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Effects of the soil source heat pump borehole spacing and arrangement on the soil temperature of well group

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Abstract

Through the establishment of the ground source heat pump staggered/in-line simulation model, studying the impact of the borehole spacing and arrangement on the soil temperature of well group, studies have shown that borehole spacing have bigger influence on the soil temperature,but when the borehole spacing is certain , staggered spacing layout can effectively save area, and compared with the in-line arrangement the influence on the soil temperature in the well group is less difference.

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Keywords: borehole spacing;arrangement;temperature drop;heat flux

1. Introduction

At present our country annually for housing construction area about 1.8~2.0 billion square meters, which is expected by the end of 2020, China's new housing construction area of nearly 30 billion square meters by[1]. Because of the characteristics of China's geographical environment, most of the buildings are in need of heating and air conditioning system, which brings great challenge to China's energy system, and Ground Source Heat Pump(GSHP) technology as a kind of high efficiency and energy saving new technology, has been vigorously supported and promoted by the country, by the end of 2012, China's GSHP application area of nearly 240 million square meters, the total area of the demonstration project is 33.22 million square meters by[1]. Research shows that, the change of soil temperature has an important effect on the operation of the GSHP system, this paper mainly study the effects of the well group arrangement and borehole spacing difference on soil temperature.

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2. The significance of the study

According to the Ministry of Housing and Urban-Rural Development of the People's Republic of China(MOHURD) published 324 GSHP project statistics by[2], we can get the distribution information of various kinds of existing GSHP demonstration projects as shown in Figure 1 by[1]; at the same time, according to the statistics of the related engineering information of the GSHP working committee component units which belongs to China Building Industry Association, the proportion of ground source heat pump, ground water heat pump, surface water heat pump, sewage source heat pump were shown in figure 2 by[1].

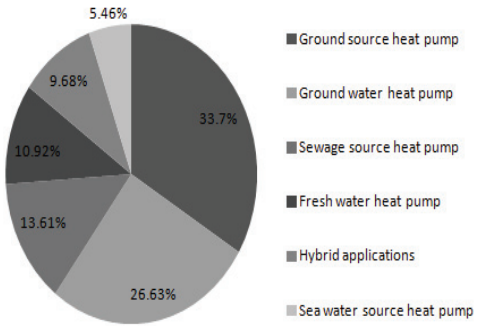

Figure 1.The proportion of various kinds of the heat pump demonstration projects

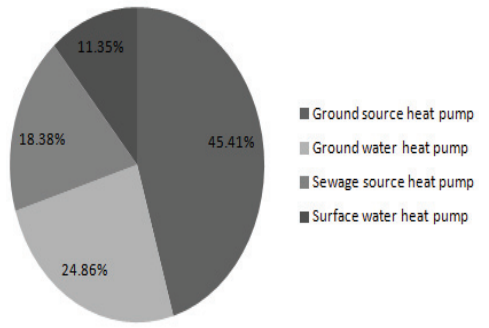

Figure 2.The proportion of various kinds of GSHP in China

What can be seen from the above two kinds of graph is that, at the present in our country the soil source heat pump has the highest share in the heat pump system, followed by the underground water source heat pump system, but because the ground water source heat pump has certain pollution to groundwater, which was gradually reduced the use of underground water source heat pump in recent years, therefore, studying energy saving for soil source heat pump has become a hot research topic, the change of soil temperature has an important effect on whether the ground source heat pump system can stable operation, and the ground source heat pump wells arrangement and borehole spacing determines the temperature of the soil, although the country has published relevant industry standards, but there was more guidance, no numerical specific was given to the project, so engineers always use experience value in practical project, which failed to optimize the project according to the actual situation by[3], this paper mainly study the temperature changes and heat flux variation of soil in northeast area of different borehole spacing and different well arrangement of heat pump system after operation for a period of time through comparative analysis, comparing the effects of borehole spacing and well arrangement on soil temperature.

Table 1.Parameters

name	parameter setting	name	parameter setting
soil thermal conductivity	λ=2.2*W/ (m·K)*	soil temperature	282*K*
soil specific heat capacity	C=895*kJ/ (kg·K)*	initial temperature of water	275*K*
soil density	ρ=1975kg/m^3	simulation time	6 *months*

3. Factors that influence the heat transfer of the well group

3.1.Effect of borehole spacing on the heat transfer well group

In order to make borehole spacing to meet the basic requirements of heat transfer, countries have made certain requirements on the borehole spacing, Chinese national standard GB 50336-2009 《Technical code for ground-source heat pump system》 in the provisions of borehole spacing should be 3 ~ 6m by[2], American ASHRAE in the《Commercial/Institutional GROUND-SOURCE HEAT PUMP Engineering Manual》recommended that the minimum spacing is 15ft (4.572m) by[4].Appropriate borehole spacing can not only reduce the attenuation of