Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2013, 5(11):275-277

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

The impacts of ground water heat pump on ground water

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ABSTRACT

The problem of energy saving and environment protection has become more and more crucial in China. Ground source heat pumps are becoming more common as the costs of energy and equipment maintenance rise. As one type of ground source heat pump, ground water source heat pump (GWSHP) is more and more in China, especially in North China Plain. Although there are some advantages of GWSHP, the problems of the groundwater waste, groundwater level recession and land collapse have arisen during these years. The problems are indicated and the solutions are discussed in the paper. The reasonable use of GWSHP should be taken seriously and should eventually be resolved in the future.

Keywords: Ground water, groundwater source heat pump, impacts, solution

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INTRODUCTION

Groundwater source heat pump is one type of ground heat pump. It emerged in the early 20th century, which is widely utilized around the world.

Ground source heat pump is considered as the most energy-efficient, environmentally clean, and cost-effective space conditioning systems available. Because of the costs of energy and equipment maintenance rise, the branch of ground source heat pump GWSHP uses natural energy to produce hot water [1,2]. The use of heat pumps for the heating and cooling of the Commonwealth Building in Portland, Oregon, United States, initiated in 1948, was a pioneering achievement in the western hemisphere [3]. It can also heat or cool the residential space, providing the perfect climate all year round. In both commercial and residential installations, GWHP systems typically have lower maintenance costs than conventional systems as all equipment is installed inside the building or underground. Because there is no outside equipment exposed to weather. All refrigerant systems are sealed, similar to household refrigerators. Furthermore, GWHP systems are very flexible. They can be easily and inexpensively subdivided or expanded to fit building remodeling or additions. In commercial installations, systems can save money by recovering excess heat from building interior zones and moving it to the perimeter of the building. They can also save money and energy by allowing management to isolate and shut down unoccupied areas of the building. However, there are some problems associated with disposal of the water after once-through the heat pump. And water has suitable qualities could change with time to poor quality that causes problems of corrosion later in time. Water tables and well output can change over time and cause future problems. In addition, open-loop systems have more potential problems than either conventional systems or closed-loop geothermal systems because they bring outside water into the unit. This can lead to clogging, mineral deposits, and corrosion in the system. Open-loop systems require a large supply of clean water in order to be cost effective. This often limits their use to coastal areas, and areas adjacent to lakes, rivers, streams, etc.

Principle of GWSHP

When the sun heats the earth, energy is stored in underground water sources known as groundwater. The natural energy stored in the groundwater can be used in a heat pump. If ground water is available and easily accessible, it

can be utilized as a heat source due to the fact that it has a temperature of between 7 and 12 ℃ all-year round. The heat-retrieving coil maintains an even temperature throughout the year, providing the ground source heat pump with a constant source of energy. This can help reduce the carbon footprint and save heating costs in the long run. The GWSHP is a efficient energy conversion device, which is also including refrigerator, condenser, evaporator and expansion valve four components. The circulation of GWSHP is shown in Fig.1. There is pumping well to pump water to condenser in summer and the heated water is injected in to ground through recharge well. On the contrary, it is opposite circulation in winter, ie., it converts from cooling mode to heating mode. In the heating mode the reversing valve slides to a position that routes the hot refrigerant from the compressor through condenser to the reversing valve. Thus the air circulated by the indoor fan will be heated. After passing through the expansion device, the refrigerant enters the outdoor coil at a low temperature. Because the temperature of the refrigerant is low, heat can be transferred from the water to the refrigerant inside the evaporator. The advantage of using water from a ground or lake loop is that backup heat is often unnecessary. If the water loop is connected to a properly size ground or lake coil, the heating efficiency is exceptionally high compared to conventional systems. The schematic diagram is presented in Fig.2.

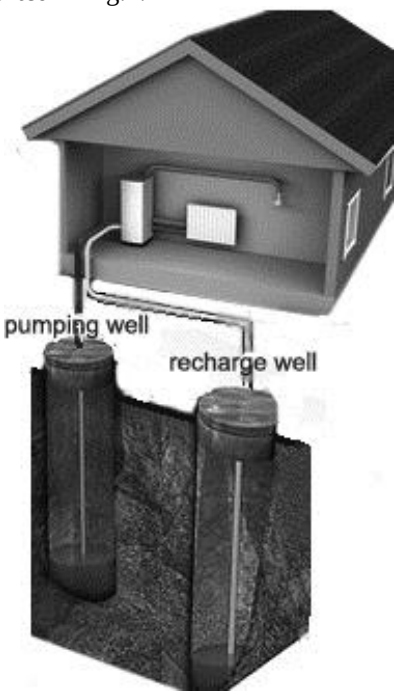

Fig.1 Graph of GWSHP

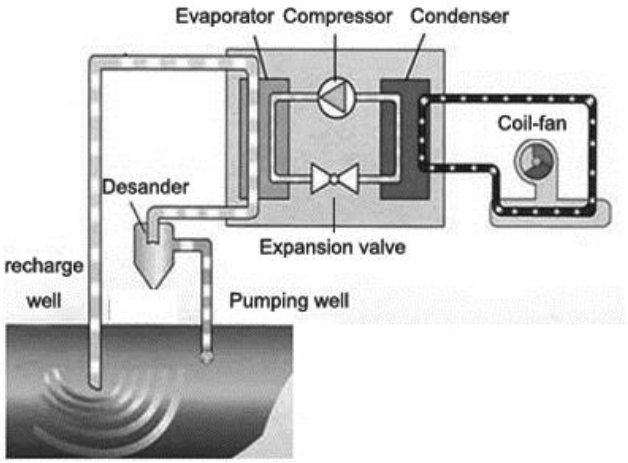

Fig.2 Schematic diagram of GWSHP

Impacts on ground water

According to the principle of GWSHP, it is required to pump water from layer of groundwater and then inject the water to exactly the same layer of ground. However, almost all of the injections are not so ideal that the groundwater is polluted or disposed to drainer. Groundwater resources are very limited in china, especially, groundwater resources over-exploitation in China has great impact on economic sustainable development.

Ground-source heat pumps change soil and groundwater temperatures, making the area around the pipes colder in the winter and warmer in the summer. Feasibility study of ground source heat pump system projects is rarely implemented in some areas [4]. Especially in northern china, many heating projects in winter are launched to use GWSHP systems. Energy from underground rock layer is adsorbed excessively and the energy cannot be recharged to the rock layer in summer. It will destroy the equilibrium of temperature, and even lead to ecological imbalance.

In addition, groundwater level recession and land collapse are caused due to the over-exploitation. In Guoliang Cao's [5] research, it is indicated that over past 50 years, the cumulative groundwater storage depletion was 1,700 mm, or 220 km^3 in North China Plain. The groundwater was not be injected completely to the layer but discharged into lake or municipal drainage. For example, there is a pumping well and four recharged well for a GWSHP system in one project in Hebei province. But the effectiveness of recharge system was not running very well sometimes. So it caused water waste and groundwater depletion.

At last, the microbes in groundwater will influence by GWSHP system. More than 95 percent of the world's available fresh water (excluding ice caps and glaciers) is underground. The microbes in groundwater are also keep

the balance of the groundwater source. The unsuitable use of GWSHP system will increase microbes problems in aquifers.

Solutions

There are advantages and disadvantages of GWSHP system. It is obvious that the system is an energy saving and efficient heating/cooling system. However, before and after the GWSHP project, some problems should be solved.

Firstly, feasibility study should be done adequately. According to the ground water situation in one area, the annual suction exothermic unbalanced rate should be analyzed with a project. Heat balance experiment should be done. For example, buried tube which is under the summer working conditions in two tests wells is tested for heat exchange performance, which obtains that heat exchange for deep unit in summer. It should compare economically with conventional air conditioning system. If the feasibility research result demonstrates that ground source heat pump scheme for the project is feasible, the project will be implemented, otherwise, the scheme should be changed. It is so ridiculous that the decision of a project was sometimes made by the real estate boss but the scientific feasibility of GWSHP. Even though there is the feasibility study passed by the government, the real study is not done adequately. With the result, it brings the destruction of underground environment.

Secondly, during the design for GWSHP system, the cooling/heating load should be calculated correctly. The load of GWSHP system should not be the difference between the maximum cooling load of the day and the maximum heating load of the day, but all-year dynamic cooling/heating load should be calculated through simulation software to obtain the difference between the energy absorbed from the ground and released to the ground. From this, it should avoid the ground heat imbalance.

Thirdly, the construction technology should be improved by training and government regulation. When a new technology appears, there is unhealthy phenomenon of going with the tide in China. A lot of GWSHP projects were started after the new technology studied from developed countries. The unbalance level of construction workers caused the different quality of the GWSHP system construction. Feasibility study is the preliminary work. Design is the basement of GWSHP system. The construction of GWSHP system is very important to run the system efficiently and decide whether the system running is environment friendly or not.

In addition, there must be an acceptable method of returning the used water to the environment. This may be limited not only by environmental factors (such as no place to dump that much water), but also by local and state regulations. Since accessibility to terminal units is important in geothermal systems, architects and mechanical and structural designers must carefully coordinate their work.

CONCLUSION

Energy is the basement of modern society development. But the rapid increase of energy consumption brings energy crisis, so sufficient and reasonable use of energy is more and more significant. The ground-source heat pump technology is known as the core technology of energy reuse. According to the characteristics of GWSHP technology, the system should be used rationally and scientifically in the view of ecological problems that may caused by these factors just like groundwater pollution, water waste and the changed soil temperature. The government should formulate relevant laws and regulations to make the GWSHP construction more scientific and environmental friendly.

REFERENCES

[1] ASHRAE. Commercial/Institutional ground-source heat pump engineering manual, ASHRAE, Atlanta, **1995**.
[2] S.P.Kanvanaugh and K.Raffery,. Ground-source heat pump-Design of geothermal systems for commercial and institutional buildings, ASHRAE, Atlanta, **1997**.
[3] M.J.Hatten. *ASHRAE Transactions*, **1992**, 98(1), 1031-1037.
[4] Gao Wei, Wang Houhua, Lin Zhenguo. *Refrigeration and Air Conditioning*, **2011**, 25, 186-190.
[5] Guoliang Cao.. Evaluation of groundwater system in the North China Plain using groundwater modeling, Ph.D thesis, China University of Geosciences, **2013**.