Designing a Heating and Cooling System in the Ground

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***Abstract*—The primary objective of this research is to describe and validate an essential ground heating and cooling system design. This experiment established that this system could sustain a room temp of 25°C. Applications/uniqueness: The breakthrough lies in utilizing the earth's constant ground temperatures as a refrigerant in a cooling system that does not rely on a heat pump to provide cooling and heating. This system can be tweaked or enhanced to match an individual's unique needs. This technique can be utilized in businesses wherever air cooling is not permitted to replace air coolers.**

***Keywords*—cooling system, heat source, ground temperature, air cooler, temperature**

I. Introduction

Earth-linked heat transfer generators are a type of underground heat exchanger capable of collecting and dispersing the temperature of the ground. The ground's temperature is practically constant underground, making it an excellent location for heating or cooling air or fluid in the home, agriculture, or industry. This document discusses our ground energy demonstration in detail and alternative energy sources that could be employed in place of existing heating and cooling systems[1]. Ground energy is a huge source of free, or almost free, energy from the ground. The ground air-cooling method is often deemed to be the highly energy-efficient type of air-cooling system offered today. [2] Additionally, an evaporative cooler and air-cooling system can be used in conjunction with a Ground Combined Heat Exchanger. It is a far more affordable alternative that also consumes less energy. It is a form of renewable energy in which heat is transported from the ground or earth to the surrounding air (Full Of Atmosphere air in the neutral state). A critical truth that everyone is aware of is that while the temperature of the surrounding air varies with the seasons, the earth's temperature remains constant throughout the year, regardless of where you are globally (roughly around 200-250C). A more sensible option would be to link the heat sink to the ground, enabling the use of a ground-coupled heat exchanger to maintain a constant temperature with the heat sink (Earth) (ambient air). In contrast to variable ambient air, most land-based systems maintain a constant temperature for both the land and the earth. It minimizes power consumption, as most systems need energy solely to maintain a steady temperature throughout the year [5]. While ambient air consumption varies according to operation load, it also exhibits an inverse connection with power usage. As is the case throughout the year, summer increases the workload because of the additional energy required to transfer heat from a building to a cooled already and hot heat source.

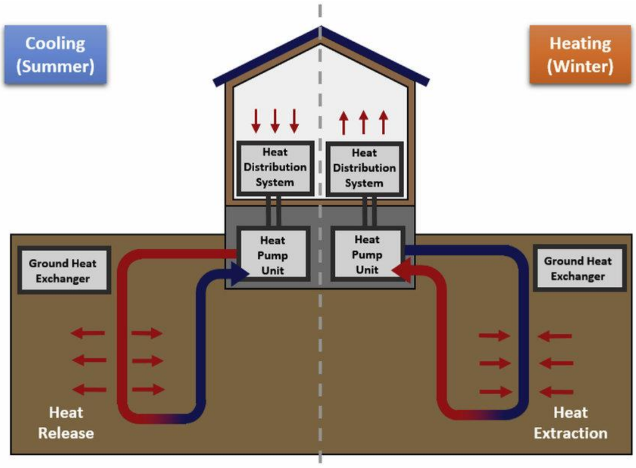

Fig. 1. Graph of Ground Heating coupled with Cooling Usage

The workload and energy consumption are reduced in the winter due to the lower temperature of the heat sink. When considering electricity consumption, using the earth or ground as a heat sink is a more cost-effective choice than ambient air. The earth's temperature is limited in its expansion and contraction throughout the year due to the same temperature of the earth and water 4-5 feet beneath the surface. This feature allows the system to function well in virtually any place at any time of year. Hot air is circulated through a ground heat pump when ground energy systems create heat. They cool by using an air-to-liquid exchange to circulate warm air. The bulk of ground-based chilling systems work by transferring heat from the surface to a 20-foot-deep (6-meter) location many feet below ground. Water is heated and absorbed into the ground as it travels under the ground's surface via a ground loop. After that, the water is allowed to ascend to the surface, where it cools and helps keep the surface temperature stable. Earth systems can frequently lower even the most intense heat sources due to the density of the ground under them. Ground energy is suited for green data centres, other industrial settings, and even households, as it is sourced from the earth's core heat. Ground cooling uses almost no energy, emits no carbon, and relies on the water already existing in the confined environment.

II. Operational Principles

The earth cooling and heating system are based on the notion that the ground maintains a continuous temp during the year at a depth below the earth's surface. The temperature usually is between 20 and 25 degrees Celsius, though this might fluctuate based on geological and geographical variables [3]. The soil's conductivity, thermal inertia, and a range of other parameters such as the soil's water holding capacity and depth determine the rate of heat transmission amongst the ground cooling and heating system and the earth [4]. While the efficiency of ground-source heat pumps and cooling systems may obtain up to 6 times the amount of heat energy consumed by electrical energy, evaporative air coolers and air-conditioning systems are less efficient, as they cannot extract this level of heat energy.

The system is comprised of the following components: an air stream (4), a water basin (2), cooling loops (3), a water drain (5), a fan (6), an ac superior motor (6), and High-Density Polyethylene Pipes pipelines (1). This operation entails extracting water from the reservoir (2) or tank (3) and transferring it to the cooling system through copper tube loops before cooling coils (5) in the cooling section. Following that, the cooling unit extracts or suctions hot air from the surrounding environment. It is composed of an outside shell, air leaks (4), capillary heat pipe coils or cooling coils (5), an excellent ac motor (6), and a fan (6). Air is channelled from the heat exchanger inside the unit to the cooling water loop and then exits the unit. It does so by heating the water in the loop, forcing it to rise. As the water rises, it transfers its heat to the copper tubing outside the unit, which is then convectively transmitted to the outside air. After turning on the cool water, hot water is now being discharged from the cooling unit via High-Density Polyethylene Pipes.

(1) Down to the ocean's bottom, Extremes of temperature are more pronounced near the ground, as it absorbs half of the sunlight that the earth receives. As a result, temperatures at a depth of 4 to 5 feet stay relatively constant throughout the year, in contrast to temperatures above the surface, which are substantially lower. A network of High-Density Polyethylene Pipes has been installed over 600 feet below the earth's surface.

(2) Grounded looping conduct heat away from hot water and act as a heat sink, cooling or returning the water to its initial level. The cold water from the water cooler then streams through the High-Density Polyethylene Pipes (1) and into the water tank (2), where it is collected, and the cycle begins again, chilling the room. While soil contributes to winter heating, it can also be used as an inside heater due to its warmth.

III. EXPERIMENTAL METHODS

The purpose of this article is to layout and test ground-based heating than a cooling method for practicality. To precisely measure the effectiveness of this system, we use a standard bedroom measuring 12 feet on each side, ten feet tall, and 10 feet long. A room with a 1200 ft3 should be refilled with new air every hour, as estimated by multiplying the room's volume by the formula (room volume) divided by the number of times every hour that new air should be placed in the room 60 meters. A regular air adjustment per period for just a room is assessed to be 6 using the air exchange index. It suggests that the Cubic Feet Per Minute value for the 1200 ft3 room is 120. Following that, we need to determine the amount of cooling coil required for the stated room, which we determined using the following data: This machine can generate up to 120 cubic feet per minute of airflow. The water pump has a maximum pumping capacity of 0.23 kg/s, the outside air temp is 45°C, and the ideal room temp is 25°C. After that, the thermobarometer is used to analyze the particular volume and air moisture of air at the system's input and output, respectfully. We calculated these statistics and concluded that the system's entrance and departure are constantly enthalpies. These measurements were used to calculate the low humidity flowrate and the ground water mass flow rates. These data suggest that once each of these computations is complete, this system's cooling load be established. To determine the required surface area for convective heat transfer, we shall examine cooling coil sizing.

Flow rate of the air dry in mass volume

$$(Ma*) = V*/V1Ma*$$

$$= 0.055/0.8 = 0.06875Kg/s$$

Mass flow rate of condensate water

$$(Ma*) = V*/V1Ma*$$

$$= 0.055/0.8 = 0.06875Kg/s$$

$$Load\ of\ Cooling\ (Q*) = Ma*\times(h2 - h1) + (Mw*\times hw)$$

$$Q* = [0.062 \times (76.08 - 125.37)] + (0.00065 \times 102.85)$$

$$= 2.8KW = 2.8KJ/s$$

Cooling loop give vent to temp.

$$F1 = Q*/(M*\times Cp)$$

$$= Tin + F1$$

$$= 27 + 2.8/(0.25 \times 4.2)$$

$$= 29.6^{0}C$$

Let's apply the approach we used for calculating heat transfer for heat exchange below to measure cooling coils, which will provide us with the heating coils contact area that will be in touch with air for the proper cooling capacity.

TABLE I. FACTORS AND PRINCIPLES

S. No	Factors	Principles
1.	Thermal mass flow rate (M*), also referred to as cooling water volume flow rate	0.25 Kg/s
2.	The temperature of the Upstream Side	30 °C
3.	Detailed Temperature Capacity of Water (Cp)	4.5 KJ/Kg K
4.	The temperature of Heat exchanger Water	47 °C
5.	Heat content (hw = hf at 25ºC)	105.73 KJ/Kg

TABLE II.

Acreage	Air Gets In	Air Get Out
Particular Humidity (W)	W1 = 0.033	W2 = 0.025
Specialized Volume (V1)	0.8 m3/s (low Humidity)	
Relative Humidity (RH)	51%	100%
Air Temp. (T)	44 °C	26 °C
Heat content (h)	h1 = (1.006 × 45) + 0.033 × [(1.84 × 45)	
Air Capacity Stream Ratio (V*)	+ 2501] = 125.36 KJ/Kg	h2 = (1.006 × 25) + 0.025 × [(1.84 × 25) + 2501] = 76.09 KJ/Kg

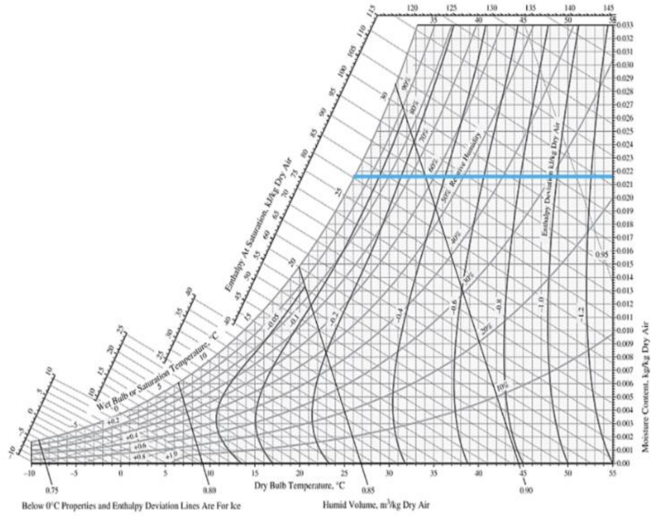

Fig. 2. Chart of Psychrometric

$$Q = h \times As \times (Ts - T\infty)$$

Where

Q = Heat created or cooling capacity

H= When copper is utilized as a method, it is the global heat transmit coefficient among air and water.

As =Convective heat spread occurs at a surface area. Ts = As's surface temperature

T = The high temperature of the water is symbolized by the letter.

$$2900 = 13.15 \times As \times (46 - 23)$$

$$As = 2900/266 = 11.01\, m2 = 119.12\, ft2$$

If any cooling loop has a 12 ft2 effective face area, the cooling element will require 9.89 or approximately 10 coils of the correct features stacked together to create a 119.04 ft2 effective surface area

IV. Conclusion

Based on the data, we determined that this system could maintain an appropriate room temperature of 25°C using water as a refrigerant for a cooling load of a room. However, there has been a major rise in the treatment of copper in the construction of cooling coils, making this system more expensive to build. This technology is more expensive than a traditional air cooler, but it uses substantially less energy and is more durable. Additives like nanoparticles could improve the effectiveness of this system in the future, and the cooling and heating might also utilize them in businesses where air coolers and the air coolers are not feasible to build.

Contrubition of the Authors

The contributions of the authors to the article are equal.

Conflict of Interest

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

Research and publication ethics were observed in this study

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