

Using Geothermal Heat Pump in Green Building

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ABSTRACT

Green and near zero energy buildings can show the significance of energy. In most green buildings, geothermal heat pumps have been used for air conditioning, heating and cooling. Isfahan is a famous and historical city that many tourists visit, so it will be a significant cultural activity if a green building was introduced. Thus, the beautification organization of Isfahan, on behalf of the Municipality of Isfahan, prepared a program for constructing a green building, where the most kind of renewable energies have been used for generating the electricity. Photovoltaic solar panels will be used for cooling and heating while geothermal heat pumps will be used for air conditioning. Energy Gostaran Tajdidpazir Co. (EGT Co.), a consultant company for renewable energies in Iran, in behalf of the Beautification organization of Isfahan, has designed the all kinds of renewable energies, especially geothermal heat pumps. In this report, calculations of GHP are explained.

1. INTRODUCTION

Isfahan, located about 340 kilometers south of Tehran, has a population of 1,583,609 and is Iran's third largest city. It is famous for its Islamic architecture, with many beautiful boulevards, covered bridges, palaces, mosques, and minarets. The city is located in the lush plain of the Zayandeh River, at the foothills of the Zagros mountain range. No geological obstacles exist within 90 kilometers north of Isfahan, allowing cool northern winds to blow from this direction. Situated at 1,590 meters above sea level on the eastern side of the Zagros Mountains, Isfahan has an arid climate. Despite its altitude, Isfahan remains very hot during the summer with a maximum temperature that is typically around 36 °C. However, with low humidity and moderate temperatures at night, the climate can still be very pleasant. During the winter, the days are mild while the nights can be very cold. Snow has occurred at least once every winter except in years 1986/1987 and 1989/1990. Because of the usage of low efficiency heating and cooling systems, energy consumption in Iran is much higher than other countries. Thus, trying to develop a culture related to energy saving is one of the most important activities of the government and other organizations. The beautification organization of each city can be assigned to develop energy savings and use renewable energy technologies for decreasing air pollution. According to these golden aims, the beautification organization of Isfahan, on behalf of Municipality of Isfahan, prepared a program for constructing a green building in the Zamzam park that uses a great variety of renewable energies. For example, generate hot water with solar, generate the electricity with photovoltaic solar panels and small wind turbines, and also using cooling and heating geothermal heat pumps for air conditioning.

2. GEOTHERMAL HEAT PUMP

The energy consumptions in a building include heating, cooling, hot water, light, cooking, refrigeration, and other applications. Most of the energy consumption buildings are used for heating and cooling. Iran has the second largest gas reservoir in the world, so a gas pipeline network has been installed. For heating and cooking, people use gas energy. On the other hand, for cooling, gas is burned for generating electricity and air to air coolers or water coolers with low efficiency have been used for cooling.

Thus, for secure heating and cooling of the green building, geothermal heat pumps were offered by EGT Co. and approved by the owner of the project (Beautification organization) because of its high efficiency and low energy consumption. In the first step, the cooling and heating loads of the green building were calculated by EGT Co. In the second step, geothermal heat pumps were chosen for all the rooms. Then, because of the existence of an extensive park around of the building, the slinky coil had been selected by the EGT Co. The technical specifications of the geothermal heat pump of the green building are collected in Table 1.

2.1 GHP for Cooling

The green building was designed with two floors and the surface of the building is shown in Figure 1. Each floor has a 450 m² area built with energy saving materials. According to the cooling load calculation, the cooling sensible capacity of the geothermal heat pump is about 92600 Btu/h for the ground floor and 74500 Btu/h for the basement floor. However, the design cooling load was calculated to be about 102889 Btu/h for the ground floor and 82778 Btu/h for the basement floor. More than 50% energy savings for cooling and more than 60% energy savings for heating were estimated by the design engineers.

Table 1: The technical specifications of the geothermal heat pump of the green building

Topics	Amount	Units
Heat Load for ground floor	21000	Btu/h
Cooling Load for basement floor	83000	Btu/h
Heat Load for basement floor	42000	Btu/h
Cooling Load for basement floor	103000	Btu/h
The area of slinky coil	18000	M ²
The depth of slinky coil	2.5	M
Total length of polyethylene pipe	3000	M
The size of polyethylene pipe	¾	inches
Number of trenches	14	--
GHP 18000	2	Unit
GHP 10000	4	Unit
GHP 24000	7	Unit

**Figure 1: the surface of the green building in Isfahan**

2.2 GHP for Heating

According to the heating load calculation, the heating sensible capacity of the geothermal heat pump is about 37100 Btu/h for the ground floor and 18500 Btu/h for the basement floor. However, the design of the heating load was calculated to be about 41222 Btu/h for the ground floor and 20556 Btu/h for the basement floor.

2.3 Selecting GHPs

According to these calculations, for the ground floor, four geothermal heat pumps with 24000 Btu/h and two geothermal heat pumps with 18000 Btu/h were selected. In addition, for the basement floor, three GHPs with a 24000 Btu/h capacity and four GHPs with 10000 a Btu/h capacity were selected. The most important parameters of these GHPs are in Table 2.

Table 2: The main parameters of the GHPs

	COP	EER	GPM (kg/s)	CFM (ft ³ /m)
GT024	4.5-4.8	15-17	6	850
GT018	4.5-4.7	15-16.5	5	550
GT010	4.2-4.5	14-16	2.5	350

3. OTHER RENEWABLE ENERGIES

3.1 Solar

Securing the hot water for cleaning, WC, and others, the capacity of the designed solar hot water tank is about 400 liters and it has two solar collectors with a 2.5 m² area. Moreover, for the light of the yard around the green building, solar light structures with a 5.5 m elevation are needed. A photovoltaic power plant has been designed for generating the electricity consumption of the green building. The capacity of the PV power plant is about 17.25 kW.

3.2 Wind

Isfahan does not have any good wind potential, so installing a wind turbine was not economical. However, to show one of the famous kinds of renewable energy, a small wind turbine had been selected with 300 watts capacity that will start with a 3 m/s wind.

3.3 Retrieve sewage

According to some input data from the beautification organization of Isfahan, 15 people will be staying during work hours (about eight hours) in the green building and about 20 to 25 people will come to the green building as clients. It is estimated that about 200 liters of water will be used per day (4800 liters per month and 57600 liters per year). A retrieval sewage system was designed for returning about 80% to 90% of this water for watering the trees and the flowers.

4. CONCLUSIONS

A green building or near zero energy building is being built to show how people can save the energy and prevent the energy losses by using renewable energy resources. For this purpose, the Beautification organization of Isfahan, created a green building project for using geothermal heat pumps as a cooling and heating air conditioner system and also a small wind turbine and solar energy for generating electricity and hot water. In addition, a retrieve sewage system will be used to return some water. According to the cooling and heating load calculations, more than 50% of energy savings had been estimated by the design engineers for cooling and more than 60% energy savings will happen for heating.

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