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Review on Performance and Working of Earth Coupled Heat Exchanger

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Abstract: **The need to address climate change caused by greenhouse gas emissions attaches great importance to research aimed at using renewable energy .Geothermal energy is an interesting alternative concerning the production of energy for air conditioning of buildings (cooling or heating) through the use of geothermal heat pumps. A ground source heat pumps (GSHP) uses the shallow ground as a source of heat thus taking advantage of its seasonally moderate temperatures.**

The calculation of Ground couple Heat Exchanger performance is very important for predicting the performance and estimating the initial cost of geothermal heat pump systems. On average GHE are oversized by 10-30%.

Vertical Ground Heat Exchanger is most common because of its smaller environmental influence and land field requirement. This paper reviews the current theoretical, analytical and numerical model to calculate the performance of ground coupled heat exchanger. The purpose of this paper is to increase the awareness of different assumption and methodologies between calculation. There primary strength and weakness are also presented.

***Keywords*: ground coupled condenser, residential building, temperature, energy conservation.**

I. INTRODUCTION

The increasing energy demands the fact that fossil fuels are finite resources and the problem of pollutant emissions has allowed renewable energy sources to be considered and developed, including geothermal. Air conditioning is now a days is essential for human comfort. Energy consumption in air conditioning is reduced by decreasing the temperature of sink.

II. AIR CONDITIONING

Air conditioning is a collective process that performs many functions simultaneously. It condition air, transports it, and introduces it in to conditioned space. It provide heating and cooling from central plant or roof top unit.It also control and maintain the temperature and control the humidity, air movement and cleanliness, sound level and pressure discrepancy. Air conditioning system is a largest energy consumer which is challenge that arises now a day. This problem can be overcome by using Ground Coupled Heat Exchanger in air conditioning system.

III. GROUND COUPLED HEAT EXCHANGER

The GCHE systems for heating and cooling are considered one of the most energy efficient and cost effective renewable energy technologies. This type of heat exchanger captures heat from ground or dissipates heat to the ground. They use the earth undisturbed temperature to warm or cool air or other fluid for residential or industrial uses. It usually consists of loop of pipe buried in earth horizontally or vertically. Temperature regime at this depth or beyond is stable without fluctuation only small variation annually. This improves the COP of air conditioning system and save electricity. In GCHE tubes are placed inside ground in which the refrigerant is drawn.

GCHE Cooling:

In this system the heat is extracted from the residential building and heat exchanger inside the earth release heat to the earth as earth temperature is always less than outside temperature in summer. Earth act as a sink in this system.

GCHE Heating:

In winter the earth temperature is more than the atmospheric temperature so heat is taken from the earth and is released inside residential buildings with the help of heat exchanger. Earth act as a source in this system. Electrical energy is saved as naturally heating of refrigerant is done. Thus by eliminating compressor we can save the energy in many ways by using earth coupled heat exchanger.

Horizontal Ground Heat Exchanger is shown in fig1. And the vertical heat exchanger is shown in fig2.

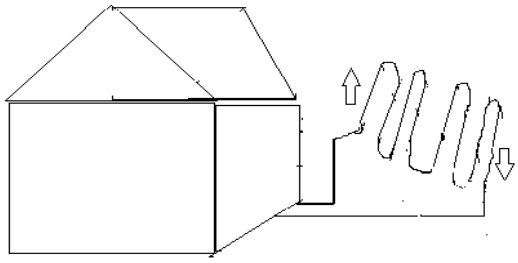

Fig1 Horizontal Ground Couple Heat Exchanger Loop

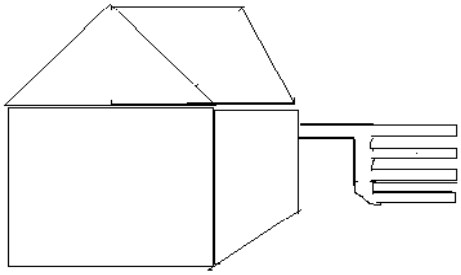

Fig2 Vertical Ground Couple Heat Exchanger Loop

Limitation:

The growth of GSHE technology was slower than other RES or conventional technologies due to many factors: non-standardized system designs, significant capital costs if compared with other systems and limited individuals knowledgeable in the installation of GSHP systems.

IV. PERFORMANCE AND METHODOLOGY

An air conditioning system with geothermal heat pumps consists of three parts

(i) Geothermal heat exchanger,

(ii) Heat pump,

(iii) Heat distribution system

The operating mechanism for heating is as follows:

(i) The fluid, flowing in geothermal heat exchanger ,exchanges heat with the ground and comes back heated to surface

(ii) Fluids transmits its heat to heat pumps and back in the heat exchangers with lower temperature

(iii) Heat pump transmits its heat to the fluid flowing in radiant floors

(iv) Radiant floors heat the building.

Nabiha Naili (2012) experimental set up was constructed for climate condition of Tunisia and evaluation was done of horizontal ground heat exchanger. To determine the ground temperature installation in different ground levels thermocouples. The ground temperature results at various depths(d) measured in summer, ground temperature changes decreases with depth exponentially. It was seen that ground temp. is nearly constant below a depth 1 m.Energy efficiency is 14 %.

The ground temp constitutes an essential data in the installations of GHE. To determine the ground temperature, we installed in different ground levels thermocouple which are connected to an acquisition system data.

The ground temperature results at various depth (d) measured in summer is shown in fig3 .we can note that ground sees its temperature change decreased exponentially with depth. This decreases diminished as the ground depth increases because the high thermal inertia of ground. Measurement shows that the ground temperature below a certain depth remain constant.The temperature at 1m depth is 23deg while outside temperature is 37deg.

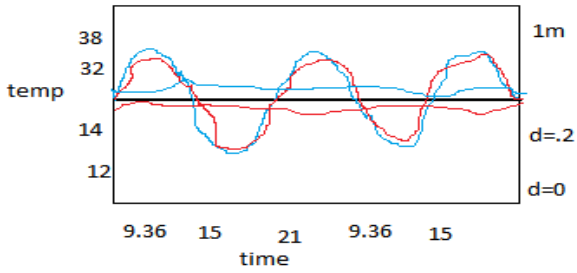

Fig 3

Miroslaw Zukowski, Beata Sadowska(2011) has done Simulation and experimental investigation of thermal performance of GCHE. Energy saving software Energy plus is used to estimate cooling potential of ECHE in residential buildings. Computer prog. Calcsoilsurftemp is used. Estimation of cooling potential of ECHE.

W U Jian –lin , Zou zu-xu, Gong Jing found that Pe(Peclet No.) is the condition to determine whether to consider the impact of ground water seepage in design of GCHE. Its physical significance is the intensity of heat convection comparison with intensity of thermal conductivity in ground water seepage.

In design to carry out geological prospecting work at construction site to understand ground water seepage ,to consider the heat transfer through ground water flow,save initial cost.

R.W. Spengler, D.P. stombaugh (1983) said that Thermal performance was simulated using finite difference techniques to obtain tubing outlet temp. as function of lateral length tube dia. And air flow rate per tube.They found that The winter fuel cost for this system was $263 and annual cost for conventional system was $431.

M.De paepe (2002) construct a method to optimize the efficiency of energy of an air earth coupled heat exchanger by decreasing the pressure drop for a pre conditioned thermal efficiency. In this method there is no need of electricity demand but waste energy caused by pressure drop is used to evaluate the coefficient of performance.

W. permchart **(2009)** Proposed the results of experiments of cooling analysis of modified air conditioned .This air conditioner uses ground as a sink of condenser. In this capacity of modified air conditioner with ground coupled condenser was investigated.

Silvia Cocchi, Sonia Castellucci, and Andrea Tucci (2013) said that TRNSYS 17 software can be used for the system simulation in order to refine the sizing .There purpose was to Reduce cost of GSHE, increase efficiency .

TRNSYS is a complete and extensible simulation environment for the transient simulation of systems, including multizone buildings. In TRNSYS simulation studio we can create projects by drag and dropping components to the workspace, connecting them together and setting the global simulation parameters. When we run a simulation, the studio also creates a TRNSYS input file.

We study following variables:

(i) Thermal loads

(ii) Air temperature in thermal zones

(iii) Fluids temperature in input and output from radiant floors

(iv) Fluid temperature in input and output from geothermal heat exchanger

(v) Average ground temperature

Yuanjun Dai, Yigong Lu, Yuxin Sun (2010) used MATLAB was used to simulate series connecting of ground source heat pump and solar collector. They found Numerical relation between length of ground heat exchanger and area of solar collector.

Manoj kr dubey Dr. j l bhagoria(2013) has done experimental studies on ECHE system parallel connection in summer climate. An experimental study was done.

Kumar and co-author (2003)experimentally tested earth tunnel located in Mathura (India) .The results of experiments was used to validate a transient implicit numerical model finite difference scheme and FTT algorithm implemented in MATLAB

V. CONCLUSION

There is further scope of work since the performance of the system is still not available for design and application. Therefore performance evaluation is required with suitable methodology.

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