Computational Analysis of Geometric Design Variation of Three Various Shape and Size of Earthe Air Conditioning System

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Abstract— The main view on our work of temperature maintains equilibrium condition in inside and outside EARTHE sink respectively. We have three geometric models such as pipe, spiral pipe and helical pipe to investigate the performance for efficiency of EARTHE air tube heat exchanger of natural air conditioning. For better performance and efficient efficiency, we need to have CFD solution for these three geometrical models to be investigate as its temperature, pressure, and velocity of flow and Reynolds number to be evaluated and achieved for best result in market and industry parameter side. The CFD investigation of linear pipe, spiral pipe and helical pipe of its thermal parameter to evaluate its performance and its geometrical requirement should meet conveniently. In summer EATHE for cooling purpose to betterment and less power consumption so we look after design meet and analysis of thermally for all three geometry of thermodynamic properties. If we chance linear parameters of pipe such as length and flow size to be optimized will get good result of efficiency and better performance and better CFD result expected. To getting good design result, we have to do CFD analysis on all three pipes (linear pipe, spiral pipe and helical pipe).For better CFD result, better Degree of freedom and assigned in a good way to all regions of boundary condition to get best analysis result.

Keywords: CAD Modeling for Spiral, Earth-Air Tube Heat Exchanger for Coolant, CFD Analysis for Pipe

I. Introduction

In tropical climates, air conditioning is widely employed not only for industrial production but also for the comfort of occupants [20]. The energy used in buildings accounts for about 28 percent of India's total energy consumption. About 80 to 90 percent of this energy use occurs when the building is occupied, and is due largely to the cooling of the building. Therefore, one way to lower energy consumption in India is to lower heating and cooling demand.

In literature, names such as Earth Cooling Tube, Ground Coupled Air System, Cool-Tube in-Earth Heat Exchanger, Earth-to-Air heat exchanger, Earth Contact Cooling Tube, Earth Tube Heat Exchanger, Buried Pipe Cooling System, Underground Solar Air heater, Earth Air-Pipes System, Air-Soil Heat Exchanger, Embedded Duct, Earth Channel, and Hypocaust are used as all alternatives to EATHE. The name, Earth Air Tunnel Heat Exchanger, is adopted in this thesis because it is commonly used in the industry.

Since the consumer need for electricity is continuously increasing. Although improvements in technology must be made. The employment of EATHE to reduce heating and cooling needs in buildings has received increasing attention during the last several years [4]. But the use of EATHE remains low. Reason for this is the uncertainty in the design of the EATHE and high installation cost associated with the heat exchanger so it is probably the

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Since the consumer need for electricity is continuously increasing. Although improvements in technology must be made. The employment of EATHE to reduce heating and cooling needs in buildings has received increasing attention during the last several years [4]. most important component. Recent investigations of EATHE systems have included topics ranging from fundamental aspects to energy and energy analyses [16].

II. Design of View

The air-conditioning system consists of underground earth tubes, blower and measuring instruments the main principle parts.

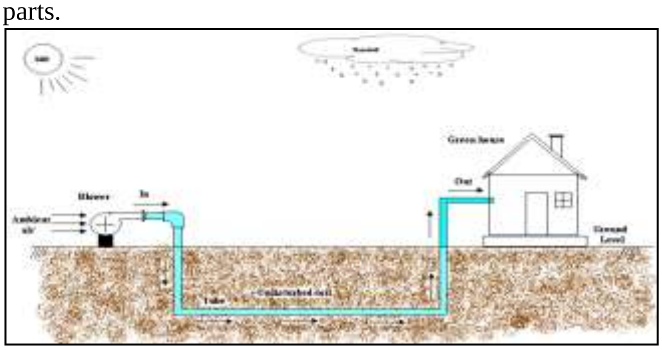

Fig. 1: Air conditioning system

III. Design Parameter

λ= Ka= 0.0366 W/mK
ρ= 1.1465 kg/m3
Cp= 1006 J/kgK
μ= 1.84*10-5 N/ms

Tin= 45oC
Tout= 35oC
Twall= 25oC
Kt= 0.19 W/mK
Do= 0.15 m; Ro= 0.075 m
Di= 0.14 m; Ri= 0.07 m
Velocity, v= 1.5 m/s
Volumetric air flow rate= 4*πRi2= 0.06154 m3/s
Density of air= 1.1465 kg/m3
Mass flow rate of air, ma= volumetric air flow rate* Density of air= 0.07056 kg/s
P= 101325 Pa

IV. GEOMETRY FOR GATHE MODELING

Three different models were developed
1) Straight
2) Spiral
3) Helical

The experimental model of GATHE is made in Ansys as mentioned earlier. The reason of using ansys is its quick and easiness to draw and also simulation can be conducted on the model consuming. The different dimensions used for the construction of GATHE is mentioned below:
1) Length of Pipe – 20m
2) External Pipe Diameter – 0.15m
3) Thickness – 0.005m
4) Burial Depth – 2m

There are three geometric structure given in below:-

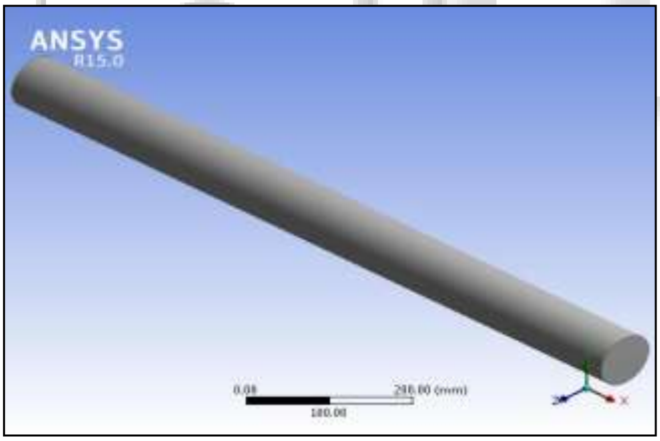

Fig. 2: Geometry of straight pipe earth model

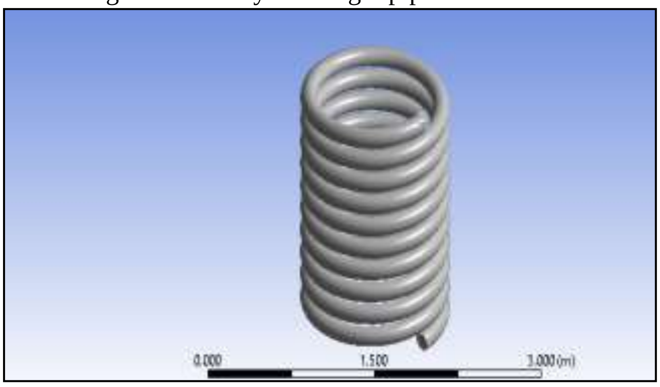

Fig. 3: Model of Helical design

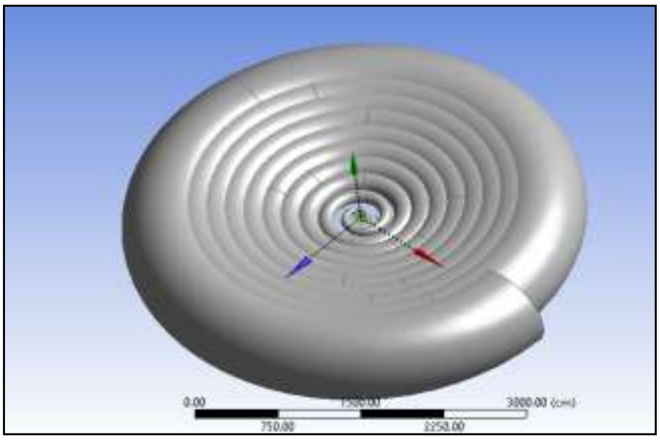
Fig. 4: Model of spiral design

V. RESULT AND ANALYSIS

The following boundary conditions were used for simulation
1) Inlet: At Inlet of GATHE the subsonic flow regime with medium turbulence is taken. The values of velocity of air flow is 2m/s, 4m/s and 5m/s is taken with the static inlet temperature of the air as 40.4^{O}C, 38.8^{O}C and 39.9^{O}C respectively is defined at inlet. The density, specific heat capacity, dynamic viscosity and thermal conductivity of air is defined at static temperature at the inlet.
2) Outlet: The relative pressure at outlet of GATHE pipe was taken as zero atm in subsonic flow regime.
3) Wall: The location along the length of pipe is defined where air temperature is to be measured. The temperature of the surface of pipe is uniform and taken equal to earth's undisturbed temperature at25.2^{O}C.

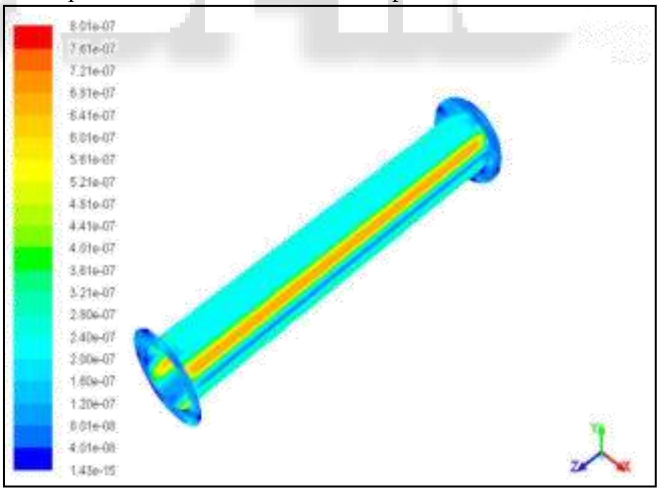
Fig 5.1: straight pipe cfd result for static pressure as well as flow velocity

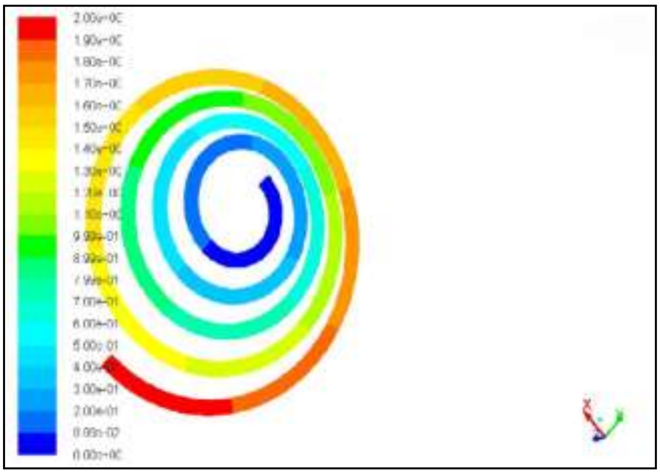

Fig. 5.2: spiral pipe cfd result for turbulent contour as well as flow velocity

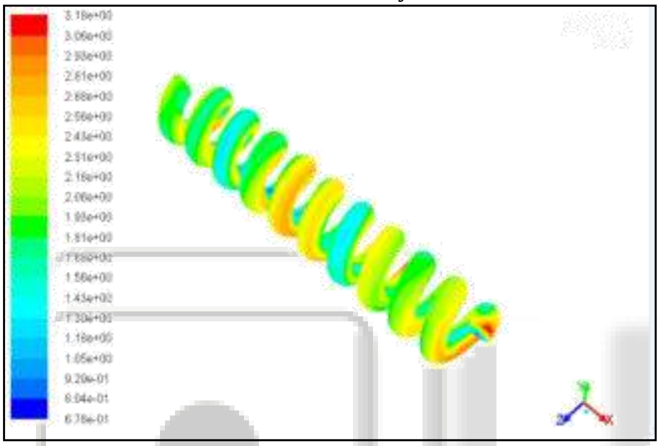

Fig. 5.3: Helical pipe cfd result for turbulent contour as well as flow velocity

VI. CONCLUSION

In this project simulation of EATHE has been carried out to determine temperature of air under steady state conditions by keeping the soil surrounding pipe of the EATHE at constant temperature of 300 K. The solution of governing equation have been given us the temperature profile of fluid which is air with different length of pipe and different velocity of air. In this study the EATHE is design for Bikaner region and the heist temperature in summer is considered for inlet temperature of EATHE. The heist temperature of Bikaner is 320.6 K. Different design of earth air tunnel heat exchanger pipe like straight pipe, spiral pipe and helical pipe has been analysis for cooling mode. The temperature fall in straight, spiral and helical pipe of earth air tunnel heat exchanger is 13.360 C, 14.000 C, and 14.460 C. The temperature fall in helical pipe earth air tunnel heat exchanger temperature is more, therefore this EATHE has been selected for further analysis

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