

Efficiency and Cost-Effectiveness of Ground Source Heat Pump for Five-Storeyed Office Building

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Abstract

Non-clean energy resources cause pollution, climate change and greenhouse gas emissions. Therefore, in present scenario it is very much required to use renewable energy resource as sustainable solution. Geothermal heat energy stored within the earth is one of the biggest sources of renewable energy. Shallow geothermal energy can easily be extracted using close- or open-looped geothermal systems and it is very effective for building heating or cooling purposes. Ground source heat pump (GSHP) is a closed-loop system where vertical boreholes are equipped with HDPE / PVC pipes (primary circuit) through which heat exchanger fluids are circulated, and when passing through boreholes they exchanges heat with surrounding ground. Heat pump is used to take out the fluids and circulate inside the building through pipes (secondary circuit) embedded in concrete floor to exchange heat with surrounding air.

A five-storeyed office building was studied to estimate energy requirements for heating and cooling demands in summer and winter for sizing GSHP using Energy-Plus software. Climatic and soil conditions for ten different metropolitan cities located mostly in tropical regions were considered. Using Ground Loop Design (GLD) software design of GSHP system was done based on energy demand of the building. A comparison of GSHP system design for the building in different cities and cost analysis are discussed. It is observed that the cost and performance of GSHP depends on several factors such as energy load demand, soil conductivity, and climatic condition.

Keywords: ground source heat pump; tropical regions; boreholes; heating; cooling; energy consumption; cost analysis.

1 Introduction

Worldwide exponential growth of energy consumption is leading to energy crisis. Use of fossil fuels cause environmental issues like global warming due to greenhouse gas emissions, increase in particulates in air, increase in global temperature, changes in weather pattern and increase in carbon footprint. These environmental issues can be controlled by use of renewable energies (wave energy, biomass energy, wind

energy, solar energy, geothermal energy), and nowadays these renewable energies are generating lot of interest.

Geothermal energy is a form of renewable heat energy which is generated and stored within the earth interior. There are two types of geothermal energy based on depth from ground level: (a) shallow geothermal energy and (b) deep geothermal energy. The zones of shallow and deep geothermal energy below ground level are shown in Figure 1. Shallow geothermal energy system is