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An Analysis of Integrated energy central heating system based on geothermal energy

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ABSTRACT

Under the background of the dual carbon goal of carbon peak and carbon neutrality, the application of geothermal energy-based integrated energy system in central heating is explored. Through the application research of "geothermal +" integrated energy system central heating of an energy station in Zhengzhou City, Henan Province, geothermal energy adopts medium and deep geothermal buried pipes and shallow buried pipes for cross-seasonal energy storage, and combines air source heat pumps to propose multi-energy complementary comprehensive energy systems such as medium and deep geothermal energy, air source heat pumps and shallow buried pipe cross-seasonal energy storage, which effectively improves energy utilization efficiency and system stability and realizes sustainable energy development.

1 INTRODUCTION

At present, China's building energy consumption has ranked among the three main energy consumption, accounting for about 21% of the total energy consumption in the country, effectively using renewable energy to replace non-renewable energy, solving the problem of building energy consumption, is an important way to cope with the energy crisis, achieve energy conservation and emission reduction.Geothermal energy is a kind of renewable energy with abundant reserves, wide distribution, green and low-carbon, and the development and utilization of geothermal energy has the characteristics of continuous stability, recyclability and renewable, which can effectively reduce greenhouse gas emissions, achieve sustainable development, and help the strategic needs of carbon peak and carbon neutrality.

Building heating is one of the main applications of geothermal energy. As of 2016, China's hydrothermal geothermal heating area is 88.75 million m2, and the use of shallow geothermal energy heating and cooling area is 430 million m2.According to the form of geothermal heating system, the main ways of geothermal heating include geothermal indirect heat supply, geothermal + heat pump unit, geothermal + heat pump unit + supplementary heat source.At present, the most suitable way for the sustainable development and utilization of geothermal energy is the third way, which can effectively avoid the limitations of geothermal energy development and utilization compared with the first two methods, and put forward the technical scheme optimization direction for the geothermal energy integrated energy system.

2 FORMS OF ENERGY USE

2.1 Medium and deep geothermal downhole heat exchange system

Medium and deep geothermal downhole heat exchange technology, also known as coaxial casing heat exchange, is a single well internal fluid circulation through coaxial casing in deep wells, based on heat conduction and formation heat exchange, so as to develop geothermal energy in the form of "heat without water", the structure diagram of the middle and deep downhole heat exchanger is shown in Figure 1-1.

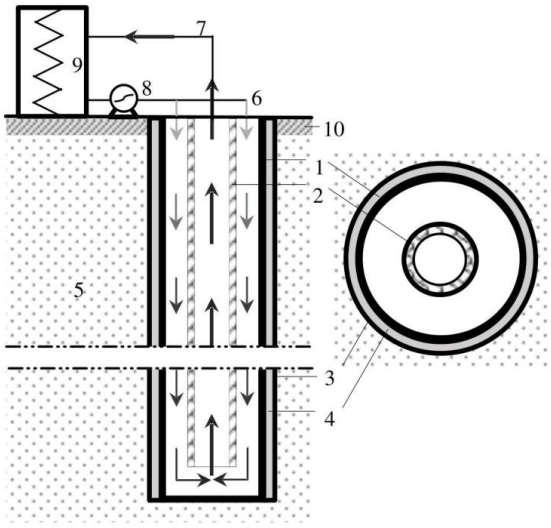

Fig 1-1 Schematic of t deep downholel heat exchanger

Medium and deep geothermal downhole heat exchange technology through the drilling rig to the deep high temperature formation drilling, with the middle and deep (depth 1000~3000m) rock and soil as the heat source, in the borehole placed closed casing heat exchanger, the heat exchange medium through the annular gap between the outer pipe and the inner pipe flows through the underground high temperature formation heat absorption, and then from the coaxial inner pipe back up, the underground heat energy is exported, and then through the heat pump unit for the user to use. The downhole heat exchanger of this technology adopts a closed heat exchanger, which does not extract groundwater, which has little impact on the underground environment and can ensure the long-term stable operation of the system.

2.2 Air source heat pump technology

Air source heat pump is also called air-cooled heat pump, its working principle is the reverse Carnot cycle, it only needs a small part of electric energy, to drive the compressor to the temperature of the air is not high to squeeze friction, to heat up, these deteriorated air condensation and then evaporation heat dissipation, cycle back, so that the heat energy in the air is extracted and directly used.

Air source heat pump has the advantages of renewability, low cost, safety and efficiency, convenient operation and practicality. By converting the energy in the air into the main power, driving the compressor to run through a small amount of electric energy, realizing the transfer of energy, without cumbersome components, recharge or soil heat exchange systems and special rooms, it can effectively reduce the emission of pollutants in the air, which is in sharp contrast with the traditional heating method, and realizes the dual purpose of heating and energy conservation and environmental protection.

2.3 Cross-seasonal energy storage

Cross-seasonal energy storage technology is an effective way to improve the comprehensive utilization efficiency of energy, the so-called cross-seasonal energy storage, refers to long-term energy storage, large storage volume, full thermal cycle long energy storage mode. According to the energy storage mode, it can be divided into: chemical energy storage, phase change energy storage, sensible heat energy storage. The schematic diagram of cross-seasonal energy storage technology is shown in Figure 1-2.

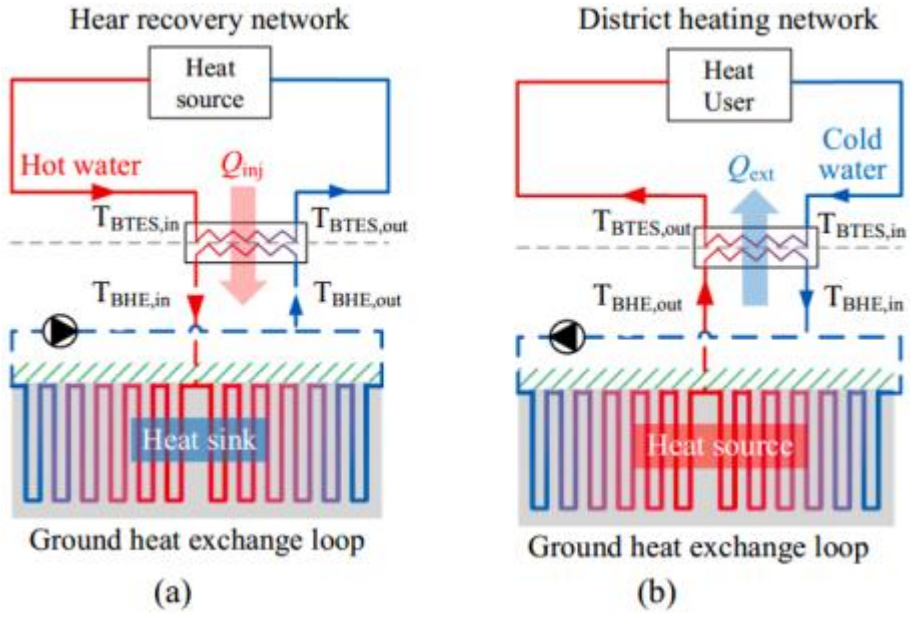

Fig.1-2 Typical working process of the BTES system with (a) heat injection and (b) heat extraction.

Shallow buried pipe cross-season energy storage technology is the use of underground soil to store heat, by driving into the shaft below 100m above the ground, set up a U-shaped pipe buried pipe heat storage device, in the non-heating season heat storage process, the medium and deep geothermal heat and other high-grade heat sources stored in the soil and rock, to the winter heating, and then the heat in the soil and rock next to the shaft is exchanged, so as to achieve the system cross-season heat storage. Through cross-seasonal energy storage, the abundant heat energy in the non-heating season can be effectively stored and used for winter building heating, thereby significantly improving the year-round energy efficiency of the heating system.

2.4 Intelligent technology for optical storage and charging

Solar storage and charging intelligent technology is to convert solar energy into electrical energy and store it in the energy storage system through the photovoltaic system, and then charge the electrical equipment and electric vehicles in the building, which is also a high-tech green charging mode supported by new energy, energy storage and intelligent charging. Photovoltaic storage and charging integrates photovoltaic power generation, large-capacity energy storage batteries, intelligent charging piles and other technologies, which can not only supply green electric energy for electric vehicles and electrical equipment, but also realize auxiliary service functions such as power peak shaving and valley filling, realize "low-carbon" or even "zero-carbon" operations, and effectively improve system operation efficiency.

3 INTEGRATED ENERGY SYSTEM APPLICATIONS

The integrated energy system can improve the comprehensive energy utilization efficiency and energy machine supply reliability, essentially by optimizing and integrating these resources with the help of the complementarity and coupling between different energy forms, so as to effectively realize the effective cascade utilization relationship between these different types and forms of energy

Taking an energy station in Zhengzhou as the research object, a multi-energy complementary integrated energy system such as medium and deep geothermal energy, air-source heat pump and cross-seasonal heat storage is adopted. The project is located in Zhengzhou City, Henan Province, providing heat sources for 8 residential communities with a construction area of 1,122,500 square meters, and the whole system is designed with 10 medium and deep buried tube wells, a depth of about 2,500 meters, 259 shallow buried pipes, and 29 high-efficiency air source heat pumps.

Medium and deep geothermal downhole heat exchange is formed in the thermal reservoir by artificial drilling to form a loop that allows the heat exchange medium to circulate between the ground and the downhole, and the heat exchange medium returns to the surface after absorbing the heat of the underground thermal reservoir, and then returns to the underground heat absorption after releasing the heat, reciprocating circulation.

Cross-season energy storage technology uses underground soil to store heat, by setting up a U-shaped buried pipe heat storage device in a shaft below 100m into the ground, in the process of heat storage in the non-heating season, the middle and deep geothermal and other high-grade heat sources are stored in the soil and rock, and when heating in winter, the heat in the soil and rock next to the shaft is exchanged, so as to realize the system cross-season heat storage, improve the utilization rate of medium and deep geothermal heat and other heat sources.

High-efficiency heat pump technology is essentially to obtain heat in the environment as the heat source of high-efficiency heat pump units, heat a network of circulating water after heating up after the high-efficiency heat pump unit, and then transport a network of circulating water to the heat user side of the secondary heat exchange station through the circulating pump, and return to the high-efficiency heat pump unit to continue to be heated after heat dissipation, so uninterrupted circulation. The whole system is closed operation, effectively ensuring the stability of the system, this system is clean, energy-saving and flexible in layout.

At the same time, the energy port is equipped with solar storage and charging intelligent technology to convert solar energy into electricity, which is used in the heating season for the clean thermal cloud intelligent control system and office electricity of the zero-carbon smart service center, the electric energy stored in the non-heating season is used to drive the operation of cross-seasonal energy storage system equipment, and the excess electric energy is used for electric vehicle charging piles in the energy port, so as to realize the low-carbon, clean and efficient power equipment in the energy port.

4 CONCLUSION

According to regional resource conditions, this paper studies the use of medium and deep geothermal energy, air source heat pump and cross-seasonal heat storage and other energy multi-energy complementary integrated energy systems for central heating, so as to realize the development of energy form from single and independent application to multi-energy complementary and comprehensive application, give full play to the advantages of distributed renewable energy and heat storage, realize the nearby consumption of new energy, and alleviate the problem of imbalance of regional resource distribution and load center.

In addition, there is still a large space for the development of integrated energy system for central heating, with the diversified development trend of energy demand, it is necessary to study multi-energy complementary integrated energy system in combination with regional resource conditions, give full play to the synergistic and complementary advantages of each energy source in each integrated energy system, and realize the efficient application of energy.

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