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FUTURE SCOPIC GEOTHERMAL COOLING

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Abstract: In India at the time of summer season around 70% of energy is required to cool the interior surface of buildings. In composite climatic zone like Nagpur, Mahatrashtra, several electro-mechanical cooling appliances viz., evaporative coolers, air conditioners,etc.are used,and this appliances required much more energy and water,so Application of geothermal cooling system is a best option for saving energy,water and reducing emission of green house gases as It is a conventional technique and ecofriendly process for cooling the interior of building envelop. In the present work the research on geothermal cooling is elaborated and it is applied to a case study of a small room of size 4"x4"x4" which is located in the composite climate. The model is prepared in summer season and the temperature variations are observed outside and inside the room having geothermal cooling system. It is found that geothermal cooling system saves around 90% of electricity as compared to air conditioner and 100% of water as compared to evaporative coolers. It was also observed that the drop of around 6˚C to 7˚C.This approach can further be extended for larger applications that will reduce consumption of energy and water in building.
Keywords: Geothermal cooling, Air Exchanger, Energy saving, Water saving, Solar batteries

I. INTRODUCTION

The word geothermal has two parts: geo, meaning earth, and thermal, meaning heat. Thus, geothermal concerns using heat from the Earth. Geothermal energy has the potential to provide long-term, secure base-load energy and greenhouse gas (GHG) emissions reductions. Accessible geothermal energy from the Earth's interior supplies heat for direct use and to generate electric energy. In electricity applications, the commercialization and use of engineered (or enhanced) geothermal systems (EGS) may play a central role in establishing the size of the contribution of geothermal energy to long-term GHG emissions reductions.

Geothermal Energy is the renewable energy with positive net balance between production and consumption. Low Temperature Geothermal Energy (LTGE) is a notable example of renewable energy that is mainly suitable for solving the problem of domestic thermoregulation. LTGE makes significant contributions to the new economic model referred to as the green economy. The concept of the green economy involves lesser use of natural resources like water, and Fossils fuel.this concept of green economy is now in a trend all over the worlds because of scarcity of natural resources and the scarcity of natural resources can be seen in a countries like India where the tremendous increase in the population is observed, such countries need geothermal techniques to deal with the shortage of natural resources.

1.1 Geothermal cooling system in India

India comes under the tropical climatic region where the environment is hot and humid. This type of climate mainly can be seen at the time of summer. The problematic situation comes in this region when there is a the rise in temperature which result in hot and humid climate and in such type of climate it is very difficult to cool the inside environment of buildings, so in India usually people are using evaporative coolers, air conditioned etc. but this type of appliances need around 70% of energy [1], and also much more water. As in India population is increasing day by day, and the use of natural resources are also increasing so peoples in India are facing problems in concern with

natural resources like water ,coal, petroleum and this scarcity is more due to the human factor than anything - such as industrialization, irrigation, domestic use, etc.

To minimize the problems related to scarcity of natural resources green technologies should be adopted and practiced, and the social acceptance of green technologies are only possible when it have cost effectiveness and its environmental performance. The conventional energies are being used for lightening or cooling purposes. whereas lightening requires 20-30% electricity and cooling requires 70-80% of electricity [1].As it is mentioned earlier that to deal with hot and humid climate evaporative coolers, air conditioned are used in India result in huge energy consumption, water consumption and also carbon emission, so geothermal cooling is the apt choice for not only reducing water consumption but also to reduce electricity consumption and environmental effects. Geothermal cooling energy utilizes the temperature gradient between soil and air or water in a pipe to cool or heat the air passing through it [1].

There are some factors which affect the ground temperature distribution which are to be considered while designing the geothermal cooling system and physical properties of ground such as bare ground, lawn, snow, etc and climate interactions (i.e., boundary conditions) determined by air temperature,wind,solar radiation, humidity and rainfall. It was observed in many researches that the ground temperature below a certain depth remains relatively constant throughout the year.

The temperature fluctuates at the surface of the ground as the depth of the ground increases because of the high thermal inertia of the soil, also there is a time lag between the temperature fluctuation at the surface and below ground. Therefore at sufficient depth ground temperature is lower in summer season and higher in winter. With this concept two type of systems, open and closed systems are made as a ground heat exchanger. In open system ground itself is used directly to heat or cool the medium. In closed system the ground is used indirectly with the aid of a heat carrier medium that is circulated in a closed system.

A number of experimental research works were carried out globally. The effectiveness of ground to air heat exchangers increases with an increase in the pipe length. Also there is an increase in effectiveness when the pipe is buried at greater depth [2]. The energy delivered by the ground heat exchanger depends significantly on different design parameters like depth, diameter and pipe material [3].Earth to air heat exchanger have been use for years in developed countries due to their higher energy utilization the underground soil temperature that stay fairly constant at a depth of about 2.5-3m for building conditioning [4].Further an experimental study is carried out which showed that 31% of energy saving was obtained from 0.9 kW solar PV cell systems.An average exergetic efficiency of air blower was found to be 63.1% and overall exergetic efficiency of the system was calculated to be 23.6%[5]. In the experimental study carried out in Valencia, Spain it was concluded that the average saving obtained by the geothermal system was 37 $\pm$ 18% of the energy consumed by conventional one[6].It was concluded that the efficiency of installation is not reduced from year to year it remains constant only maintainace is operations are needed [7].

II. CONCEPT OF GEOTHERMAL COOLING

In geothermal cooling system the hot air from the atmosphere is passed through porous duct like clay pipe which is embedded in the ground at certain depth where the temperature is low as compare to the atmospheric temperature and this hot air becomes cool by the capillary action of clay pipe and cool air is circulated in the room envelop by using exhaust fan which is running by means of solar batteries. Geothermal cooling system is the conventional method because it uses ecofriendly material which utilizes lesser energy and water and this type of system does not cause any pollution. By using all the above ecofriendly materials a case study of a small room is done in composite climate.

The application of conventional and geothermal cooling system is compared in terms of energy consumption.

III. CASE STUDY

A geothermal cooling system is constructed at GNI, Nagpur campus which lies in composite climatic zone of India.

3.1 Material used

Clay Pipes -: Pipe made from clay that has been subjected to vitrification, a process which fuses the clay particles in a very hard, inert, ceramic state is used and its diameter is 4" and length of 3.5 ft. It is also long-lasting and offers the ability for flexible joints.Vitrified clay pipes meet high standards and ensure safe, reliable and sustainable operations. It also has the long-term durability and service life.

1. Clay Pipes

Clay Bent-: For connection of two clay pipes bend is used to make it air and water tight.and its one end is of 4" diameter and another end is 2.5".

2. Clay Bend

Fly ash brick-: These bricks are environment friendly. Fly ash is a by-product of thermal power stations; it Save agricultural land .and also required Less energy intensive compared to clay bricks. It can be manufactured at construction site also.

3. Fly ash brick

Exauhst Fan-: It is used to transfer, the cool air from the clay pipes inside the ground to the room, its diameter was 6″ With thermal fuse protection and its dimension is 170mm x 170mm and its Air delivery capacity is 159 cu.ft./min.

4. Exauhst Fan

Solar Batteries-: This is used to run the exauhst fan.It works on solar energy as we are using this at the time of summer season so because of sunlight it automatically get charged its have high power density.Its Initial cost is hight but its life span is more and its efficiency is more.

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5. Solar Batteries

3.2 Procedure

A room made of fly ash bricks having size 4x4x4 ft is constructed at GNI,Nagpur campus which lies in composite climatic zone of India. Excavation up to a depth of 4 ft is done at the backyard of room and Four clay pipes of 4” dia and length of 3.5 ft and three bent pipes are also used to make duct which is beneath the ground,whose one end is open to atmosphere and another end is inserted inside the fly ash room touching the ground surface.Two Clay pipes are laid horizontally and two vertically with the help of bent pipes in the excavated area. An exhaust fan is connected at the face inside the room which will transfer the cool air from the pipes to the room .Broken pieces of tiles are being placed at the top of the asbestos sheet so as to reflect the heat.

6. Construction and installation of Geothermal cooling System

IV. OBSERVATION AND DISCUSSION

Day	Time	Duration	Atmospheric Temperature	Initial Temperature	Final Temperature
Day 1	8 AM to 9 AM	60 min	36° C	32° C	28° C
	12 PM to 1 PM	60 min	42° C	34° C	30° C
	4 PM to 5 PM	60 min	40° C	34° C	29° C
Day 2	8 AM to 9 AM	60 min	36° C	32° C	27° C
	12 PM to 1 PM	60 min	39° C	34° C	29° C
	4 PM to 5 PM	60 min	42° C	34° C	30° C
Day 3	8 AM to 9 AM	60 min	42° C	32° C	27° C
	12 PM to 1 PM	60 min	44° C	34° C	29° C
	4 PM to 5 PM	60 min	44° C	34° C	28° C
Day 4	8 AM to 9 AM	60 min	39° C	32° C	27° C
	12 PM to 1 PM	60 min	40° C	32° C	27° C
	4 PM to 5 PM	60 min	42° C	34° C	28° C
Day 5	8 AM to 9 AM	60 min	36° C	30° C	24° C
	12 PM to 1 PM	60 min	40° C	32° C	27° C
	4 PM to 5 PM	60 min	39° C	31° C	26° C
Day 6	8 AM to 9 AM	60 min	39° C	32° C	27° C
	12 PM to 1 PM	60 min	41° C	34° C	28° C
	4 PM to 5 PM	60 min	42° C	34° C	28° C

The energy performance and the temperature variation of discussed cooling systems is analyzed for 6 days for the duration of 60min at three specific time of day such as 8 AM to 9 AM, 12 PM to 1 PM and 4 PM to 5 PM according to the direction of sun.This model have given the temperature variation of around 6° C to 7° C from the atmospheric temperature outside the room.As the asbestos sheet is used as roof, the drop in the temperature was lesser if we construct the RCC slab then we would have got the temperature variation of atleast 10 ° C.

V. CONCLUSION

The setup will be ecofriendly as clay pipes and fly ash bricks are used.This require very less water and electricity,though cost of solar battery is high but it give long lasting usage and save electricity.the setup is economical, it require less money than the evaporating coolers and air conditioners. It is easy to construct and does not require much skill. The set up is only one time investment and only maintenance is needed periodically. If the pipes can be laid in garden area so that it will definitely give much effective results because soil in garden area will be moist and the capillary reaction will be better in clay pipe and the fall in the temperature will be more.

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