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Space Heating and Cooling using Heat Pump and Geothermal Energy for Homes and Commercial Buildings

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Abstract HVAC, Space heating and cooling are the key topics when improving energy performance in new building. The environmental conditions need to be taken care of when such systems are designed. This thesis is based on reducing the carbon emission caused by the air conditioners or any such devices which is used for cooling or heating the rooms as it is free from such emissions. The heat is exchanged by the environment and the ground which is considerably at a lower temperature than the surrounding during summers.

The temperature difference causes the heat to flow from higher temperature to a lower temperature. The same mechanism is reverted when the surrounding comes to a lower temperature.

The heat is exchanged by continuously circulating water between the room and the underground earth.

1. INTRODUCTION

In commercial and residential buildings, a large portion of energy is consumed for space cooling, heating, and ventilation. Ground-source energy can be widely used in homes due to its energy saving potential, but in certain cases it becomes unacceptable capital cost. The performance of such devices mostly depends on the local conditions such as ground properties because of the presence of the geothermal heat.

In moderate climate, in summers the temperature inside the ground approx. 15m depth is considerably lower than the outside air. Thus, a large geothermal store is available with significant heat capacity for exchanging heat. That is heat extracted from the building in summer, while extracted from the ground source and supplied to the building in winters.

In summer, most of the time, the HP can be bypassed and the heat carrier fluid circulated through the ground by the BHEs and through the heating/cooling distribution. When free cooling alone cannot satisfy the cooling needs, HPs can be reversed for cooling since they can operate in normal (heating) and reverse (cooling) mode.

1.1 Geothermal energy

Geothermal energy is heat derived within the sub-surface of the earth that actually is caused by the long-lived radioactive compounds. Furthermore 'geothermal' energy itself states the energy inside the crust in the form of heat. Depending on its characteristics, geothermal energy can be used for heating and cooling purposes or can be harnessed to generate clean electricity. However, for electricity generation high temperatures are needed to get the heat from the steam. The geothermal energy stored inside our planet could be exploited to directly produce electric energy or could be used to heat another working fluid in a power cycle.

2. CFD

Computational fluid dynamics (CFD), allows engineers to visualize flow velocity, density, thermal impact and chemical concentrations for any region where the flow occurs. This in-turn helps engineers analyze the problem areas and suggest the best solutions. CFD is widely used across the construction industry for analysis and design optimization of an HVAC system.

Using Computational fluid dynamics, fluid flows can be simulated and HVAC performance can be analyzed without actually installing the HVAC system or building its prototype. Hence, crucial problems can be identified and solutions can be devised to enhance the HVAC performance within a building.

In order to analyze and design an HVAC system, it is important to avail detailed information about the flow within an occupied zone. This information can also be derived via advanced CFD analysis and simulations of the occupied zone. Hence, the data is extracted by the simulation, changing the material of the pipe, variable pipe length, and the refrigerant used.

The thermal conductivity of tubing materials describes the amount of energy required to increase the temperature of the liquid inside the tubing to the same temperature on the exterior of the tubing. Simply stated, thermal conductivity is the rate at which heat is transferred through a material.

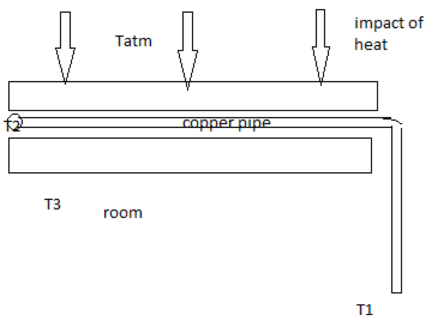
Different materials contain differing thermal conductivity rates, based upon their molecular structure. The thermal conductivity of the selected materials and the calculated heat transfer per unit of time is presented in Table 1.

Table -1: Thermal Conductivity of Tubing Materials

Piping	Material	W/mK
Steel	Carbon Steel	54
Copper	Copper	401
PVC	Polyvinyl Chloride	0.19
CPVC	Chlorinated Polyvinyl Chloride	0.14

Heat transfer rate

$Q = m \times c \times \Delta T = U \times A \times (Tatm - T3)$



The temperature (T2) is found out by the analysis done by assuming the different atmospheric temperatures and then the temperature of room is found by considering a cross flow heat exchanger.

Tatm	T1	T2
35°C	20°C	24°C
40°C	20°C	26°C
45°C	20°C	30°C

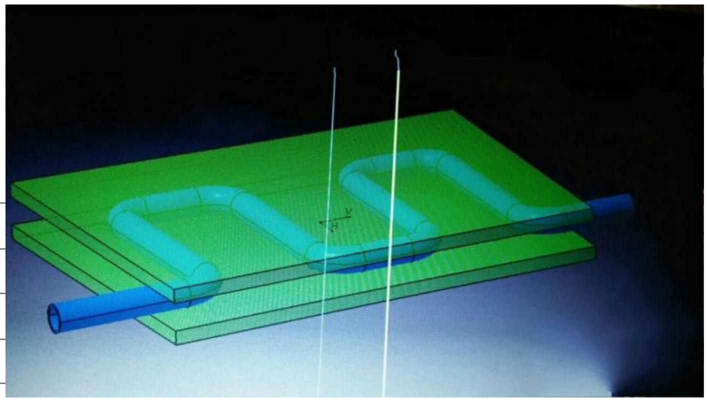


Fig -1: design of roof with piping

3. CONCLUSIONS

With this work it was evaluated the possibility to fulfil the heating and cooling load of the house using a low-temperature district heating system operated with groundwater heat pumps. From the environmental point of view, it is a very good choice, because it prevents the CO2 emissions related to the consumption of fossil fuels and moreover using a natural refrigerant as working fluid all the environmental direct impact (GWP and OPD) is negligible. However, the setup cost is considerably high because of the use of the copper pipes deep inside the ground. These lines laid are just a one-time cost which have certified-life for around 50 years.

The results of this work are affected by some necessary assumptions, which were made to proceed with the analysis. It required a continuous operating pump which would circulate water to exchange heat, added up to the running cost. But this can also be eliminated by using the solar operated pump.

REFERENCES

[1] Vasile Manea, "journal of green building".
[2] Vaidya D, Shah M, Sircar A and Sahajpal S, Cooling Application Based on Low Enthalpy Geothermal Reservoirs
[3] Yaohua Zhao, Wei Xu, Solar heating system

BIOGRAPHIES

Description "Swastik Agarwal is a scholar working on energy saving. His research interests include (not limited to) heat transfer and energy utilization."