Impact of Various Pipe Geometries on Performance Parameters of Ground Source Heat Pump

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Abstract: With the consistently expanding issues over ecological affect and the rising costs of fuel, numerous property holders have started to appear to substitution methods for warming and cooling their properties. An inexorably well-known procedure to accomplish the previously mentioned interests is by means of utilizing ground-supply heat siphons (GSHP). GSHPs have normally been hailed to reduce both non-renewable energy source use and electricity. Besides, a wide assortment of set up decisions are accessible making them achievable for a couple of circumstances.

Introduction:

The way closer to power consumption worldwide is increasing, renewable energy technologies like solar, wind, geothermal and so on. Are attracting the attention of renewable power sources to meet the energy demand. Constrained availability of conventional energy assets fossil fuels (coal, oil, natural gasoline) on this planet and the high carbon emission for power construction by way of them are the predominant factors for specializing in the renewable non-traditional power sources. Researchers are establishing new renewable vigour applied sciences, which might be environment-pleasant emitting low or no carbon to the atmosphere and further doing development to toughen their procedure efficiency.

Ground source heat pump (GSHP) is one of the sustainable power source advancements, which is broadly utilized for space warming and cooling. Master Kelvin presented the idea of GSHP framework in 1852 and afterward it is altered by Robert Webber during the 1940s. GSHP framework utilizes the ground as a warmth source in cooling mode by engrossing warmth starting from the earliest stage as a warmth sink in warming mode by discharging the warmth to the ground.

The GSHP system is of two types: 1- Open loop cycle system

2- Closed loop cycle system

In open circle framework, groundwater is most broadly utilized as a warmth source or sink in the framework. While shut circle framework is ordered into conceivable two different ways-

1-Direct extension, where the refrigerant is circled legitimately through the ground circle.

2-Indirect extension, where a water/liquid catalyst arrangement flows through the ground circle and vitality is moved to or from the warmth siphon refrigerant circuit by means of a warmth exchanger.

Types of ground heat exchanger

Indirect heat exchanger - This type of system consists high-density polyethylene pipe in a closed loop inside which working fluid circulates and the heat transfer takes place indirectly between GHX and heat pump.

Direct heat exchanger - In this type of system copper pipe is used inside which fluid circulates, which increases the efficiency of the system due to their high thermal conductivity. Heat transfer in the direct expansion is high as compared to indirect expansion due to good thermal contact of fluid circulating pipe and the ground. More refrigerant requirement for the system and risk of refrigerant leakage are the main drawbacks of the system.

Literature Review:

S.C. Karytsas et. al. (2017) Presented a layout of the Greek laws which is straightforwardly or not legitimately with respect to ground supply heat siphon (GSHP) programs in which worry, among others, geothermal control, shallow geothermal vitality, set up of warming/cooling systems and residential boiling water development, utilization of surface water or groundwater, heat siphons, progress of sustainable power source bases, vitality related items and vitality effectiveness of structures are delineated. GSHPs has been increased after some time routinely because of the significant European orders and choices; anyway additional upgrades and improvements are required. The abuse of shallow geothermal vitality in Greece is seen quintessential — explicitly because of the financial downturn of the nation—as GSHP strategies give warming, chilling and household heated water in a couple of kinds of capacities, with clear monetary, natural, power, social and stylish points of interest in correlation with close by non-traditional or regular frameworks.

Liang Fanga et. al. (2017) Learned about a position of place of business with around 10000 m2 ground subject, which utilizes GSHP strategy for warming and cooling. various conditions with various parameters, for instance, separating between boreholes, borehole expansiveness and structure, warm conductivity of soil, are given for reproduction. Furthermore, in every single situation, the correlations of the method effectiveness with reference to the vitality give and venture for single and twofold U-tube heat exchangers are introduced. On this examination, with a fundamental soil warm conductivity and low drill cost, twofold U D-25 and 6 m borehole isolating would be the significant level structure plan parameter. At the point when the penetrating rate is exceptionally reasonable, picking single U D-32 will presumably be genuinely better. The given methodology and results could give a reference to prevalent plans of the GSHP strategy which seek after complete economy other than its warm proficiency.

Wanjing Luo et. al. (2017) contemplated a novel semi explanatory framework was once created to procure abilities of the warm productivity of multi bore hole floor heat exchangers with irregular diagrams. By methods for tolerating a uniform delta fluid temperature (UIFT), rather of uniform warmth progress, the consequences of warm deterrent and the warm productivity change between incredible boreholes may likewise be analyzed. Re-enactment final product call attention to that the month-to-month normal outlet liquid temperatures of GHEs will grow consistently while the yearly cooling heap of the GHEs is superior to the yearly warming limit. Beside, two instruments, the warmth dismissal and the warmth expansion impact, will research the warmth switch underground, which may likewise be extra partitioned into 4 phases. What's more, some boreholes perhaps smashed; that is, gaps can take in heat from floor when the GHEs are underneath the cooling mode. Regardless, as demonstrated with the guide of additional examinations, this breakdown can be avoided through using developing borehole dividing.

Monika Ignatawicz et al., (2017) had examined the exhibition of various ethyl liquor based auxiliary liquids (business items in European nations) in GSHP. The presentation assessment is done based on heat move and weight drop in the BHE, taking EA20 as a source of perspective liquid. (EA18+PA1.6+BA0.4), most usually utilized a business item in Sweden had indicated the best execution as far as lower pressure drop and higher warmth move up to 2.7% and up to 10% separately. Further with the lower pressure drop (up to 2%) and higher heat move (up to 5%), (EA20+MEK2+MIBK0.5) had demonstrated the second-best execution. (EA17.5+PA2+BA0.5) and (EA20+MEK1.8+MIBK2.7) had indicated the most exceedingly terrible exhibition both regarding pressure drop and warmth move than EA20.

G Dumitraşcu et. al. (2016) broke down the exhibitions (COP, power and, warming heat cost perform of time) for a base-coupled heat siphon that is utilized to warm a space for the time of winter climate, for a time of 180 days. The investigation plan is to survey the time-arranged adjustments in estimations of COP and, vitality moves of a geothermal warmth siphon, considering about a situation for the variety of the surrounding temperature in time and an indicative response for the time dependence of the dirt one. The temperatures and the power move rates have been chosen the premise of the irreversible entropy balance condition. The entropy solidness condition of the irreversible warmth siphon permitted whole connecting of all factor in time parameters, temperatures, vitality move charges and COP. The scientific model of this evaluation might be used to various continuous established prohibitive stipulations.

Jeffrey Molavi et. al. (2016) Learned about Geothermal heat Pump strategies in Retail developments. Research for the achievability of the framework and improvements in their productivity is a great idea to have a comprehension of their full capacities. In the event that the world's having of petroleum product gets depleted, the power business will have no ideal anyway to utilize sustainable properties. The earth is prepared of providing the whole vitality the earth would require through characteristic strategies that don't modify the science of the earth.

Ahmet Kose et. al. (2016) Learned about the recognizable proof, execution and impersonation of the ground source heat Pump (GSHP) Model. It additionally offers an examination of exceptional models. The technique includes borehole heat exchangers, a warmth siphon and warmth dissemination stage. More often than not, the reason for this paper is to set up a procedure to foresee the conduct of GSHP models. The mannequin with the lovely execution is the Hammerstein-Wiener model. The assurance criteria had been the top notch fit, parameter estimation, approval of the model and constitution of dynamic models. All out, the primary execution is a perceived mannequin of GSHP short helical warmth exchanger to dissect the ground temperature subject and to raise foresee the measure of warmth vitality starting from the earliest stage. The work is given by methods for

Graphical buyer Interface (GUI). The proposed recognizable proof and assessment could likewise be significant in creating GSHP strategies.

Tabatabaei et. al. (2016) In this examination the monetary viewpoint for warming is investigated for various locales of Iran and for various estimating procedures for power and gas. This is done reliant on numerical re-enactments over a year subject to temperature information, for nearby warming reliant on a warmth siphon conversely with gas-based warming. In this examination it is demonstrated how recreation models can be utilized to discover which kind of warming framework can be a financial decision in various districts in Iran, along these lines taking into reason diverse estimating choices. The work detailed here can be refined and different in various manners.

Zoi Sagia et al., (2016) had done a search to find the most suitable environment-friendly replacement of R-22, most widely used refrigerant as working fluid of heat pump in a GSHP system. 7 different alternative refrigerants (5-binary mixtures and 2-ternary blend) was examined for a given GSHP system to meet the required energy demands. MATLAB and REFPROP 8.0, two computer software's were used to studying the performance of refrigerants in the heat pump system. The ternary mixture R-152a/R-125/R-32 had shown the highest COP (4.608) value among all other proposed alternatives, closest to the COP (4.61) of R-22 and it also can be taken into account for the effective operation of the heat pump due to a high glide at a relatively small pressure.

Nui et al., (2016) has done an experimental study on the performance of GSHP system for R-410A refrigerant. The result reveals that increase in condensation temperature from 30 degree C to 60 degree C keeping evaporator temperature constant at 5 degree C, decreases cooling capacity and COP by 33% and 66%, whereas increases the input power by 97.8% respectively. It was also observed that increased evaporation temperature from 0 to 12.5 degree C, increases both input power and refrigeration effect by 20% and 55% respectively. The refrigerating capacity was affected by temperature drop of chilled water and cooling water flow rate.

Md. Hasan Ali et al., (2016) experimentally investigated the performance of horizontal GHX's for two different orientations, standing and reclined. LDPE coated copper tubes were taken for GHX's pipes, which were buried 1.5m deep inside the ground and ground temperature distribution was also monitored by placing thermocouples (T-type) at different depths up to 10m deep. From the results, it was concluded that the increase in flow rate from 1l/m to 2l/m, increases heat transfer rate by 17.5% and 21.7% for reclined and standing GHX. Standing GHX has higher heat transfer rate as compare to reclined one due to the higher thermal conductivity of backfilled sand.

Apostolos Michopoulos et. al. (2015) Investigated the vitality, natural, and budgetary favorable circumstances of the establishment of ground source heat siphon frameworks in private developments in Cyprus. The result are interpreted in basic vitality utilization expecting two exceptional customary frameworks for warming, a LPG-and an oil-terminated heater, just as an aerial break type heat siphon for cooling. The ground supply heat siphon framework is dimensioned with the guide of EED 3.16 application and broke down using an in home created and approved code; accordingly, the foremost vitality utilization is determined. Moreover, and established on the principal vitality utilization, the CO2 emanations of the elective strategies are determined and when looked at. The result demonstrate that gigantic vitality and monetary points of interest can be done by means of the substitution of traditional warming and cooling procedures with geothermal warmth siphons on the lodging division of Cyprus.

Ioan Vlad et. al. (2015) Considered with respect to the effectively assessment of ground-source heat Pumps. There are two essential classes of GSHP frameworks, the open and the shut circle process. The open framework used groundwater to give water to the warmth siphon in a flash from a structure decent. The shut circle methodology utilizes parallel or straight up sorted out floor heat exchanger in which streams a working liquid (for example Water with liquid catalyst operator). The utilization these nearby floors regular geothermal vitality by method for ground supply heat siphon (GSHP) systems has boundlessly gotten in notoriety in state-of-the-art years. That seeing that the highlights of ground-supply heat siphons for warming, cooling and boiling water for various cherished one's townhouse and for private developing are monetarily productive in contrast with basic vitality sources-set up strategies.

Yong Liu et. al. (2015) In light of figuring and assessment warm opposition of vertical GHE, this addition information on have dissected prevalent components, which impact the warmth switch productivity of floor heat exchangers' (GHEs) beneath explicit conditions. Joining practical designing utility, frameworks of diminishing the warm obstruction and enhancing warmth move of GHE are proposed. For bettering warmth move productivity and diminishing silly warmness squander, a fresh out of the box new ground heat exchanger with three delta channels and one outlet pipe is presented. Also, as per the aftereffects of hypothetical computation and investigation, it is distributed that the warmth move protections of the GHE with funnels underneath factor conditions are ceaselessly lower than that of GHEs with either single U-pipe or twofold U-pipe.

Yu Jin Nam et. al. (2015) Inspected the characteristics of the technique, a unique recreation was once done underneath different conditions. The result of our case learns give focused on activity information suggestive of warmth exchange value, warmness supply temperature, and warmth siphon COP. Consequently, the warmness siphon COP of SAGHPS was once 4.7%, 9.3% higher than that of the GSHPS. On this examination, so as to help the procedure productivity of a GSHPS, a story heat siphon strategy coordinated with sun powered warm stockpiling used to be created. This solar- assisted ground heat siphon approach (SAGSHP) can each keep up the unfaltering quality of the dirt temperature effectively and procure more prominent strategy productivity than the regular framework.

Lale Valizade et. al. (2013) Examined the ground supply heat Pumps are a few kinds of warmth siphons that they have numerous points of interest not at all like their dangers. Their essential advantage is high effectivity (high COP), and they might have the option to outfit each warming inside the winter and turn around cooling in the mid year. CO2 emanations from heat siphons are obviously lower than fuel or oil-terminated warming frameworks and because of the poor quality power source used through warmth siphons are seen a sustainable power source supply. A story supply siphon could accomplish 450%, contrasted and a productive gas kettle of ninety% positively this is a monster change. The cost of hardware, material and establishment can be lavish, depending on the type of warmness siphon establishment intentional.

Components used

To perform Study of Ground source heat pump temperature variations by using HDPE Fibre pipe with plain and corrugated profile. Following components used in setup:

- Water circulating pump
- Rotameter
- Pipe
- Thermocouples
- Thermometer
- Temperature Sensor meter

Table 3.1: Details of Component

Sr No.	Components	Specification	
1	Water circulating Pump	Input 240 V Discharge head up to 2 m	
2	Rotameter	Discharge rate 0 - 5 L/min	
3	Pipe	Shape - 1) Corrugated 2) Plain	Each pipe is 10 m long
4	Thermocouples	6- Thermocouples (Pt 100) type	
5	Thermometer	Digital type Range (-200^{o}C to 200^{o}C)	
6	Temperature Sensor Meter	Digital (8 Channel Type) Temperature Range (-200^{o}C to 200^{o}C)	

This area comprises fundamentally of two sections: establishment of a GSHP framework and the observing framework. I right off the bat present the area, development and establishment of the GSHP framework. At that point, the information logging framework concerning screen activity of the GSHP framework is additionally portrayed. This piece of the work gives some fundamental data to assist investigation of warm execution of the GSHP framework.

Table 3.2: Basic climate parameters of system installed

Sr No.	Parameters	Specification
1	Study in months	July to September
2	Daily mean temperature in July	23 – 25 units

3	Mean heating hours	1800 h
4	Cooling period	November - February
5	Daily mean temperature in Sep.	20 – 22 units

Figure 3.2: Corrugated profile pipe setup in ground

Figure 3.3: Plain pipe used in setup

Heat flow process is shown in the following figure:.

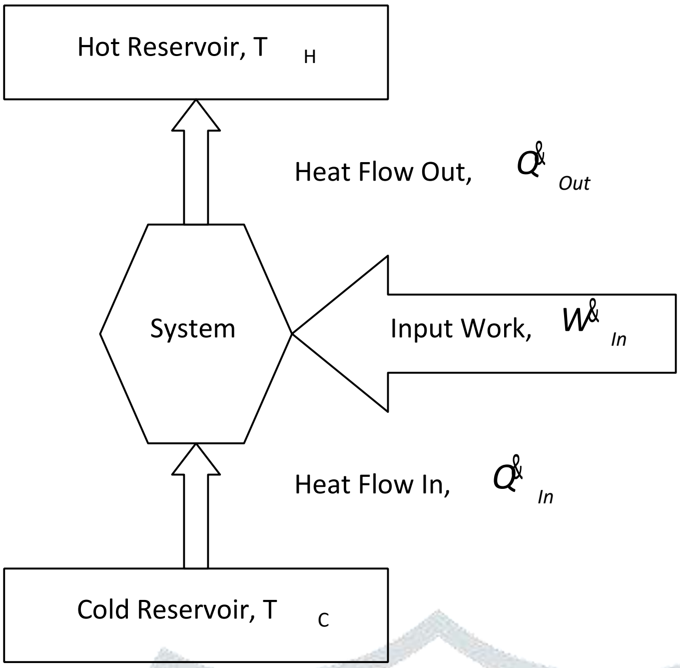

Figure 3.5: Thermodynamic interactions of the heat pump cycle

A GSHP uses a vapor pressure cycle which can be work in reverse direction to produce both heating and cooling. A fume pressure cycle utilizes a refrigerant as a medium to retain heat at one point and reject it to another. The graph in Figure 6 delineates a run of the mill GSHP framework in a warming cycle with the expansion of household high temp water.

The association among BHE and indoor units is the warmth siphon framework that is composited of two sections: Heat exchanger (HX) and warmth siphon. In cooling mode, vitality is infused into the ground. For this situation, the ground is utilized as a "heat sink" to scatter the warmth expelled from the structure. A metal plate with high warm conductivity is utilized as an HX to associate between the ground and the structure. While in warming mode, the ground goes about as "heat source," and the warmth is extricated starting from the earliest stage the HP.

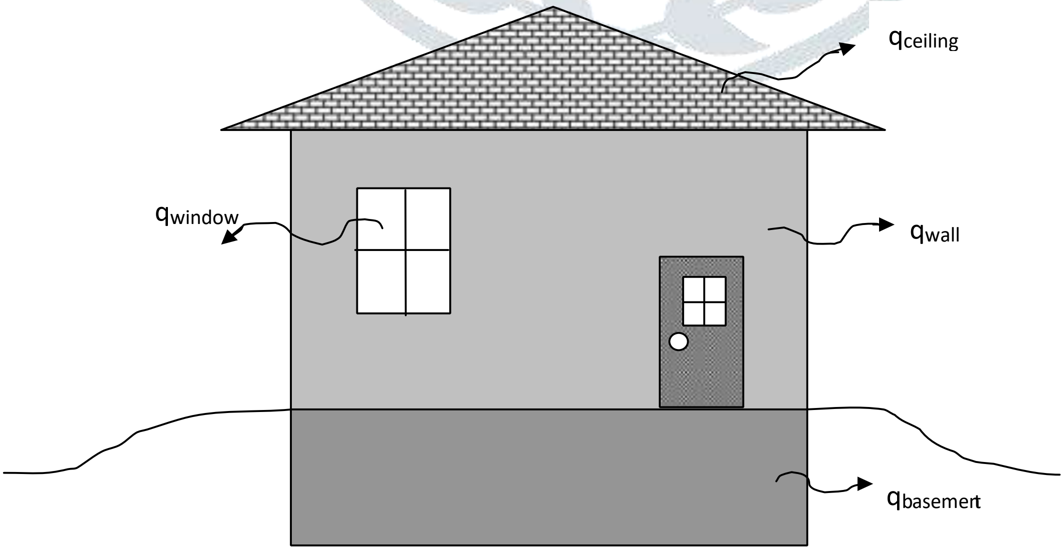

Figure 3.8: Heat transmission in the home

The warm opposition of most building materials (dividers and roofs) are commonly appraised utilizing an R-esteem. The R-esteem rates the material dependent on a for each unit zone premise. These qualities can be acquired from producers or normal tables, for example, from ASHRAE. On the other hand, heat move coefficients or U-qualities can be utilized to decide the warmth transmission. A straightforward connection between the R-worth and U-esteem is seen as:

U = 1/R

In the event that the U-esteem is increased by its particular region, the transmission zone for the structure envelope is found.

On the off chance that the U-esteem is duplicated by its separate region, the transmission territory for the structure envelope is found.

$$UA = \frac{A_{ceiling}}{R_{ceiling}} + \frac{A_{wall}}{R_{wall}} + U_{basement}A_{basement} + U_{window}A_{window}$$

Results and Discussions:

System modelling of the HPWH system was an essential task for this research. Each experimental run took upwards of 15 hours, and the ability to accurately estimate the system performance was paramount in determining the validity of each test.

The heat pump water heater system was modelled using two different profiles of pipe to predict and verify system performance under a variety of different physical operating conditions.

This chapter provides the details of the results that were used to determine the optimal design and operational conditions with respect to energy for an HPWH unit in India. First, the experimental results are described; second, the modelling results, third, the optimization techniques and findings, and final, the sensitivity and uncertainty analysis are detailed.

4.2. Experimental Results

Several experimental runs were executed to characterize the HPWH performance parameters, including power draw, energy consumption, and COP, as outlined in Table 4.1. To characterize the thermal response, the power demand and temperature profiles were plotted with respect to time. In conjunction, the COP and power demand were plotted with respect to time to determine the heat pump performance with respect to fluid temperature. These plots were generated for all experimental runs, but only the high and low set-point temperature runs will be highlighted. Sensor types and locations are described.

Figure 4.1 and Figure 4.2 show the temperature decreases that are experienced by the Fibre pipe profile, pump, and both simultaneously. They also show how the tank reacts during periods without cooling, which proved useful in the calibration process to determine tank thermal properties. It is apparent from the figures that the water heat is rejected by the pipe profile to the ground surface. This was reflected in the model and confirmed through the calibration process.

Table 4.1: Experimental Readings for Corrugated pipe geometry (1 Ltr /min water flow rate)

	Date	Reading Timing (after 10 min)	Ambient air Temp. (oC)	Inlet Water Temp. (oC)	Outlet water Temp. (oC)	Temp. Diff. (Inlet - Outlet) (oC)	Average of Temperature diff.	Water flow velocity (Ltr / Min)
	25-07-2018	12:55:00	24.7	24.3	23.6	0.7	0.57	1
		13:05:00	23.6	24.6	24	0.6		1
		13:15:00	23.2	24.5	24.1	0.4		1
	26-07-2018	13:15:00	23	23.4	23.3	0.1	0.17	1
		13:25:00	22.5	23.7	23.4	0.3		1
		13:35:00	22	23.6	23.5	0.1		1
	27-07-2018	13:25:00	22.1	21.8	22.7	0.9	0.08	1
		13:35:00	22.6	22	22.5	0.5		1
		13:45:00	22.2	22.3	22.4	0.1		1
		20:00:00	19.7	21.5	22.2	-0.7		1
		20:10:00	19.5	21.5	21.9	-0.4		1
		20:20:00	19.4	21.8	21.7	0.1		1
	28-07-2018	18:40:00	19	19.1	21.6	-2.5	-1.95	1
		18:50:00	18.08	19.4	20.8	-1.4		1
	29-07-2018	12:15:00	25.9	21.1	23	-1.9	-1.07	1
		12:25:00	25.6	21.5	22.6	-1.1		1
		12:35:00	25.7	22.4	22.6	-0.2		1
	29-07-2018	22:30:00	21.4	22.9	22	0.9	0.73	1
		22:40:00	21.2	23	22.3	0.7		1
		22:50:00	21.6	22.8	22.2	0.6		1
	30-07-2018	18:50:00	21.6	26.4	22.6	3.8	2.33	1
		19:00:00	21.7	26.3	23.7	2.6		1
		19:10:00	21.8	24.7	24.1	0.6		1
	31-07-2018	21:05:00	21.5	23.9	22.6	1.3	0.77	1
		21:15:00	21.2	13.9	23.2	0.7		1
		21:25:00	21.4	23.7	23.4	0.3		1
	01-08-2018	13:15:00	24	25.6	24.5	1.1	1.08	1
		13:25:00	24.9	25.5	24.6	0.9		1
		13:35:00	24.6	24.9	24.7	0.2		1
		20:15:00	22.8	25.6	23.6	2		1
		20:25:00	22.9	25.7	24.5	1.2		1
	02-08-2018	14:05:00	27.2	26.6	25.5	1.1	0.78	1
		14:15:00	27	27.1	26.2	0.9		1
		14:25:00	26.9	26.7	26.3	0.4		1
		21:55:00	22.6	25.7	24.6	1.1		1
		22:10:00	23	25.7	24.8	0.9		1
		22:20:00	22.5	25.3	25	0.3		1
	03-08-2018	14:00:00	25.6	25.8	24.2	1.6	0.80	1
		14:10:00	24.8	26	25.2	0.8		1
		14:20:00	25.6	25.8	25.5	0.3		1
2		20:40:00	22.7	25.2	24.3	0.9		1
		20:50:00	22.8	25.5	24.7	0.8		1
		21:00:00	21.7	24.3	23.9	0.4		1

Table 4.2: Experimental Readings for Corrugated pipe geometry (0.5 Ltr /min water flow rate)

	Date	Reading Timing (after 10 min)	Ambient air Temp. (oC)	Inlet Water Temp. (oC)	Outlet water Temp. (oC)	Temp. Diff. (Inlet -	Average of Temperature diff.	Water flow velocity

						Outlet) (oC)		(Ltr / Min)
	04-08-2018	13:30:00	26.8	25.6	25.3	0.3	1.08	0.5
		13:40:00	26.1	25.7	25.2	0.5		0.5
		13:50:00	25.5	25.7	24.5	1.2		0.5
		21:00:00	22.2	24.6	22.7	1.9		0.5
		21:10:00	22	24.4	23	1.4		0.5
		21:20:00	22.2	24.1	22.9	1.2		0.5
	05-08-2018	12:25:00	22.7	23.2	22.7	0.5	0.33	0.5
		12:35:00	22.4	23.1	22.9	0.2		0.5
		12:45:00	22.8	23.1	22.8	0.3		0.5
	06-08-2018	14:15:00	23.7	21.9	22.8	-0.9	-0.68	0.5
		14:25:00	23.2	21.9	22.8	-0.9		0.5
		14:35:00	22.5	22	22.7	-0.7		0.5
		20:35:00	19.2	21.2	21.8	-0.6		0.5
		20:45:00	20.3	21.2	21.8	-0.6		0.5
		20:55:00	20.1	21.2	21.6	-0.4		0.5
	07-08-2018	20:00:00	19.9	21.3	21.9	-0.6	-0.47	0.5
		20:10:00	19.8	21.3	21.7	-0.4		0.5
		20:20:00	19.4	21.2	21.6	-0.4		0.5
	08-08-2018	17:00:00	24.8	26.3	22.1	4.2	2.03	0.5
		17:10:00	25.7	26.3	24.1	2.2		0.5
		17:20:00	23.8	26.2	24.1	2.1		0.5
		20:30:00	20.9	23.5	22	1.5		0.5
		20:40:00	20.8	23.5	22.2	1.3		0.5
		20:50:00	20.2	23.4	22.5	0.9		0.5
	09-08-2018	09:30:00	24.4	21.8	22.2	0.4	0.77	0.5
		09:40:00	24.2	21.8	22.1	0.3		0.5
		09:50:00	25.1	21.9	22.1	0.2		0.5
		14:10:00	26.8	24.4	22.6	1.8		0.5
		14:20:00	27.5	24.5	23.4	1.1		0.5
		14:30:00	27.2	24.7	23.9	0.8		0.5
	15-08-2018	18:00:00	22.9	25.5	22.5	3	2.03	0.5
		18:10:00	23.8	25.5	23.8	1.7		0.5
		18:20:00	22.4	25.4	24	1.4		0.5
	16-08-2018	17:00:00	24.5	26.1	22.4	3.7	2.33	0.5
		17:10:00	24.7	26.1	24.3	1.8		0.5
		17:20:00	24.8	26	24.5	1.5		0.5

Table 4.3: Experimental Readings for HDPE Circular pipe geometry (for 1 Lt/hr water Flow rate)

	Date	**Reading Timing (after 10 min)**	**Ambient air Temp. (°C)**	**Inlet Water Temp. (°C)**	**Outlet water Temp. (°C)**	**Temp. Diff. (Inlet - Outlet) (°C)**	**Average of Temperature diff.**	**Water flow velocity (Ltr / Min)**
	23-08-2018	19:00:00	21.2	23.8	22.9	0.9	0.32	1
		19:10:00	21.7	23.8	23.1	0.7		1
		19:20:00	21.4	23.2	23	0.2		1
		22:10:00	20.5	22.5	22.6	-0.1		1
		22:20:00	21.2	22.5	22.6	-0.1		1
		22:30:00	21.2	22.4	22.6	-0.1		1
	24-08-2018	17:40:00	22.3	24.6	23	1.6	0.93	1
		17:50:00	22.7	24.5	23.5	1		1

		18:00:00	22.4	23.6	23.4	0.2		1
	25-08-2018	21:00:00	20.8	23.4	22.5	0.9	0.43	1
		21:10:00	20.8	23.4	22.9	0.5		1
		21:20:00	20.8	22.8	22.9	-0.1		1
	26-08-2018	16:00:00	24.2	23.5	22.8	0.7	0.40	1
		16:10:00	23.4	23.5	23.1	0.4		1
		16:20:00	23.9	23.2	23.1	0.1		1
	28-08-2018	19:50:00	20.9	23.8	22.3	1.5	0.83	1
		20:00:00	21.3	23.8	23	0.8		1
		20:10:00	21.1	23	22.8	0.2		1
	29-08-2018	20:50:00	20.6	22.8	22.3	0.5	0.33	1
		21:00:00	20.6	22.8	22.4	0.4		1
		21:10:00	20.8	22.4	22.3	0.1		1
	30-08-2018	13:35:00	25.1	23.7	22.4	1.3	0.70	1
		13:45:00	25.1	23.8	23.2	0.6		1
		13:55:00	25	23.4	23.3	0.1		1
		20:25:00	21.3	23.3	22.3	1		1
		20:35:00	21.2	23.3	22.8	0.5		1
		20:45:00	20.7	23.3	22.9	0.4		1
	31-08-2018	13:00:00	25.2	23.5	22.4	1.1	0.50	1
		13:10:00	25	23.5	23.2	0.3		1
		13:20:00	25.4	23.4	23.3	0.1		1

Table 4.4: Experimental Readings for HDPE Circular pipe geometry (for 0.5 Lt/hr water Flow rate)

	Date	**Reading Timing (after 10 min)**	**Ambient air Temp. (°C)**	**Inlet Water Temp. (°C)**	**Outlet water Temp. (°C)**	**Temp. Diff. (Inlet - Outlet) (°C)**	**Average of Temperature diff.**	**Water flow velocity (Ltr / Min)**
	31-08-2018	19:40:00	21	23.6	22.3	1.3	1.10	0.5
		19:50:00	20.8	23.5	22.3	1.2		0.5
		20:00:00	20.7	23.4	22.6	0.8		0.5
	01-09-2018	13:45:00	23.8	23.2	22.5	0.7	0.60	0.5
		13:59:00	24.1	23.3	22.7	0.6		0.5
		14:05:00	23	23.3	22.8	0.5		0.5
	02-09-2018	13:55:00	25	23.5	22.4	1.1	0.67	0.5
		14:05:00	24.5	23.5	22.6	1		0.5
		14:15:00	24.9	23.6	23	0.6		0.5
		19:30:00	19.2	22.4	21.8	0.6		0.5
		19:40:00	19.3	22.3	21.9	0.4		0.5
		19:50:00	19	22.3	22	0.3		0.5
	04-09-2018	14:15:00	23	23.3	22.2	1.1	0.67	0.5
		14:25:00	23.5	23.3	22.4	0.9		0.5
		14:35:00	23.6	23.4	22.7	0.7		0.5
		19:50:00	21	22.6	22	0.6		0.5
		20:00:00	20.7	22.5	22.1	0.4		0.5
		20:10:00	20.6	22.5	22.2	0.3		0.5
	05-09-2018	14:10:00	25.7	24.2	22.5	1.7	1.50	0.5
		14:20:00	25.4	24.3	22.8	1.5		0.5
		14:30:00	25.1	24.4	23.1	1.3		0.5
	06-09-2018	13:55:00	27.5	24.4	22.3	2.1	1.98	0.5
		14:05:00	27.1	24.4	22.9	1.5		0.5
		14:15:00	27.5	24.4	23.2	1.2		0.5
		17:40:00	21.3	25.1	22.2	2.9		0.5

		17:50:00	21.5	25	22.6	2.4		0.5
		18:00:00	22	24.9	23.1	1.8		0.5

Conclusion

India is a quickly creating economy, and its financial development had a significant impact on its structure area. In view of all year climate conditions, about10–12 states in India need both warming and cooling.

In this Study, we optimize earth heat by mounting the pipe in the ground source for heat exchange. We optimize the data from the inlet and outlet section of the pipe by measuring water temperature in both the design of pipes.

In this experimental study of the GSHP system, the effects of different pipe geometries on the system performance parameters such as COP and power consumption of the system will be investigated. A suitable pipe geometry can be found for the system from the obtained results on the basis of the overall performance of the GSHP system. Based on the analytical and experimental investigation reported in this paper, the conclusions are as follows.

- In corrugated profile pipe, when the water flow rate is 1 L/Hr total 10 days experimentation process run and we got 6th days minium temperature difference between inlet and outlet is 0.733 °C and the maximum temperature difference is 2.33 °C, this is the average temperature of all processes in the same day.
- In the corrugated profile pipe, when the water flow rate is 0.5, L/Hr total 10 days. Minimum temperature differences of water found 0.33 °C and the maximum temperature difference is 2.334 °C.
- When Plain profile pipe is used, then in 1 L/Hr water flow rate, temperature differences of water found 0.33 °C and the maximum temperature difference is 0.93 °C.
- Then Plain profile pipe is used, then in 0.5 L/Hr water flow rate temperature differences of water found 0.6 °C, and the maximum temperature difference is 1.98 °C.

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