

Ground Source Heat Pump Technology and Its Application Prospect

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Abstract: With the sustainable development of our country and the rapid economic development, the ground-source heat pump system is a renewable and clean energy system, which conforms to the concept of sustainable development of our country. This paper mainly discusses the working principle, classification, characteristics and advantages of ground-source heat pump technology.

1. Introduction

With the development and application of science and technology and economic globalization, in recent years, more and more energy has been consumed, and environmental problems have also increased, such as global warming, and pollution has further intensified. Therefore, energy conservation and environmental protection are the main concerns of our society at present, and ground-source heat pump technology as a renewable and clean technology has naturally received widespread attention. Therefore, this paper analyzes the working principle, classification, characteristics and advantages of ground-source heat pump technology, and puts forward some reasonable suggestions.

2. Working principle of ground-source heat pump technology

Ground source refers to underground energy, mainly solar energy and a part of geothermal energy, etc. According to different forms of geothermal energy exchange, ground source heat pump system is mainly divided into two types. Namely, water source heat pump system and ground source heat pump system.^[8]

Although there are some differences between the working principles of the water source heat pump system and the ground source heat pump system, in a word, they use the law of conservation of energy to convert energy into heat energy through energy conversion to meet the needs of people's production and life. Next, we will mainly introduce the working principle of ground source heat pump: ground source heat pump converts underground energy into geothermal energy through a series of methods, and then supplies it to residents. It uses the soil outside to absorb a lot of solar energy, and then uses solar energy to convert energy into other forms of energy, such as geothermal energy. Due to the large distance to the ground, it is less affected throughout the year, such as in summer. The outdoor temperature is higher than the indoor temperature but lower than the

underground temperature. It is cool in summer because the soil is used to remove heat. At the same time, the outdoor temperature is very low in winter, and the underground temperature is very high. The indoor temperature is very warm because the soil is used for energy conversion. Therefore, it can provide cooling for rooms and residences in summer and heat for rooms and residences in winter to meet the production and living needs of residents.

The heat pump device is composed of an evaporator, a condenser, a compressor, an expansion valve, and a four-way exchange valve. It uses the exchange function of the four-way exchange valve to complete the mutual conversion between cold and hot working conditions.^[4]

3. Classification and characteristics of ground source heat pump

3.1 Ground-source heat pump

The first is the ground-source heat pump. The ground-source heat pump uses the soil and buried pipes to absorb the energy of the soil to realize energy conversion and heat supply. Its main components are buried pipeline system, namely buried pipe heat exchanger. According to the different ways of pipe burying, it can be divided into vertical pipe burying and horizontal pipe burying. The vertical buried heat exchanger has the following characteristics: large buried depth, relatively stable soil temperature, suitable for use in large buildings, and small floor area; Among the vertical buried pipes, there are two most common types, one is U-shaped pipe type, and the other is sleeve type. Because it has the advantages of simpler construction and less leakage than the latter, and the sleeve-type heat exchange capacity is stronger, but the construction is difficult and easy to leak, and the buried pipe depth is smaller than the former. The horizontal buried pipe heat exchanger is located 2-4m below the ground and is suitable for buildings with small heating area. It covers a large area. When the buried pipe is deep, the problem of ground temperature recovery is considered, and it is usually coupled with solar energy. ^[2] Compared with traditional heat pumps, ground-source heat pumps can save a lot of energy, but ground-source heat pumps also have some disadvantages, that is, they are greatly affected by the soil. If the temperature difference of the soil changes greatly, the performance parameters of ground-source heat pumps will also change greatly, thus affecting the use of ground-source heat pumps. In addition, there will be other factors that will have some bad effects in the actual application process, so we will not give a thorough study here. Another disadvantage is that the floor area of ground-source heat pump is not optimistic, which may lead to uneven temperature and great changes in soil temperature. Of course, other heat pump units also have this problem.

3.2 Underground water source heat pump system

The groundwater source heat pump system is different from the ground-source heat pump system. It uses the energy of water for energy conversion. It is more suitable for building in areas with rich resources such as groundwater. It is divided into indirect groundwater system and direct groundwater system. As the name implies, indirect groundwater system means that water can exchange heat without entering the ground, but in the case of direct groundwater system, water needs to enter the ground to exchange energy. Both of them enter the ground after energy exchange. Compared with the direct groundwater system, the indirect groundwater system has more advantages, which is convenient for maintenance, inspection, and prevention of pipe blockage.

Compared with the traditional heat pump, the underground water source heat pump system has the advantages of less cost, better economy and relatively small floor area. Of course, its disadvantage is that underground water cannot enter the pipeline directly, and can only enter the pipeline after a series of engineering treatment, so that its water quality can reach the standard. Otherwise, it may cause

water pollution and cause certain damage to the environment. It is also worth considering that with the increasing requirements of the country, the standards for water quality are also gradually becoming higher, so the groundwater source heat pump system may be reduced compared with the other two systems in the future.

3.3 Surface water source heat pump system

The surface water source heat pump system is different from the underground water source heat pump system. It uses the elevation difference of the surface water as the energy transmission. It is worth mentioning that the surface water also includes some industrial wastewater and domestic sewage, so it is in line with the current development requirements of our country for the environment, so the future prospects will be very broad. The surface water heat pump system is also divided into two types, one is open type, the open type will be recycled after the surface water is treated, and the other is closed type, the closed type can be used without treatment. Instead, it directly circulates to achieve the effect of heat exchange.

The advantage of surface water source heat pump system is that it is more economical and more efficient, and its occupied area is almost as small as that of underground water source heat pump system. However, there are many disadvantages. For example, long time will corrode the pipeline equipment, so the service life will not be very long. In addition, the temperature difference of water will vary greatly, so it has a certain impact on the heat transfer performance. In the future, we can consider the factors that affect the groundwater source heat pump system.

4. Advantages of ground source heat pump

4.1 Energy conservation and environmental protection

The energy used by the ground source heat pump system comes from the ground, so the use of electric energy will be relatively small, so from this point of view, it conforms to the national concept of carbon peak and carbon neutrality and the principle of sustainable development. It can effectively alleviate the pressure of a part of resources shortage in China. In addition, the use of ground-source heat pump system can also reduce the emission of pollutants. For example, the ground-source heat pump system can use domestic sewage and industrial wastewater for extraction and utilization until it meets the national emission standards, so it is friendly to the environment and helps to protect the environment. Finally, conservation and development are the themes of the world today, and green is the development direction of the world today. Therefore, ground-source heat pump technology can obey the development concept of the world, and is a way to further achieve this goal.

4.2 Reliable operation

At present, the ground-source heat pump system has been used worldwide for more than 50 years, and is still one of the most successful and effective heat pump technologies in the world. It involves a wide range of applications, such as the most widely used in buildings, such as hotels, shopping malls, office buildings, etc.

With the continuous development of ground-source heat pump technology, ground-source heat pumps have been used as building heating and cooling systems in many countries, such as the United States, Germany, Japan and other countries. In developed countries such as Europe and Asia, ground-source heat pump technology has also been widely used.

Ground-source heat pump technology has been applied on a large scale in Beijing, Shanghai, Tianjin, Shenyang and other places in China. In addition, some air conditioning systems in the "coal

to electricity" project in Beijing use ground-source heat pump systems; the ground-source heat pump technology is used in some air conditioning systems of Tianjin "Tian'an Digital City" project.

4.3 Strong comfort

The ground source heat pump is less affected by the environment, because its working environment is basically in a stable state, and the soil temperature change is not obvious, so it can operate reasonably in winter and summer. In summer, it can provide enough cooling capacity, and in winter, it can provide enough heat, so it has a great role in promoting people's life needs. Another point worth mentioning is that it can install a certain sound insulation function on the surface, which can basically not interfere with the user's work.

4.4 Long service life

The stable operation of the ground source heat pump will not cause great harm to the unit, and its service life is many years longer than that of the ordinary central air conditioner, and even can be the same as that of the building. The ordinary air conditioner may have problems after ten or twenty years of operation, but the ground source heat pump system will not. Its stability and reliability are very high, and it can be used safely, and its function is not worse than that of the ordinary central air conditioner.

When applying ground-source heat pump system, in winter, in order to ensure the need of indoor heat load, the system must be reformed. In the process of underground pipe burying, the indoor heat load and cooling load can be solved by laying the water source pipe in the soil within a certain depth. In winter, the air conditioning unit carries out the heating cycle through the refrigeration cycle of the compressor, while in summer, the air conditioning unit carries out the refrigeration cycle through the water compressor. When the outdoor temperature is too high, groundwater can be used as water source to meet the cooling demand. In order to meet the needs of heating in winter and cooling in summer, the ground source heat pump system is treated as a whole system. This can save energy, reduce costs, and improve the efficiency of the system. If the performance of the underground heat exchanger can meet the indoor heat load in winter, but cannot meet the requirements of the indoor cooling load in summer, the cooling tower can only be added to the system. When the difference between the cooling and heating loads in the system is large, the method of buried pipe+cooling tower can be adopted to reduce the cost on the premise of ensuring the system performance. This method does not require the use of boilers, which can make the overall operation of the system more convenient. ^[7]

5. Prospect of ground source heat pump system in China

5.1 Existing problems of ground-source heat pump system at present

Ground source heat pump is a clean energy technology with the advantages of energy saving, environmental protection, high efficiency, and wide application fields. However, as it is a relatively new technology, there are still many problems in its development and application. The first point is that the theory and engineering practice are not well combined in the design of ground-source heat pump. Due to the complexity of the environment, the adopted parameters such as soil layer characteristics and heat capacity are lack of accuracy, which makes it difficult to balance the designed system with the actual demand; In addition, there are many differences between the theoretical design and the actual factors that should be considered. Secondly, the use of underground water source heat pump requires high floor area and initial investment; In addition, in the process of application, there

will also be an imbalance of underground heat balance. Take the northern region as an example, because of the different seasons, the difference between cold and hot loads is relatively large. The third problem is that at present, there is no standard management system for the use of underground water source heat pump system in China. After the system is installed, special staff are needed to operate, maintain and maintain it. If there is no standard management, it will have a great impact on the operation of the system, so that it can play a better role. ^[2]

5.2 Development and prospect of ground source heat pump in China

With the development of economy, some non-renewable energy is used less and less, so renewable green energy such as ground-source heat pump is in a higher position. As a clean energy, ground-source heat pump system has been adopted in many places. In order to meet the requirements of national energy conservation and emission reduction, ground-source heat pump system is used in many places. With the promotion of national policies, the application of ground-source heat pump will be more and more extensive, while applying ground-source heat pump, I hope you will make it more and more perfect and reasonable, instead of just using existing technology to maintain, we should make more efforts to develop technology.

6. Conclusion

To sum up, the ground-source heat pump technology is being fully promoted because of its economy, environmental protection, stability and energy conservation. The concept of new energy has also brought more space for development and promotion. Its working principle also has a high technical level of support, as well as strong scientific basic knowledge. Reasonable use of ground-source heat pump technology can make the environment more friendly, energy consumption slower, and pollution less, with higher economic efficiency, it is slowly moving towards sustainable development. However, at present, the ground-source heat pump technology is still not perfect. We need to work together to make the ground-source heat pump technology more in line with the requirements of contemporary development. It is indeed difficult to use the ground-source heat pump technology in many regions. We should carefully consider its limitations and make its application more extensive. We should combine theory with practice, so as to promote its development. At the same time, I hope that the government will also work hard to promote the development of China's science and technology.

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