IJFEAT
INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

A REVIEW ON GEOTHERMAL HVAC IN TROPICAL REGIONS

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***Abstract*—This paper includes a study on Geothermal HVAC System (Heating, Venting, and Air-Conditioning). Since most central air conditioning systems are air-cooled, there has been much concern about the energy conservation strategies which ultimately reduces global warming also. The earth absorbs almost 50% of all solar energy and remains a nearly constant temperature of 10°C depending on geographic location; a geothermal unit utilizes this constant temperature to exchange energy between the building and the earth as needed for heating and cooling. Geothermal heat pumps are among the most efficient and comfortable heating and cooling technologies available because they use the earth's natural heat to provide heating, cooling, and often, water heating.**

***Keywords* - Heating, Venting, Air-Conditioning, Geothermal Energy.**

I. INTRODUCTION

A geothermal system can be used to heat and/or cool an indoor space and it efficiently operates 24*7*365.

Geothermal heat pump (GHP) technology harnesses that constant, stable moderate temperature to heat and cool buildings. It is an energy efficient way of heating and cooling buildings utilizing the constant temperature of the earth. Geothermal heat pump (GHP) systems first became popular in the 1950's after the initial introduction of the technology at the Commonwealth Building in Portland, Oregon, in the U.S. Numerous replications of that system, dating from about the same time, can be found throughout the western United States, serving a number of commercial and institutional buildings and complexes. Resurgence in the development of GHP systems came following the oil crises of the 1970's when fears over rising costs and the availability of energy drove developers to look to systems that used indigenous resources.

This paper deals with geothermal energy as a future alternative to traditional heating and air conditioning systems. Geothermal energy is the energy which is harnessed from the mother earth. Geothermal air conditioning system is considered to be the most efficient air conditioning systems available till date on this planet.

Now let us study Geothermal Heat Pumps. Using a heat exchanger, a geothermal heat pump can move heat from one space to another. In summer, the geothermal heat pump extracts heat from a building and transfers it to the ground for cooling. In winter, the geothermal heat pump takes natural heat from the ground and transfers it to the home or building for heating.

Installing a geothermal heat pump system can be the most cost-effective and energy-efficient home heating and cooling option. Geothermal heat pumps are a particularly good option if you are building a new home or planning a major renovation to an existing home by replacing, for example, an HVAC system. This works on the basic principle that the temperature remains constant below earth throughout the year irrespective of the temperature above the ground. During the seasonal changes the temperature of air changes from one extremity to the other and the variation is over a time period of day or gradually over the season. Due to variation in temperature there is increase or decrease in running efficiency of all HVAC systems be it the ones dependent on air cooled condensers water cooled systems with cooling towers. Geothermal exchange systems on the other hand use a constant thermal body earth to give you higher energy efficiency level. Earth with its huge mass is a neutral source of thermal energy for cooling or heating purposes. During summers as the temperature of earth is lower than the atmospheric temperature see it can be used for cooling purposes whereas during winters the earth temperature is higher than the atmospheric temperature, it can be used for heating purposes.

The temperature within earth is negligibly affected by variation in atmospheric temperatures. While going down into earth the upper 5 to 8 feet is affected by the seasonal changes with a time lag of a few days to months the variations are from 3 to 6^0C, but as we progress down with in the range of 8 to 20 feet. This variation reduces down to a change of 2 to 4^0C over a time period of a few months based on lag in transfer of thermal gradient through earth. After this the temperature remains nearly stable with in a variation of 1 degree as we progress in to the earth and nearly constant after a depth of around 30 feet.

Thus in most parts of India requiring cooling the average temperature in earth below 8 feet depth is around 25^0C with a variation of around two degrees either way with respect to geographical conditions. For checking the temperature of Earth the simplest procedure is to check the temperature of water coming out of the bore well in your local area. The point about temperatures below ground is that they are relatively stable or constant compared to the daily and seasonal variations of above ground temperatures because of the insulating effect of the ground itself (very slow to warm up and very slow to cool down). The deeper you go, the further from the surface, the more constant the temperature compared to the surface air variation.

II. LITERATURE REVIEW

The biggest benefit of GHPs is that they use 25%–50% less electricity than conventional heating or cooling systems. This translates into a GHP using one unit of electricity to move three units of heat from the earth. According to the EPA (Environmental Protection Agency), geothermal heat pumps can reduce energy consumption and corresponding emissions up to 44% compared to air source heat pumps and up to 72% compared to electric resistance heating with standard air-conditioning equipment. GHPs also improve humidity control by maintaining about 50% relative indoor humidity, making GHPs very effective in humid areas. Because they have no outside condensing units like air conditioners, there's no concern about noise outside the home. A two-speed GHP system is so quiet inside a house that users do not know it is operating: there are no tell-tale blasts of cold or hot air [1].

AH.N. Lam and H.M. Wong show in their paper that the assumed geological properties of the site and the local weather conditions of Hong Kong, it is quite clear that if the heat pump system is used for cooling only, acceptable sustained long-term performance cannot be achieved. This is due to rise of the ground temperature and the resultant drop in the heat pump COP. On the other hand, there are good improvements of the system performance if operation of the heat pump system is for cooling and heating. The cyclic heat rejection to and heat removal from the ground help maintain an acceptable steady ground temperature and sustained heat pump COP. It can therefore be concluded that the simulation results demonstrate it is feasible to adopt the use of geothermal heat pump systems for cooling and heating in Hong Kong.

Apart from technical feasibility, there are other factors such as energy efficiency, environmental impacts, service life, maintenance requirements which will influence the choice of a geothermal heat pump system over other types of cooling and heating systems.[2].

From experimental analysis by Mr. Sanjay N. Mali, Dr. Ashok B. More and Mr. D. S. Patil it was found that with the increase in the pipe diameter the cooling effect increases. Results show that using PVC pipes the interior temperature can be reduced up to 10 degree, which will reduce the cooling load of the building.[3].

From the experiments performed by Gaffar G.Momin it can be concluded that the Geothermal conditioner gives fairly constant temperature output irrespective of the ambient temperature. The output temperature is near to 250C which is comfort temperature of human body. With adding the evaporative cooling to the ground cooled water, the COP of the system almost doubles which make the system more effective.[4].

III. TYPES OF GEOTHERMAL HVAC SYSTEMS

A. Ground Water Based Systems: In this method a bore is made up to deep water table source and water which is at the temperature of earth is extracted and passed through a heat exchanger thereby removing heat from a refrigerant, water or air.

B. Vertical Loop Systems: In this method a vertical closed loop fluid is composed of pipes that run vertically in the ground. Vertical loop fields are typically used when there is a limited area of a land available.

C. Horizontal Loop Systems: In this method a vertical closed loop fluid is composed of pipes that run vertically in the ground. Excavation for horizontal loop fields is about half the cost of vertical drilling, so this is the most common layout used wherever there is adequate land available.

D. Surface Water Loop Systems : In this method Surface water or pond loops use a body of water as the heat sink. Heat escapes the water through surface evaporation, so the process is closely connected to pond temperature and ambient wet bulb.

E. Slinky Coil Geothermal Ground Loop Systems : In this method Rather than using straight pipe, slinky coils , as you might expect, are overlapped and piping is laid out horizontally along the bottom of a wide trench.

IV. MERITS AND DEMERITS OF GEOTHERMAL HVAC SYSTEMS

Merits:

- The advantage of closed loop geothermal systems is that energy not required in some areas can be moved and used in areas that do require energy .
- Geothermal systems require smaller mechanical rooms than other HVAC systems.
- There are fewer emissions associated with geothermal heat pumps compared to conventional systems.
- Indoor air quality is generally superior.
- Reduces maintenance expenses
- Decentralized design and equipment failure, would only affect the zone in which the equipment is located.

Demerits:

- High initial investment for a water supply or loop system.

- Public education. Consumers need to be made aware of the fact that a geothermal unit does not have a defrost cycle and that the compressor sits inside
- Coordination of trades can be a problem during installation as two or more additional contractors are involved for well driller-trenching- plumbing.
- Most people are afraid to get involved in a new technology

V. Conclusion

The biggest benefit of using geothermal energy for HVAC Systems is that it is a renewable source of energy and it is totally green. Also use of geothermal energy reduces electricity consumption to a great extent. Geothermal heat pump systems have an average 20+ year life expectancy for the heat pump itself and 25 to 50 years for the underground infrastructure. Additionally, they move between three and five times the energy they consume between a building's interior space and the ground. Hence they should be used extensively.

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