Influence of Geothermal Resources Development on Environment and Countermeasures

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Abstract： Energy shortage and environmental pollution are two major problems that perplex the development of world economy. High-speed economic development, energy consumption increases, at the same time, the degree of environmental damage also increased. In order to ensure sustainable development, in recent years, countries not only pursue higher economic efficiency in economic development, but also pay more and more attention to the impact of production itself on the environment, adjust and formulate the corresponding environmental protection measures. Geothermal energy as an alternative energy has environmental and economic advantages, and its emission level of pollutants is much less than conventional energy. The world's current geothermal use is equivalent to 150 MT/A of oil. After more than 20 years'practice, great progress has been made in the exploration, development and utilization of geothermal resources in China. Due to the extraction of a large number of steam and fluids from the geothermal reservoir, these thermal fluids and vapors contain a large number of chemical and chemical substances, which have a certain impact on the environment, take appropriate measures to protect the environment. Geothermal and environmental protection workers in various countries have monitored and evaluated the environmental impact of geothermal development and utilization, and put forward various preventive and protective measures.

1 The concept and function of geothermal development

Geothermal energy is geothermal energy, divided into shallow geothermal energy and deep geothermal energy, we convenient distinction, we can simply call them: Geothermal Energy and geothermal energy. From the name you can see the difference between geothermal energy and geothermal energy, that is the difference in temperature: "Temperature"and "Heat".

Using geothermal energy directly for heating, heat supply and hot water supply is a geothermal utilization method next to geothermal power generation. Because this kind of utilization way is simple, the economy is good, is taken seriously by all countries, especially is located in the high and cold area Western country, Iceland develops the utilization best.Geothermal energy is widely used in agriculture.[1]

2 Environmental Impact of geothermal development

Compared with traditional fossil energy resources, shallow geothermal energy resources have the characteristics of stable resources, huge reserves, rapid regeneration, energy saving and environmental protection, dual use of winter and summer, and convenient development, etc. , and has achieved remarkable economic, social and environmental benefits. The development of shallow geothermal energy is to use heat pump technology to draw heat or cold energy from the underground environment, and then inject the cold energy or heat energy back into the underground environment, so as to realize the energy exchange between the building and the underground

[1] Laloui L, Nuth M, Vulliet L. Experimental and numerical investigations of the behaviour of a heat exchanger pile[J]. International Journal for Numerical & Analytical Methods in Geomechanics, 2006, 30(8):763-781.

environment, the purpose of heating in winter and cooling in summer is achieved.[2]However, the energy transfer will inevitably have an impact on the geological environment, which in turn will have an impact on the energy efficiency and application effect of heat pump system. Therefore, it is necessary to construct the ground source heat pump monitoring system to monitor and study the influence of geological environment.

Influence of exploitation and utilization of shallow geothermal energy on geological environment. The influence of exploitation and utilization of shallow geothermal energy on geological environment and its problems are as follows: the accumulation of heat and cold load of rock and soil environment makes the temperature field of underground environment change in a single trend; The change of microbial population and quantity caused by the change of soil temperature, the cross pollution between aquifers caused by the construction of buried pipe, or the groundwater quality pollution caused by the infiltration of surface pollutants; The groundwater can not be recharged completely, which leads to the decrease of groundwater level and the geological disaster of ground subsidence in loose layer. There are two kinds of heat transfer modes in the development and utilization of shallow geothermal energy in Shandong area, the former is about 8.5% of the total quantity of heat pump project, the latter is relatively less, about 1.5%. This paper analyzes and discusses the influence of the operation of the heat pump project on the geological environment.[3]

2.1 Influence on geological environment temperature

During the operation of the buried pipe heat pump system, the heat or cold energy is continuously released to the surrounding rock, soil and ground water, thus changing the temperature of the geological environment in and around the buried pipe area, the magnitude of the change is affected by many factors. The ground-source heat pump project needs a large cooling and heating load, and the heat transfer capacity of the buried pipe is large, the continuous operation of heat pump units, single refrigeration or single heating, small spacing of buried pipes and poor seepage conditions of ground water. The underground environment under such conditions is not conducive to the dissipation of heat and cold loads, and the greater the variation of the temperature of the geological environment, the other way around is smaller.

For example, the air conditioning system of office building and exhibition hall is intermittent Operation Mode. During the period of shutdown of heat pump unit, the heat and cold loads in rock and soil mass are released gradually to the surrounding underground environment, which is beneficial to the recovery of ground temperature However, in the continuous operation mode of hotels, hotels and some residential buildings, the heat pump units operate for 24 hours in a heating or cooling season, the heat exchangers continuously input cold or heat to the underground environment, and the cold and heat loads can not be dissipated in time, the temperature decreased and increased in a single trend. The influence of a single buried pipe heat exchanger on the underground environment temperature is that the heat exchanger is centered and near the center, the underground environment temperature varies greatly, and the change range of underground environment temperature decreases along the radial direction away from the heat exchanger until it is not affected. If the spacing is too small, the heat effects of the adjacent heat exchangers superimpose each other, and the range of temperature changes increases. Therefore, in the design of buried pipe engineering, the distance between buried pipes should be as large as possible, the mutual interference between heat exchangers in the pipe group should be minimized or avoided, and the temperature influence should be controlled within an acceptable range of temperature variation. Groundwater seepage flow is

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[2] Saggu R， Chakraborty T. Thermal analysis of energy piles in sand[J].Geomechanics and Geoengineering, 2015, 10(1): 10-29.

[3] Saggu R, Chakraborty T. Cyclic Thermo-Mechanical Analysis of Energy Pilesin Sand[J]. Geotechnical and Geological Engineering, 2015, 33(2):321-342.

beneficial to weaken or eliminate the cumulative effect of heat and cold load caused by heat transfer of buried pipe. The heat and cold load is transferred downstream by groundwater and dissipates gradually. The faster the seepage flow, the faster the heat and cold load dissipates, the temperature change of underground environment is relatively small.[4]

2.2 The influence of groundwater quality

On the heat pump project requires a large amount of water, the same site sometimes requires the construction of a number of wells, wells in different locations, groundwater quality is not the same. Even if the same well exists, there are some differences between different aquifers. If the water intake section penetrates multiple aquifers, the groundwater will be mixed; if the shallow aquifers are polluted and the deep aquifers are of good quality, the cross-layer pollution will occur. The mixing of water quality in different layers of the same well, the mixing of water quality in different wells or the mutual conversion of production and irrigation function in well groups can change the quality of groundwater to some extent, while the recharge in the same layer has little influence on the quality of groundwater. If the sealing of the recirculation system is poor, the quality of the groundwater will be changed by oxidation. In addition, the metal outlet pipe or recirculation pipe may be corroded by bacteria, galvanic couple crevice and oxygen concentration difference. Accidental rupture of the well tube may also cause surface sewage or contaminants to seep directly into the Aquifer through the rupture site and contaminate the groundwater.

2.3 Influence on microorganisms

Recharge of water source heat pump project changes the temperature of groundwater and aquifer particles, which may affect the living environment of microorganisms sensitive to temperature change, and thus affect their population and quantity.

3 Countermeasures to reduce the influence of geothermal development on environment

In order to develop, utilize and protect the geothermal water resources reasonably and ensure its sustainable utilization, the following protective measures can be taken:

3.1 To investigate, evaluate and manage the geothermal water resources

The state should formulate relevant laws and regulations, strictly manage geothermal resources as mineral resources, scientifically plan and rationally exploit them, so as to realize the sustainable utilization of geothermal resources and ensure that mining activities do not bring negative environmental impacts.

3.2 Groundwater Dynamic Monitoring Network System

To strengthen the dynamic monitoring of underground hot water and land subsidence, and to establish a perfect dynamic monitoring network system of underground hot water.

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[4] Pasten c, Satamarna J c. Themall Iduced Long-Tem Dipacement ofThermoactivePiles[J. Jounal of Geotechnical and Geoenvironmental
Eninering, 2014, 140(5):06014003.

Flow rate, water level, water temperature and water quality of geothermal wells. Monitoring every ten days to times, and the monitoring data in the past comparative analysis, timely understanding of the region geothermal resources dynamic situation.

3.3 Adopting artificial recharge technology.

This technique is now considered to be an economical and effective treatment method widely used in various countries. The recharge of geothermal tail water can not only artificially accelerate the rate of recharge of geothermal water or increase the amount of recharge water, but also keep the pressure of the thermal fluid stable, the water quantity of geothermal well stable, and eliminate the influence of geothermal tail water on the environment, the utility model can prolong the development and utilization life of geothermal resources and realize sustainable utilization.

3.4 Other solutions

There are many methods to control and solve the thermal pollution.[5] The best way is to use the cascade heat resources as many times as possible to improve the utilization rate of geothermal water, and at the same time to reduce the temperature of the discharge tail water. For example, Beijing Beiyuan Jiayuan district 6 has adopted the geothermal cascade utilization technology, which is the multi-stage utilization of high-temperature geothermal water.[6]The secondary temperature measurement of geothermal water after plate heat exchange can meet the supply and demand when heating directly, do not meet the needs of water-source heat pump after upgrading heating. The method of recirculation can also be adopted, but it is necessary to treat the tail water so as to meet the quality requirements of recirculation water and not to cause secondary pollution.

3.5 Make relevant regulations

In this regard, countries are attaching increasing importance to the establishment of regulations to regulate geothermal development activities, and the submission of impact assessment reports for new geothermal projects to establish monitoring plans to observe all possible environmental effects during geothermal development. The United States strictly prohibits the discharge of geothermal water into the surface environment. Geothermal companies will not be allowed to build or operate geothermal power plants without strict environmental protection measures. Every phase of geothermal development in the Philippines -- including geological survey, geological exploration (road construction, housing construction, tree felling, etc.), production well drilling and resource development -- requires an environmental permit issued by the relevant authority to operate. Other countries such as Japan, New Zealand, Germany, Iceland, and Italy and so on have a series of regulations to restrict and reduce the impact of geothermal development on the environment. Article twenty-four of Chapter V of the Regulation on the management of geothermal resources, development and utilization in China stipulates that the planning of geothermal resources development and utilization must include the assessment and prediction of the environmental impact after development and utilization and the proposal of prevention, treatment and solution measures,

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[5] Gao J, Zhang X, Liu J, et al. Numerical and experimental assessment of thermal performance of vertical energy piles: an application[J]. Applied Energy, 2008,85(10): 901-910.

[6] Li X, Chen Y, Chen Z, et al. Thermal performances of different types of underground heat exchangers[J]. Energy and Buildings, 2006, 38(5): 543-547.

otherwise the competent department of the plan shall not approve the plan. The evaluation of geothermal fluid quality and environmental quality is also clearly stipulated in the geothermal resource exploration code in China, but it is weak relative to the resource exploration in the whole process of geothermal fluid development. It is urgent to perfect and standardize the environmental impact assessment of geothermal development under the requirement of gradually strengthening environmental awareness and ensuring sustainable development.

4 Summary

The time for large-scale development and utilization of shallow geothermal energy is relatively short, only more than 10 years. Construction units often attach importance to engineering construction and ignore the impact of energy development on geological environment. Most projects do not build corresponding monitoring systems, even for projects with monitoring systems, the number of monitoring projects is small and most lack effective management, making monitoring a mere formality. How much and to what extent does the current heat pump project, which has been operating for 5,10 or more years, affect the geological environment, there is no hard data to back it up. Therefore, the construction of a comprehensive ground-source heat pump monitoring system or even regional dynamic monitoring network, monitoring data for scientific analysis, timely detection of problems and take effective measures to prevent and remedy, to ensure that the heat pump project economic, efficient, energy-saving and durable operation.

Geothermal development may cause a series of major environmental problems, such as land subsidence, heat pollution, air pollution, water pollution and soil pollution. Therefore, great attention must be paid to geothermal development and utilization, and effective protective measures must be taken, geothermal energy can become a real “Clean energy”, so as to achieve the sustainable development of geothermal energy development and utilization, to give full play to the social, environmental and economic benefits of geothermal energy.

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[1] Saggu R， Chakraborty T. Thermal analysis of energy piles in sand [J]. Geomechanics and Geoengineering, 2015, 10(1): 10-29.

[2] Saggu R, Chakraborty T. Cyclic Thermo-Mechanical Analysis of Energy Pilesin Sand [J]. Geotechnical and Geological Engineering, 2015, 33(2):321-342.

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