Development and Utilization of Geothermal Resources in China: Current Situation and Prospect

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Abstract

Geothermal energy is a kind of renewable energy that has been widely concerned. The development and utilization of geothermal energy resources can effectively alleviate the current dependence on fossil energy. This paper introduces the development and use of geothermal energy in China, analyzes the existing problems, and discusses the prospect of China's geothermal energy industry.

Keywords

Geothermal resources; Renewable energy; Current situation; Prospect.

1. Introduction

Geothermal energy is the useful component of the thermal energy in rocks and geothermal fluids that can be scientifically and rationally developed in the crust under current technical, economic and geological conditions. As a kind of stable and clean renewable energy, it has attracted extensive attention in the case of the increasing shortage of fossil energy.

2. Classification of geothermal energy

China's geothermal energy resources can be divided into three categories according to temperature, geological structure, and development and utilization mode [1].

2.1 Hydrothermal geothermal resources

Hydrothermal geothermal resources are generally buried at a depth of 200-3000m in the form of hot water and steam. The temperature of high-temperature geothermal resources is usually higher than 150℃, mainly used for high-temperature dry steam power generation and industrial utilization. The temperature of medium-low temperature geothermal resources is generally 40-150 ℃, which is usually directly used for heating, bathing, planting, and breeding, etc. Meanwhile, the technology of medium-low temperature power generation has also been developed in recent years.

2.2 Shallow geothermal resources

Shallow geothermal energy refers to a kind of low-temperature thermal energy stored in soil rocks and groundwater within about 200 m of the shallow surface of the earth, which is generated by gradient warming of the earth and solar radiation. It is a kind of high-quality clean energy with the advantages of vast reserves, wide distribution and shallow burial. Water source heat pump system and ground pipe heat pump system are often used to utilize shallow geothermal resources.

2.3 Dry and hot rock resources

The dry hot rock geothermal resource refers to the exploitable geothermal energy existing in the underground rock mass above 150°C. The geothermal resources of dry hot rocks have great potential for exploitation but are difficult to be exploited because of their deep burial. Dry hot rock geothermal resources can only be exploited through enhanced geothermal system technology, that is, artificial reservoirs formed by artificial fracturing. Therefore, although the dry hot rock geothermal power generation technology has been developed since the 1970s, it is still difficult to realize large-scale commercial operation with good economic benefits.

3. Development and utilization of geothermal resources in China

3.1 Development process of Geothermal energy in China

China is rich in geothermal resources. The amount of hydrothermal geothermal resources alone is equivalent to 1,250 billion tons of standard coal, according to the statistical report of the Ministry of Land and Resources in 2015. The utilization of geothermal resources in China is dominated by direct use, which ranks first in the world for many consecutive years. However, the proportion of geothermal resources in China's energy utilization is still very small [2].

China's geothermal resources are mainly distributed in the Circum-Pacific and Yunnan-Tibet regions, among which the circum-Pacific terrestrial tropics include Taiwan, Fujian, Guangdong and the Liaodong Peninsula. In the early 1970s, the first wave of geothermal energy utilization in China was launched, and a number of geothermal demonstration plants were built in Jiangxi, Guangdong, and other places. In 1977, construction began on a medium-high temperature geothermal power plant in Yangbajing, Xizang province, which meant that medium-high temperature geothermal energy began to be developed in China [3]. Over the next two decades, however, geothermal power in China stagnated, only picking up slightly in recent years. Geothermal power generation increased by 2MW in Yangbajing in Xizang in 2009, by 400kW in Huabei oilfield in 2010, by 400kW and 500kW in Yangyi in Xizang in 2011, and by 160kW in Gonghe in Qinghai in 2014. By the end of 2016, China's accumulated installed capacity of geothermal power generation was 27 MW, but it was still only the 18th in the world, far behind developed countries.

Hot spring resorts have long been one of the main ways of using geothermal energy in China. Fortunately, by the end of 2014, geothermal heating accounted for 19 percent of China's geothermal utilization, surpassing the hot spring resorts for the first time, which accounted for 18 percent. This means that the resource property of geothermal energy can be demonstrated. Since the 1990s, in Beijing, Tianjin, Baoding, and other cities, middle-low temperature geothermal heating began to spread. By 2015, China's geothermal heating area reached 102 million square meters, of which Tianjin's geothermal heating area reached 25 million square meters, accounting for 6% of the city's central heating area, making it the largest city in China in terms of geothermal heating.

The development and utilization of shallow geothermal energy in China has also grown rapidly in recent years. By 2016, the floor space of shallow geothermal energy utilization in China had reached 478 million square meters, among which the Beijing-Tianjin-Hebei region is the largest [4].

3.2 The utilization of geothermal energy resources in China

At present, the use of geothermal resources in China mainly includes geothermal power generation, geothermal heating, industrial and agricultural production, tourism and health care, etc.

3.2.1 Geothermal power generation

Most of China's geothermal resources are medium-low temperature geothermal resources, and the geological conditions are very complex, so the price of power generation is relatively high. However, the cost of geothermal power generation is still lower in most cases than thermal power, hydropower, and nuclear power. As geothermal power generation is not affected by climate and seasonal changes, the generation capacity is stable. Traditional geothermal power plants include dry steam power plants, flash evaporator power plants, dual working medium power plants, and flash - dual working medium combined power plants [5]. At present, the most widely used technologies in China are flash vaporization technology and dual-working medium power generation technology, which is suitable for the condition that China's geothermal resources are mainly medium-low temperature geothermal resources.

3.2.2 Geothermal heating

Geothermal heating has a high initial investment, but it is energy efficient, pollution-free, and provides hot water throughout the day. Hydrothermal geothermal heating and ground source heat pump heating are two main geothermal heating systems in China. Hydrothermal geothermal heating is to extract underground high-temperature water with a well and transfer the heat of hot water to

circulating water in the heating network in the heat exchange station, and then send to the user. At present, Tianjin is the city with the most widely used hydrothermal geothermal heating system. Ground source heat pump heating is a heating system that uses the solar energy stored in the soil as a cold source for energy transformation. In this system, the conversion from low-grade heat energy to high-grade heat energy can be realized by inputting a small amount of high-grade energy. At present, the application of ground source heat pump system in Jiangsu province is relatively successful.

3.2.3 Industrial and agricultural production and geothermal energy

Geothermal energy is also widely used in industrial and agricultural production, such as geothermal greenhouse, geothermal aquaculture, geothermal printing and dyeing, geothermal paper making, etc. Using geothermal energy in agricultural and industrial production can save coal and electricity consumption, reduce costs, improve the quality of industrial products, and increase the output of fruits and vegetables [7].

3.2.4 Geothermal energy bath and recuperation

In China, hot spring bathing has long been a way for people to use geothermal energy to relax. Meanwhile, the role of geothermal energy in recuperation is increasingly recognized. Hot mineral water from underground often contains a variety of trace elements, which can play a role in alleviating skin diseases, joint diseases, neurasthenia, and other aspects.

3.3 Problems in the utilization and development of geothermal energy in China

China has great potential for geothermal energy development, and some achievements have been made in its utilization in recent years. However, in general, as China's geothermal energy development and utilization are still in the exploratory stage, there are still many difficulties and problems.

3.3.1 Obsolete technology

It is necessary to further study the selection of pipe materials, heat transfer enhancement and pipe spacing arrangement for the technology of using shallow geothermal resources, otherwise, the expected energy saving effect cannot be achieved. In the development and utilization of hydrothermal geothermal resources, the problems of water level decline and surface collapse caused by immature groundwater recharge technology have not been thoroughly studied. As for geothermal power generation, China has not made critical progress in the research of medium-low temperature geothermal power generation system in line with its practical conditions and has not made technological breakthroughs in the field of dry hot rock geothermal power generation, which has attracted wide attention in the world recently. In general, The development and utilization of geothermal energy in China lags behind that in developed countries.

3.3.2 Lack of talents

There is a huge talent gap for the development of the geothermal energy industry in China. There are only a limited number of research institutions and experts engaged in geothermal energy research. Many practitioners have previously studied other fields, and there is no complete training system in universities, which poses a great challenge to the healthy development of the geothermal energy industry [9].

3.3.3 Insufficient support and imperfect management system

The development and utilization of geothermal energy resources need strong support from national policies. Although China has issued documents to encourage the development of geothermal energy, it still lacks specific implementation rules, so its role is limited. Meanwhile, the industry standards and engineering specifications of geothermal energy development are not perfect, which cannot guide the rational and orderly development of geothermal energy. Also, the department in charge of management is not clear, and the management is chaotic, which is also a big problem restricting the development of geothermal energy.

4. Prospect

In order to develop geothermal energy resources, the exploration of geothermal resources should be done well. Clarifying the potential of geothermal resources in various regions is conducive to the scientific utilization of geothermal energy and provides a reliable basis for the planning and management of geothermal energy development. At the same time, geothermal energy exploration can also enable investors to discover the huge potential of geothermal energy development and utilization, increase investment and input more workforce and material resources, so as to break through the technological bottleneck, conduct deeper research and narrow the technological gap between developed countries. The development of geothermal energy should not be isolated. Complementing the advantages of other clean energy to realize the integrated development of various clean energy and the common development of other industries such as real estate are the future development trends.

5. Conclusion

Geothermal energy is a kind of renewable energy with great potential, which has been widely concerned in China. Although the development and utilization level of geothermal energy in China still lags behind the international leading level due to restrictions of policies, technologies, and funds, with renewable energy playing a more and more important role in China's energy structure, the development prospect of geothermal energy in China is very broad.

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