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GEOTHERMAL ENERGY APPLICATION FOR A HEATING AND COOLING

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ABSTRACT :

Geothermal (or Geo-exchange) is a type of HVAC System (Heating, Venting, and Air-Conditioning).The earth absorbs almost 50% of all solar energy and remains a nearly constant temperature of 10°C (50°F) depending on geographic location. Working with an underground loop system, a geothermal unit utilizes this constant temperature to exchange energy between the building and the earth as needed for heating and cooling. Geothermal is the most efficient Air-conditioning system because the ground temperature stays stable and has no regard for the above ground ambient temperature. A geothermal heat pump simply takes advantage of this low temperature energy source and pumps it up to a usable level to cool/heat the building. Geothermal Heat Pumps draw energy out of the ground which stays relatively constant year round. According to the 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. The biggest benefit of GSHPs is that they use 25%–50% less electricity than conventional heating or cooling systems . Although geothermal energy is not the sole renewable energy solution, it can play a significant role in helping to meet the heating, cooling, and energy needs of communities across the India. The advantages of geothermal system are more pronounced in larger installations and institutions.

Index terms –GSHP, Energy efficiency ratio, Geo cool , Geothermal , Geothermal Heat pump , HVAC, EER, SEER.

1. INTRODUCTION

There is a growing, majority consensus amongst scientists and policy makers that Climate Change is real, and the problem is a direct result of the world's consumption of fossil fuel based energy resources. Other concerns regarding the India's dependence on fossil fuels revolve around the country's unending dependence on foreign oil for its energy requirements and the necessity for energy security. These issues have set in motion the gradual progression of initiatives, policies and regulations that will deter the country from relying so heavily on fossil fuels, and set goals for emissions reductions and reliance on alternative forms of energy. Over the last decade India has created a comprehensive collection of state policy/regulation that lays the groundwork to reduce greenhouse gas emissions and related energy consumption. In 1945 Robert Webber of the Indianapolis Power and Light Company installed what is considered the first geothermal heat pump at his residence. During the next few years, all of the popular forms of ground source heating coils that are seen today were introduced in their early forms [3].

A ground source heat pump (GSHP) is a heat pump which uses the ground as its low-temperature reservoir (heat source) and uses a heating load as its high-temperature reservoir (heat sink). Heat pumps are often reversible, meaning the cycle can be switched from heating to cooling, using a cooling load as its heat source and the ground as its heat sink. Using the ground, rather than air, as a heat pump source/sink for heating/cooling can improve efficiency because local ground temperature (below 19 meters) is relatively constant and about the local mean air temperature (the local climate temperature), in contrast to the outdoor air temperature, which changes with the weather and experiences diurnal and annual hot and cold extremes.

2. GEOTHERMAL HEATING AND COOLING

The air conditioning systems considered are shown in Figures 1 and 2 and are all-water type systems. The vast majority of heat pumps work on the vapor compression cycle principle. The main components in such a heat pump system are the compressor, the expansion valve and two heat exchangers, which are referred to as the evaporator and condenser. A volatile liquid, known as the working fluid or refrigerant, circulates through the four components. Geothermal heat pump systems are similar to ordinary heat pumps. GSHP systems use the ground heat source instead of outside air temperature to provide heating and air conditioning.

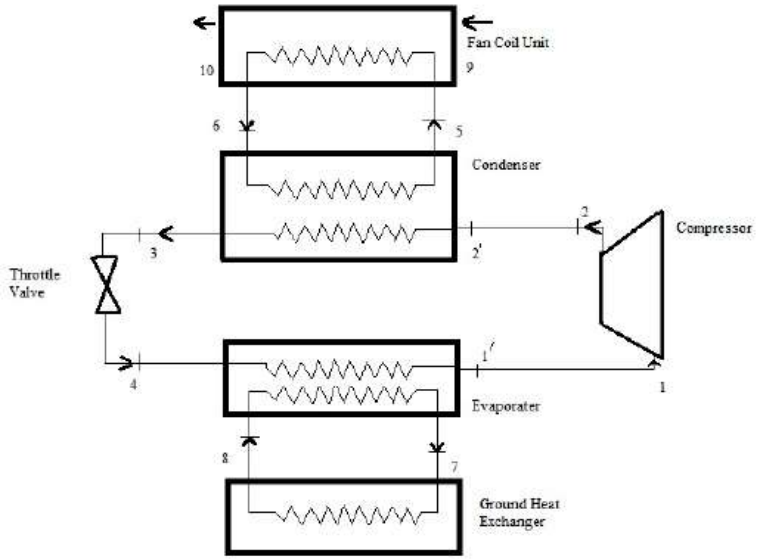

Fig. 1 :Schematic diagram of an air conditioning system for winter operations.

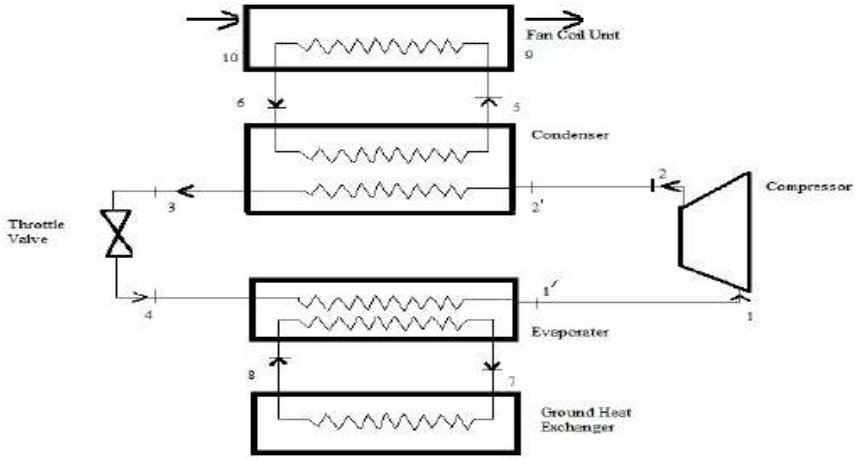

Fig. 1 : Schematic diagram of air conditioning system for summer operations.

3. GEOTHERMAL VS CONVENTIONAL AIR CONDITIONER:

Comparisons between Geothermal and conventional air source units are convoluted because of the sharp decrease in efficiency of air source equipment as a function of outside air temperature. Manufacturers of air source equipment are quick to post impressive EER(Energy efficiency ratio) and SEER (Seasonal Energy Efficiency Ratios) numbers on their "high efficiency" models, but a closer examination of the actual performance data shows that these lofty numbers do not correlate well under realistic installed conditions. A typical example of a 3-ton air source unit shows manufacturer's EER as 12.0. However, a closer look at performance values yields a calculated EER value of 10.5, at rated conditions. This would represent a daytime temperature of about 32.2° C. When the outside temperature rises to 37.7°C, the air source EER drops to 9.2, which represents a reduction in efficiency of 12%. If outside temperature rises to 43.3° C, the air source EER drops even further to 7.7, which represents a reduction in efficiency of 27%. This means that the unit is requiring 27% more electricity to yield the same cooling . As indicated in the table 1, Geothermal systems for air conditioning are considerably more efficient than the conventional air source units. Simple calculations show that energy costs for a Geothermal are nominally 40% less than air source; 50% less than air source at 100 degrees; and can be as much as 55% less than air source as temperatures rise further

4. PROS:

1. High Efficiency and Stable Capacity
2. Comfort and Air Quality
3. Simple controls and Equipment
4. Low Maintenance Cost
5. Low Cost Water Heating
6. No Outdoor Equipment
7. Packaged Refrigeration Equipment
9. An earth-coupled heat pump can be applied practically anywhere for residential, commercial and industrial heating & cooling systems.
10. An earth-coupled heat pump system has the lowest operating cost of any space heating or cooling system.
11.GSHPs are safe and clean because there are no combustion flames, no flues, and no odors; just safe, reliable operation year after year. And compared to most conventional HVAC systems, GSHPs deliver constant comfort and improved humidity benefits
12. Energy efficient , long life, easy installation, low maintenance.
13.Reduces Pressure from Grid
14. Reduces Dependence on Imported Oil
15. Reduces Installation Size and Operating Cost of Captive Power Generator
16. Going Geothermal adds Points towards Higher level of 'LEED' (Leadership in Energy and Environmental Design) Certification with 'Indian Green Building Council'.
17. Reduced air emissions (e.g., pollution) by 44% as compared to conventional air-source heat pumps and 72% in comparison to standard electric heating with air-conditioning systems.
18. Flexible design allows for new and retrofit installations .
19. System takes up less space compared to standard systems .
20. Quiet and very little noise compared to conventional air conditioners .
21. GHPs can maintain 50% relative indoor humidity and are appropriate for zone heating and cooling .

5. CONS :

1. High initial investment for a water supply or loop system.
2. Coordination of trades can be a problem during installation as two or more additional contractors are involved for well driller-trenching- plumbing.
3. Public education. Many consumers are distrustful of heat pumps due to past bad experiences with air-to-air heat pumps. 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.
4.Most people are afraid to get involved in a new technology.
5. Potential negative environmental effects if installed or operated improperly.
6. Groundwater/environmental contamination in the event of a pipe leak

6. FIGURES AND TABLES:

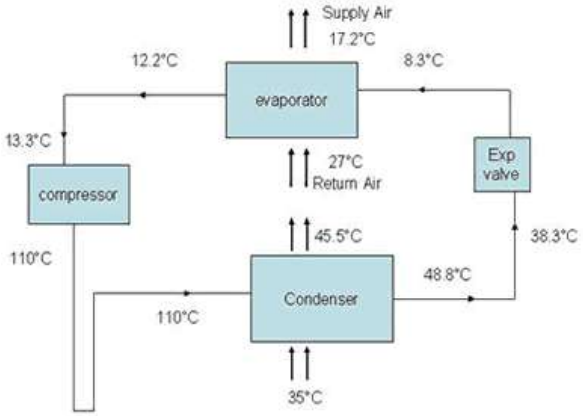

FIG 1. A CONVENTIONAL AIR CONDITIONING SYSTEM

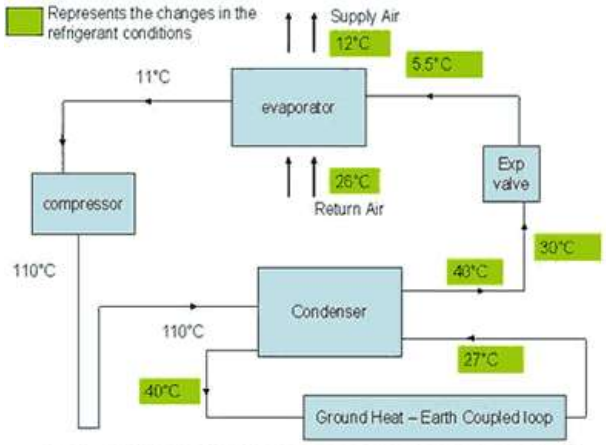

FIG 2. AN EARTH COUPLED GEOEXCHANGE SYSTEM

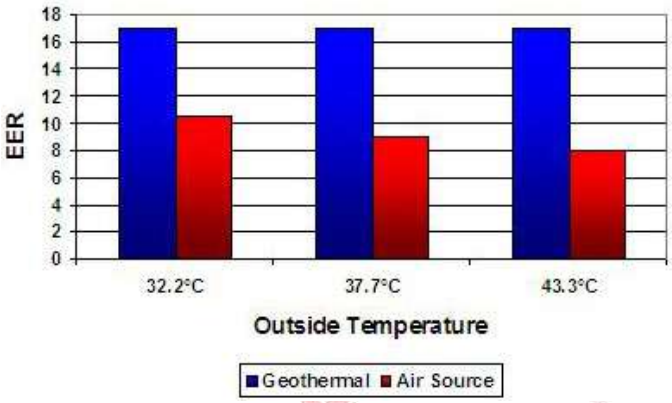

CHART 1 Outside Temp Vs EER

TABLE 1 :EER Comparison Geothermal v. Air Source Cooling

Outside Temp	32.2°C	37.7°C	43.3°C
Geothermal	17	17	17
Air Source	10.5	9	8

TABLE 1 :EER Comparison Geothermal vs. Air Source Cooling

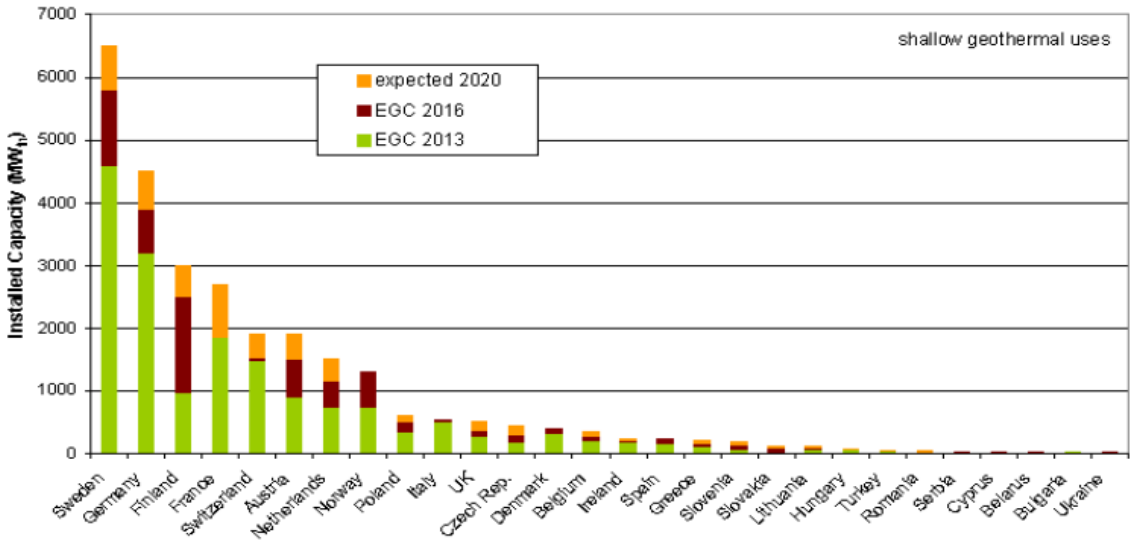

Chart 2: Installed capacity in geothermal heat pumps in Europe 2012-2015, after EGC 2013 and EGC 2016, and reported expectations towards 2020.

7. CONCLUSIONS :-

The biggest benefit of GSHPs 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. GSHPs also improve humidity control by maintaining about 50% relative indoor humidity, making GSHPs very effective in humid areas. Geothermal heat pump systems allow for design flexibility and can be installed in both new and retrofit situations. Because the hardware requires less space than that needed by conventional HVAC systems, the equipment rooms can be greatly scaled down in size, freeing space for productive use. GSHP systems also provide excellent "zone" space conditioning, allowing different parts of your home to be heated or cooled to different temperatures. Because GSHP systems have relatively few moving parts, and because those parts are sheltered inside a building, they are durable and highly reliable. The underground piping often carries warranties of 25–50 years, and the heat pumps often last 20 years or more. Since they usually have no outdoor compressors, GSHPs are not susceptible to vandalism On the other hand, the components in the living space are easily accessible, which increases the convenience factor and helps ensure that the upkeep is done on a timely basis. 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.

Because the energy consumption of a geothermal heat pump system is low and the ground-underground water temperature is stable throughout the year, geothermal-source heat pumps are attractive as heat sources. Consideration should be given to geothermal-source heat pump systems for the industrial sector in India. In this way, the efficiencies of heating and cooling systems can be improved. Finally, considering the rapid growth of India's energy consumption and imports in recent years, the use of geothermal heat pumps in heating and air conditioning systems is more attractive than traditional system and should be encouraged.

Geothermal heat pumps are a high-efficiency means of heating and cooling buildings. With careful planning, they can be installed almost anywhere and can provide homeowners with significant annual energy savings. Although geothermal energy is not the sole renewable energy solution, it can play a significant role in helping to meet the heating, cooling, and energy needs of communities across the India. The advantages of geothermal system are more pronounced in larger installations and institutions.

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