure 2. Temperature curve of system supply and return water

Test data analysis

The author continued to test hydronics performance data between November 28, 2020 and March 9, 2020. During the test, the internal temperature was around 20 °C. Figure 2 shows the change in water temperature and return water temperature. In the first stage of heating, due to the outside temperature, the thermal load of the logistics station is low, the water temperature is from 39-42 °C. In the rainy season, the outside air decreases and the thermal load of the logistics station increases. To heat, slightly increase the water temperature to 45 °C. At the end of the heating period, the thermal load of the logistics station decreases according to the temperature, and the hot water is between 38 °C and 40 ° C between each heating, the temperature difference of the product and the heat return water. 3 °C and 4 °C.

According to the test, when the frequency of the water pump is set to 45 Hz, the water volume of the system is 250 m^3 per hour, and the water flow through one unit is about 15 m^3 per hour. The heat capacity of the system is calculated:

$$Qh = \sum_{i=1}^{T} pvc_p (t_{wli} - t_{w2i}) \Delta \tau i / 3600 \tag{1}$$

where Qh [kW] is the heating capacity of the system, P [kgm^{-3}] – the density of water, V [m^3 per hour] – the system circulating flow rate, T_{wli} [°C] – the thermal water transfer heat at $\Delta\tau i$ [second] – the i^{th} test interval, and T – test cycle.

The efficiency of the system is measured by the COP value of the system, which is the ratio of the energy produced to the consumption. The higher the COP value, the better the operational performance. The COP of the system is calculated:

$$COP_i = \frac{Q_{hi}}{N_{ji} + N_{si}} \tag{2}$$

where COP$_i$ is the system coefficient of performance of heating in the i^{th} period.

Figure 3 shows the electrical capacity and energy efficiency of the system. In the figure, it can be seen that the electrical capacity of the system decreases before and after the increase. January has the lowest air temperature and the highest temperature at the logistics station. During the measurement, the daily heating capacity of the engine ranged from 8760-17158 kW, with an average of 12835 kW. The body's daily energy consumption ranges from 3700-12000 kWh, with an average of 6756 kWh. The pattern of electricity consumption is the same as that of heat capacity, and as heat capacity increases, energy consumption increases. Calculations show that the daily average coefficient of physical activity ranges from 1.3-2.8, and the average value of COP is 2.1. The lower the temperature, the lower the COP of the system.

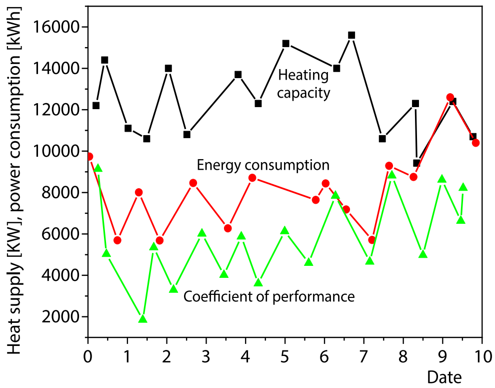

Figure 3. Changes in daily heat capacity, energy consumption, and physical activity coefficient during the experiment

System optimization plan

Small difference in system supply and return water temperature

Most of the heat pump repairs are only maintenance of the heating equipment without final adjustment, especially in old logistics centers that use old electricity. The original boiler is designed to have a water temperature of 95 °C, a return water temperature of 70 °C, and a temperature difference between supply and return water of 25 °C. The temperature of the generator is about 82.6 °C, and the indoor air is 19 °C and 65.5 °C. After repair, the pump water temperature is about 42 °C, the return water is about 36 °C, the air temperature is 37.6 °C, and the indoor air is 19 °C. Only 20 °C temperature difference. Therefore, the heating power of the generator is greatly reduced, and the temperature difference between the equipment and the return water is small, which makes the building worse. The pressure must now act on the water heater, which generates energy. can be used. To reduce the amount of water in the system, there are two things to consider. The water temperature can be increased, but the efficiency of the heating device will decrease when the output power increases. Therefore, it is necessary to find a balance of hot water and reduce the flow of water in the body, and the temperature of the water heater should not exceed 50 °C, and the temperature of the room should be above 50 °C. On the other hand, it is necessary to repair the heating terminal by increasing the generator area or replacing it with a floor generator [5, 6].

Mismatch in temperature difference between the large temperature difference heat dissipation end and the heat pump unit

The temperature difference between the supply and return water on the condenser side of the heat pump is set to 6 °C, and the best performance is achieved when the temperature difference is 6 °C. Those, after removing the last heater, the lower heater or replacing the heater, the temperature difference between the product and the back is finally higher than 6 °C. If the difference between the product and the return is 6 °C, the heat capacity cannot be fully used. If the design is based on the end of the heat exchanger, then the temperature difference between the device and the water cannot return to the condenser by 6 °C, and if the flow rate is too low, then the water meter will be available. After that, you can equalize the pressure of the main unit and decide to add another check valve. The water flow from the end of the system is according to the temperature of the end, and the remaining water enters the room through the return pipe, and the flow is different by 6 °C. Return hot water from rooms and equipment. Those, although the total consumption of the pump does not decrease, the resistance of the connected pipe becomes squared with the flow rate, as can be seen from the characteristic curve $H = SQ$ of the pipe connection. Reducing the flow rate will reduce the pipe resistance and reduce the nozzle head, thereby reducing the nozzle force and achieving the goal of energy saving.

Heat loss during unit operation

The heat pump heating system is designed according to the maximum load, but as the outside temperature changes, the load of the logistics park also changes. During the heating season, the air source heat pump usually works at a load rate of 65-75%. In this case, some settings can be turned off to reduce energy consumption. When the equipment is not working, the water flow of the system will pass through the condenser of the pump, and part of the heat will make the refrigerant in the condenser and evaporate. Evaporated refrigerant is less dense, so it flows upwards and cools and liquefies in the coil layer. It then returns to the condenser again due to gravity. This circulation causes more heat to pass through the outer coil, which causes heat loss. During the test, the temperature of the outlet of the water failure is shown in figs. 4 and 5, and the temperature difference between the inlet water and the outlet. The temperature is between 0.4 °C and 0.5 °C . According to a unit water flow of 16 m^3 per hour, the heat loss per unit is 5.3-6.8 kW.

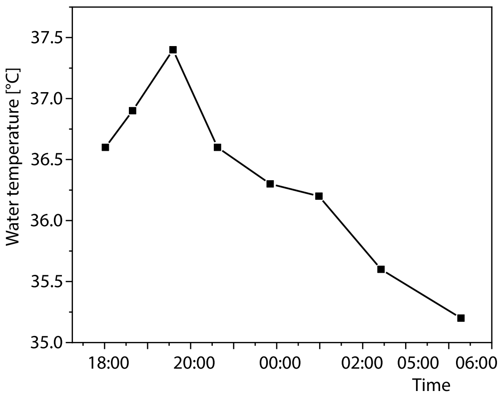

Figure 4. Inlet water temperature

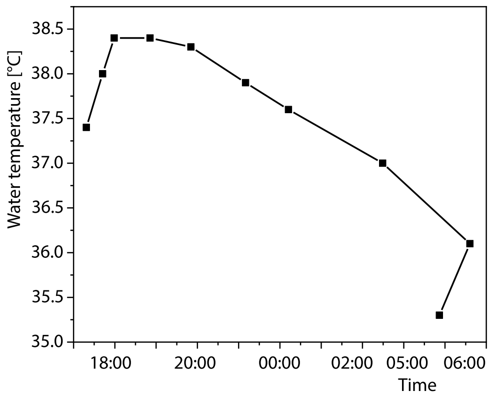

Figure 5. Changes in inlet and outlet water temperature of a single non-working unit during the testing period

Most of the entire heating season, the system is operating under partial load, and the units are not operating at full load. Some units are in a shutdown state, and the units in the system are in parallel. In order to ensure the flow rate of a single unit, the entire system still needs to operate at a high flow rate, resulting in high energy consumption of the water pump. Meanwhile, according to the previous analysis, the circulating water in the system will lose some heat when passing through non-working units. Some scholars propose to close the valves that enter and exit the unit during non-working hours, but when encountering extreme weather, there is a risk of freezing damage due to the condenser being filled with water. In order to solve the previous problems, in the design phase of the system, it can be considered to group and manage the units according to the initial load, mid-term load, and final load of the heating season. In the initial and final stages of heating, the main pipe valves of the units that have not been opened after group control can be closed, and the water in the condenser of the units can be drained [7, 8]. This cannot only reduce the total circulating water volume in the system, reduce the flow rate of the water pump, and thereby reduce the energy consumption of the water pump, but also reduce the heat loss of non-working units.

Discussion

As an important part of the logistics industry, the problem of winter heating of the port in the port has become an important issue during the construction process, and it is important to improve the appearance of the city and develop the economy. development. Using heat pump equipment to heat ports in ports can solve heating problems in winter and reduce energy consumption and performance.

Hydronics can offer various models for the Inland Port Logistics Park, such as air conditioners, air conditioning heat pumps, radiant floor heating systems*, etc.* Heat pump heating uses clean energy and does not require the use of fossil fuels. It is a green and low carbon technology with wide potential for practical applications. Using heat from an air source heat pump cannot only be zero carbon and improve energy efficiency, but also reduce CO_2.

During the operation of the air heater, only a small amount of electricity is required to achieve heat recovery and utilization. For example, heat can be recovered from hot water heaters in winter and cold water from air conditioners in summer. In addition, air heaters can transfer heat energy from the environment to water, thereby achieving the goals of water conservation, energy conservation, and energy conservation. In summary, air source heat pumps can save a lot of energy [9, 10].

Conclusions

The author analyzed the actual performance of air source heat pumps by testing the actual performance of air source heat pumps operating in an Inland Port logistics park. Based on this, problems are identified and improvement plans are developed. The following conclusions are made.

- In the heating season, the heating capacity of the wind turbine starts to increase and then decreases, with an average heating capacity of 12835 kW per day. Different patterns of energy consumption are similar to heating equipment, with an average energy consumption of 6756 kWh per day. The COP of the system first shows a change and then increases, and the lower the temperature, the lower the COP of the system, and the average value is 2.1.
- When the heat pump is running, the temperature difference between the equipment and the return water is only 24 °C. It can increase the temperature of the heater or change the end of the generator. It is necessary to find the balance between body temperature and water temperature, make the difference between the material and the return water, reduce the flow of water, and thus reduce the power of body.
- When the temperature difference between the terminal and the return water bit is large after heating the floor or changing the generator, the heat pump can add a bypass to the equipment and return the water in the main pipe. It will not only provide the thermal conductivity of the terminal, but also the flow and temperature will be different from the meter.
- During partial load operation, water flow rate is not good and heat is generated. The unit can be grouped and controlled during design to prevent unit condensers from freezing and reduce waste-water and heat.
- Different heating systems have different heat-dissipating capacities, which requires reducing heat loss by dividing the system or adding a valve to the floor heating end user.

- Heat pump heating equipment can be used in Lugang Logistics Park, which can solve the heating needs of the park and reduce energy consumption and pollution. It is a promising green and low carbon technology.

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