DESIGN AND CFD ANALYSIS ENGINE COOLING SYSTEM THROUGH ADDITION OF THERMOSTAT WITH DIFFERENT MATERIALS

Sk Md Shafeez [1]

[1]Assistant professor, Department of Mechanical Engineering, ABR College of Engineering and Technology, Chinairlapadu Village, Kanigiri, Andhra Pradesh- 523254

Beesetti Dileep [2], **B. Bharath Kumar** [3], **Palla Sai Suresh** [4], **K Mahesh** [5], **P. S. A Sarma** [6]

[2,3,4,5,6] Students, Department of Mechanical Engineering, ABR College of Engineering and Technology, Chinairlapadu Village, Kanigiri, Andhra Pradesh- 523254

Abstract:
Thermostat is utilized to transfer thermal energy from one supply system to different for the aim of continuous heating and cooling. It's created to perform cooling process in automobile industry. It is always a source of heat to its environment; this could be either for the aim of heating this surrounding or for cooling the flu id agent equipped to cool the engine. In this project concluded that different nano fluids mixed with base fluid water are analysed for their performance in the thermostat applied to the different types of fluids. The fluids are water, air and aluminium oxide nano fluid. 3D model of the radiator is done in CREO parametric software. CFD analysis is performed on aluminium radiator by using ANSYS Flow simulation module and its analysis is performed on radiator by selecting different fluid i.e. fluid water and Air with two nanofluid such as Copper oxide (CuO) and Aluminium oxide (Al_2O_3) (2%,4%). Boundary conditions is provided as 300K for inlet temperature of fluid, which will cooled by radiator pipe and fins by means of convection process on ambient temperature of 25˚C. Due to convection temperature of fluid flow inside radiator will decrease, which varies in the temperature of fluid along with Pressure and Velocity streamlines. By seeing the results, we can conclude that nanofluid provide higher convection i.e. better cooling to engine compared to that of water.

Key words: Thermostat, Nano fluids, Cooling system, CREO, CFD analysis,

1.0 INTRODUCTION

A cooling system for an internal combustion engine uses air or liquid to remove excess heat. A liquid or air-cooling system can be used according to the surrounding atmosphere, the location, and the purpose of the engine. The air-cooling system is used for engines with low capacity or when located in open spaces, such as those on bikes. With a higher capacity engine, we need a liquid cooling system, in which the liquid is injected into the engine's surroundings and functions in a closed loop system. Liquid has higher heat capacity than Air, and it will help to remove heat quickly from the engine but in liquid cooling system we need additional assembly like radiator, pump, piping system which increases the weight and cost. Since aircraft design requires lighter engine cooling systems, we use air-cooled designs. Liquid cooling systems are generally used in automobiles based on requirements, and the engine cooling system weight is optimized.

Thermostat:

This study is the first to investigate the feasibility of installing electronic thermostats in commercial vehicles in India. To date, this technology has only been seen in high-end automobiles. In daily life, an electronic thermostat functions similarly to a standard thermostat.

Cooling System: In a typical 4-cylinder car travelling at 30 mph, the engine will undergo 4000 controlled explosions each minute as the spark plugs in each cylinder ignite fuel. These explosions produce a tremendous amount of heat. They can destroy an engine in minutes if they are not controlled. The cooling system is responsible for maintaining these extremely high temperatures.

Requirements of efficient cooling system

For a cooling system to be effective, it must include both of these things:

- Only 30 percent of the heat generated will be lost in the combustion chamber. Reduced thermal efficiency is one of the side effects of excessive heat removal.
- It is simple to dissipate engine heat while the engine is hot. The cooling process must be very gradual at start-up for the engine's moving parts to quickly attain their operating temperatures.

Thermostat:

A heat exchanger, or thermostat, is a device used to regulate the temperature of a room. Its purpose is to allow the hot fluids passing through it to warm the air being pushed across it by a fan. Aluminium thermostats are standard in today's automobiles. To create thermostats, thin aluminum fins are brazed into squarish aluminum tubes. Several hundred boxes, all installed in a parallel configuration, carry the coolant from the entrance to the outlet. The fins transfer the heat from the tubes to the air entering the thermostat.

There usually are three types of Thermostats:

- Gilled Tube Thermostat
- Tubular Thermostat
- Honey Comb or Cellular Thermostat

Gilled Tube Thermostat: Gilded-tube thermostats are among the earliest models still in use today. Within these tubes, the liquid can move freely. Multiple rings or fins tightly pushed over the exterior of each box.

Tubular Thermostat: A gilled tube thermostat is identical to a tubular thermostat, but for the absence of individual fins for the tubes. The vertical lines of the thermostat traverse thin, delicate copper sheets that run horizontally.

Honey Comb or Cellular Thermostat: The cellular thermostat is built from a large number of air cells that are submerged in water. A single route's obstruction would only have a little effect on the cooling surface area. However, the tubular thermostat loses its cooling action entirely if even a single tube becomes blocked.

Problem of the statement:

Mechanical thermostats in India often fail as a result of weather changes or location changes. As our vehicles are designed for Indian conditions, we consider a normal temperature or weather, but nature or location change the temperature, so our thermostats must adapt accordingly. For example, if we have a winter and rain season, then the thermostat will help to maintain an optimal working temperature. And if we are in summer season, in that case thermostat will help to maintain this optimum working temperature as well. We can see in both cases thermostat is in working condition. So, the failure chances increase due to continuous uses.

Limitations:

Thermostat design as it is now is very rudimentary and has not advanced significantly in recent years. Airflow above the thermostat creates a significant impediment to heat transfer, which is the primary issue with conventional thermostats. Thermostats in use today are difficult to control and provide design constraints because of their size, weight, and resistance in their heads.

Objectives:

- To design the helical and straight tube models done by using CREO parametric software
- To analyzed the performance in the thermostat applied to the different types of fluids (water, air and aluminum oxide, CuO nano fluids)
- To conclude that nanofluid provide higher convection i.e. better cooling to engine compared to that of water.

2.0 LITERATURE REVIEW

Sharma et. al. [1] constructed a duct for an office building's air system and analyzed how duct design influences overall system efficiency. Improper duct designs resulted in issues like frictional loss, unequal cooling in the building, more excellent installation cast, increased noise level, and increased power consumption. The pressure drop in the circular duct was lower than that of the rectangular duct. **Whalley et. al. [2]** modelling strategies for HVAC systems on a massive scale and across a wide geographic area were also studied. This study presented a discussion of current methods as well as suggestions for implementing new types of analysis. **Xu et. al. [3]** conducted a site evaluation of the efficiency of five different thermal distributed systems in four other significant commercial buildings. They researched duct leakage and found that the amount of air lost from these systems in large commercial buildings differed significantly. Duct sealing and insulation effectively reduce the energy loss caused by leaks. **BarisOzerdem et. al. [4]** air leakage energy loss was analysed using a power law model. The diameters of the ducts were measured to ensure accuracy. In the end, they determined that sealing gaskets reduced air leakage from the junction by nearly half. **Michal Krajcík et. al. [5]** have conducted simulated laboratory experiments on airflow, ventilation efficiency, and room temperature in a low-energy structure. The tests were conducted in various weather conditions, with varying degrees of internal heat build-up and air change rates. They found that the high potential for thermal discomfort was unaffected by using warm air heating or a floor heating system. **Fisk et. al. [6]** examined the practical leakage areas (ELAs), air-leakage rates (ALRs), and conduction heat gains (CHGs) of duct systems through field research in large commercial buildings. The results of several alternative methods for measuring air loss were compared. Their analysis revealed a wide range of air leakage rates, from zero to thirty percent. Furthermore, supply air temperatures increased, on average, by 0.68°C to 28°C due to heat gains between the cooling coils and the supply registers. **Liping Pang et al. [7]** established the percentage of recycled outside air to air. Aiming for superior air quality, thermal comfort, and energy savings, various input types had their conditioned temperatures carefully designed. In addition, multiple experiments were run, and the results were compared to those of competing systems. **Srinivasan et al. [8]** designed and tested orifice plate-based flow metering systems, gaining experience assessing air leakages in HVAC system components. Differences between the discharge coefficients and the Stolz equation were found to be more significant for small Reynolds numbers. It was found that a polynomial of degree two was insufficient to describe the connection between pressure drop and flow rate.

3.0 METHODOLOGY

In this research methodology we first study the previous research work to understand the topic, and then we need to find the failures in design, the key components of the full assembly which may fail during operation. Then we start our own design using cad software according to particular engine dimensions after that we perform some analysis, in our research work we need to perform the CFD analysis. According to the results we have to modify our traditional design as per current requirements and again perform the analysis, at last we have to conclude the result. In an automobile, fuel and air produce power within the engine through combustion. Only a portion of the total generated power actually supplies the automobile with power -- the rest is wasted in the form of exhaust and heat. If this excess heat is not removed, the engine temperature becomes too high which results in overheating and viscosity breakdown of the lubricating oil, metal weakening of the overheated engine parts, and stress between engine parts resulting in quicker wear, among other things.

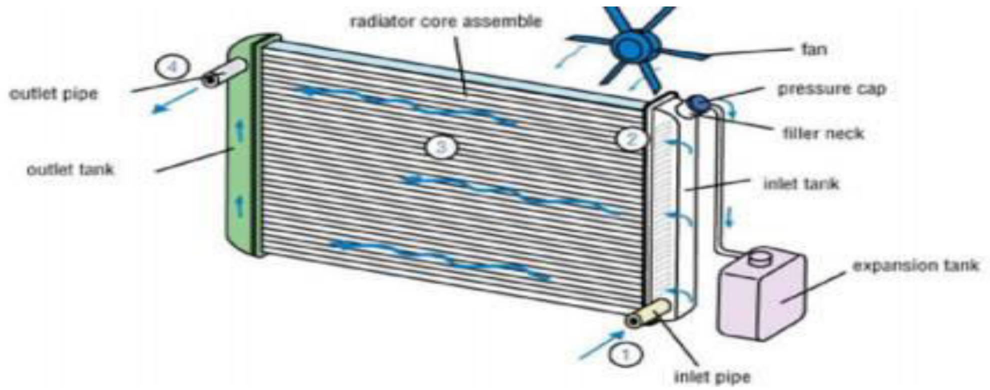

Fig. 1: Components within an Automotive Cooling System

Working of a Cooling System:

The primary principle to generate the cool has common characteristics which is making the refrigerant changes its form from liquid to gas, resulting in temperature drop. The initialisation of the cooling system starts from the heat reduction by using the evaporator.

Traditional Thermostat Valve Fluid Control (Case 1): The common cooling system has three key components working to regulate engine temperature: thermostat, water pump, and thermostat fan. Conventional thermostats are wax based; their operation depends on the material properties of the wax in the thermostat housing and the coolant temperature surrounding it Traditional water pumps and thermostat fans are generally mechanically driven by the engine's crankshaft. Specifically, the water pump is driven as an accessory load while the thermostat fan is often connected directly to the crankshaft with a clutch. Factory cooling systems typically present two problems

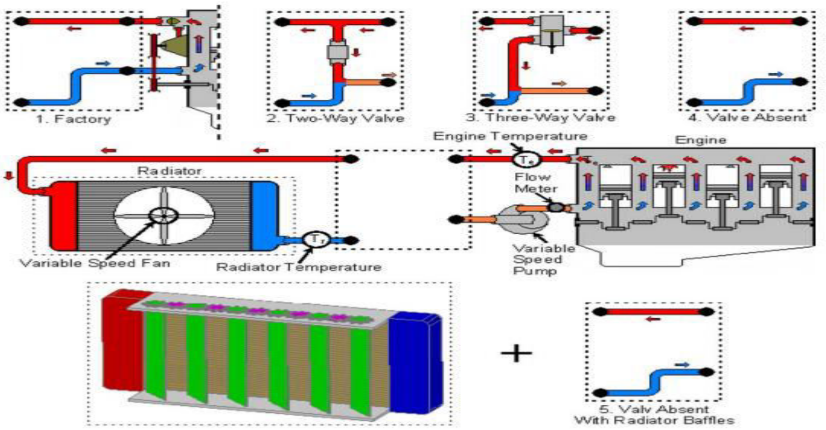

Fig 2: Five thermostat valve configurations to enhance fluid flow control; note the two thermocouples

Two-Way Valve Fluid Control (Case 2): The two-way smart valve controls flow by blocking the coolant from entering an external bypass. When the valve is oriented in the bypass mode, some coolant will always flow through the thermostat, which is a major drawback when trying to rapidly warm the engine to operating temperature. Further, the amount of coolant flow through the bypass and thermostat is determined by the valve's geometry and location within the cooling circuit. It is possible to place two-way valves in many locations for an advanced cooling system that would alter the thermal dynamics.

Three-Way Valve Fluid Control (Case 3): The operation of a smart three-way valve is very similar to the two-way valve. However, a three-way valve controls coolant flow through the bypass and thermostat loops. Unlike the two-way valve, the coolant flow can be completely blocked from entering the thermostat or bypass, which aids in engine warm-up time This is the primary advantage of utilizing a three-way valve in the cooling circuit. Although increased control is achieved, the introduction of hardware with greater functionality can be expensive. In addition, valve geometries can become complicated when designing a three-way valve that proportionally controls coolant flow while minimizing the pressure drop.

No Valve Fluid Control ((Case 4): When control over the coolant pump speed and therefore flow rate can be achieved, the possibility exists to eliminate the thermostat valve completely. As mentioned earlier, the thermostat's main role is to regulate the coolant flow rate and direction. Therefore, the valve loses one of its primary purposes due to active pump speed control. The valve is now reduced to controlling fluid flow between the bypass and thermostat loops, which is only required during warm-up conditions.

Thermal Models and Operating Strategy:

To describe an engine's in-cylinder thermal behavior, detailed multiple node lumped parameter thermal models were proposed by with application to automotive coolant flow control by However, a reduced order mathematical model can describe the engine's thermal management system transient response for controller design needs.

$$C_e\dot{T}_e = Q_{in} - c_{pc}\dot{m}_r(T_e - T_r), \quad C_r\dot{T}_r$$
$$= c_{pc}\dot{m}_r(T_e - T_r) - \varepsilon_r c_{pa}\dot{m}_a(T_r - T_\infty) - Q_o$$

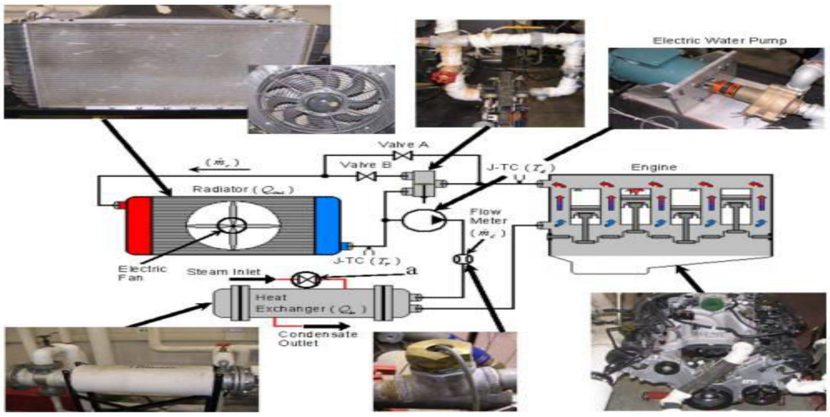

Fig 3: Schematic of thermal test bench with actual cooling system components, engine block, sensors

Design of new thermostat includes: thermostat cover, fins, core, grills etc. which come in between the path of air flow when air flow from atmosphere through the thermostat assembly. Such parameters like; Shape of thermostat core, direction flow of working fluid, frontal area of thermostat, Space between fins, space between tube, fin & tube size, coolant mass flow rate, material of fins, pitch of tube, velocity of fluid, air inlet temperature is kept in mind to design a better automobile thermostat.

The basics of CFD simulation:

Computational fluid dynamics uses data analysis to solve problems that involve fluid flows, including the flow of air and heat transfer, as well as the interaction of heat and air with surrounding materials. CFD software is often thought of as a virtual wind-tunnel, flow bench, and thermal test rig all in one

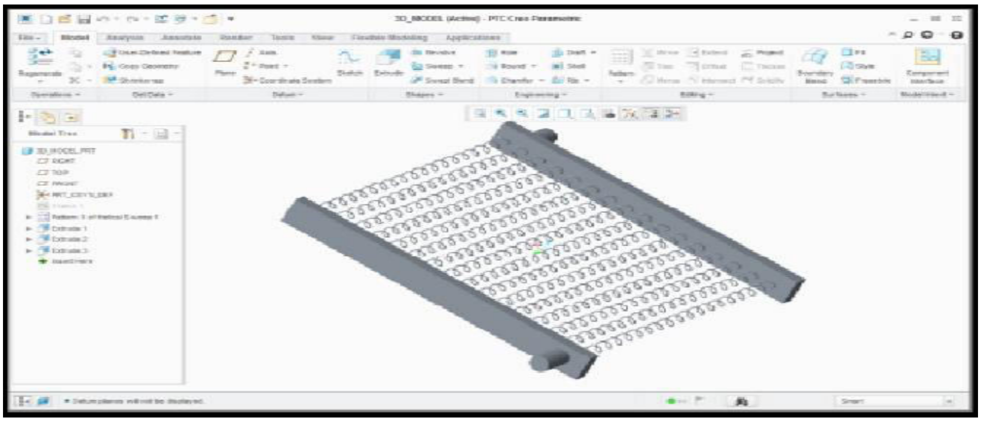

Fig 4: Model of Thermostat

Thermostat Specification for Helical type tubes
Number of tubes: 29
Helical type tube mean diameter: 30mm
Inner diameter of tube: 2 mm
Outer diameter of tube: 4 mm

CFD ANALYSIS OF THERMOSTAT CASE -1

STRAIGHT TUBEAT MASS FLOW RATE-2.8 KG/SEC

FLUID-AIR→→Ansys → workbench→ select analysis system → fluid flow fluent → double click →→Select geometry → right click → import geometry → select browse →open part → ok

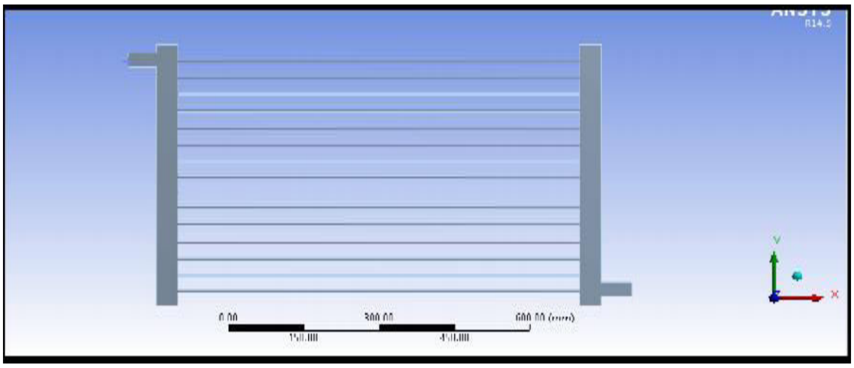

Fig 5: Thermostat model

→→ select mesh on work bench → right click →edit → select mesh on left side part tree → right click → generate mesh →

The model is designed with the help of CREO and then import on ANSYS for Meshing and analysis. The analysis by CFD is used in order to calculating pressure profile and temperature distribution. For meshing, the fluid ring is divided into two connected volumes. Then all thickness edges are meshed with 360 intervals. A tetrahedral structure mesh is used. So, the total number of nodes and elements is 6576 and 3344

4.0 RESULTS AND DISCUSSIONS

Automotive thermostats are one of the most important components in a vehicle thermal management system. It is responsible for maintaining an acceptable working temperature in the engine both to prevent catastrophic failure and keep it operating as efficiently as possible. As vehicles have become more complex with their cooling systems, so too have thermostats. These parts are no longer as simple as a single flow path in and then either flow to bypass or the thermostat. It is easy for these components to now have at least three or four inlets and multiple outlets.

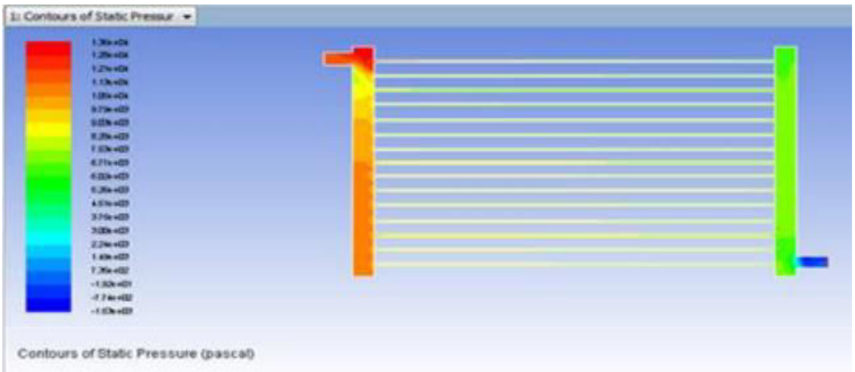

Fig 6: Static pressure

According to the above contour plot, the maximum static pressure at inlet of the thermostat helical tubes because the applying the boundary conditions at inlet of the boundary and minimum static pressure at the adjacent sides of the narrow plate. According to the above contour plot, the maximum pressure is 2.50e+04Pa and minimum static pressure is -2.14e+04Pa.

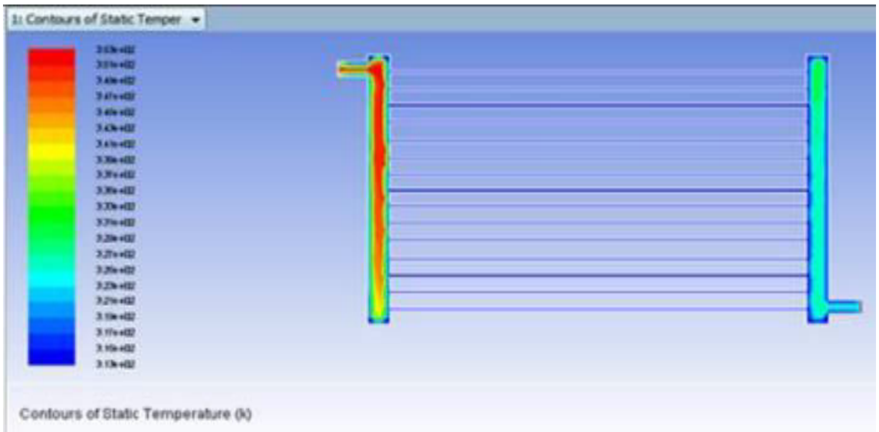

Fig 7: Static temperature

According to the above contour plot, the maximum static temperature magnitude of the air at corners of narrow plate, because the applying the boundary conditions at inlet of the boundary of the thermostat helical tubes and minimum static temperature magnitude at around edges of the narrow plate. According to the above contour plot, the maximum static temperature is 2.22e+02m/s and minimum static temperature is 1.11e+01m/s

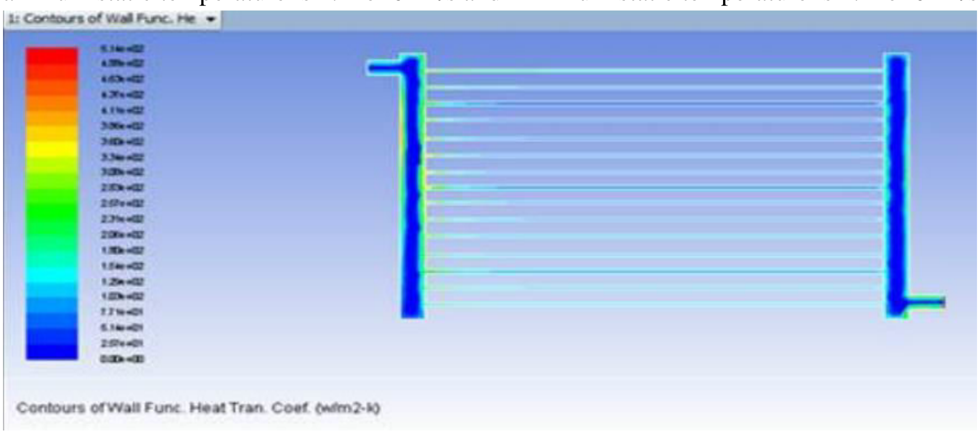

Fig 8: Heat transfer coefficient

According to the above contour plot, the maximum heat transfer coefficient of the air at edges of the thermostat helical tubes and minimum heat transfer coefficient between around the boundary edges and thermostat helical tubes edges. According to the above contour plot, the maximum heat transfer coefficient is 3.14e+02w/m2 -k and minimum heat transfer coefficient is 1.57e+01w/m2 -k.

REPORTS MASS FLOW RATE

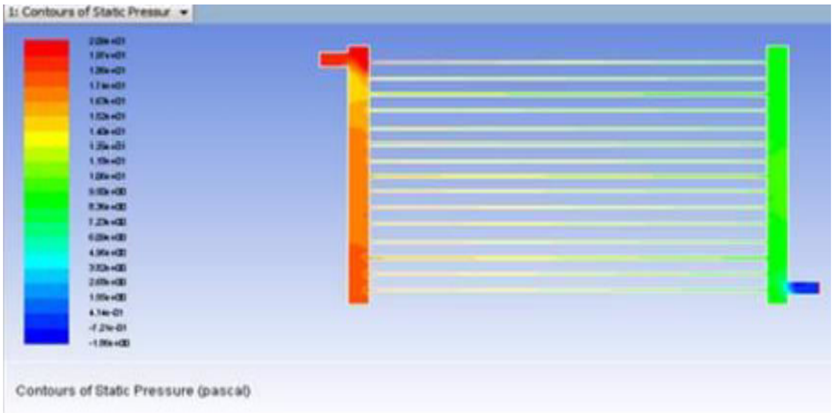

Fig 9: Fluid-water static pressure

According to the above contour plot, the maximum static pressure at inlet of the thermostat helical tubes because the applying the boundary conditions at inlet of the boundary and minimum static pressure at the adjacent sides of the narrow plate. According to the above contour plot, the maximum pressure is 1.03e+05Pa and minimum static pressure is -8.57e+04Pa.

HELICAL TUBE AT MASS FLOW RATE-2.8 KG/SEC FLUID-AIR

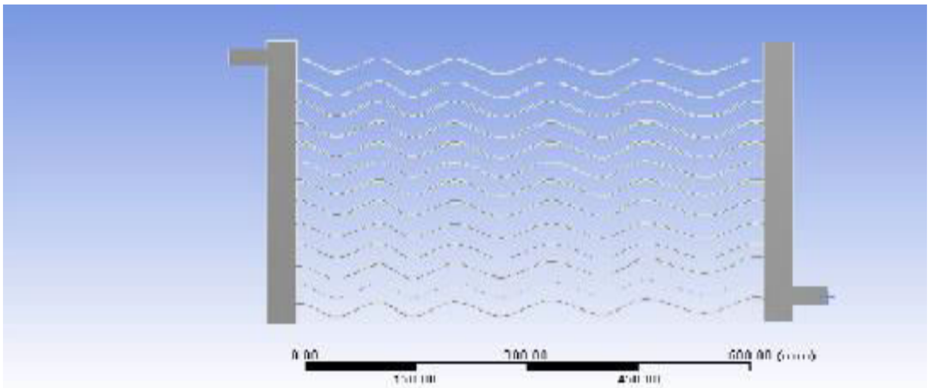

Fig 10: Helical tube thermostat model view

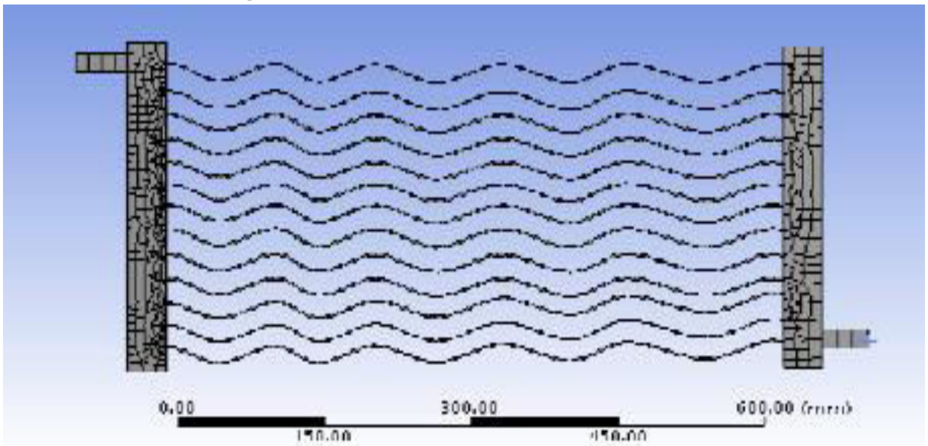

Fig 11: mesh Model view

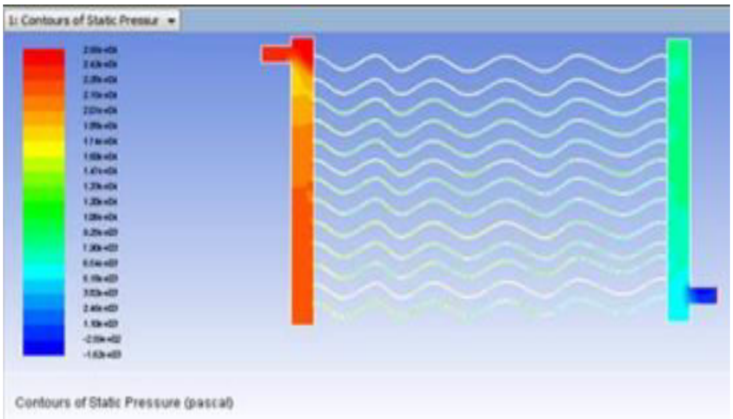

Fig 12: Static pressure

According to the above contour plot, the maximum static pressure at inlet of the radiator helical tubes because the applying the boundary conditions at inlet of the boundary and minimum static pressure at the adjacent side of the narrow plate. According to the above contour plot, the maximum pressure is 1.35e+05Pa and minimum static pressure is -8.68e+04Pa.

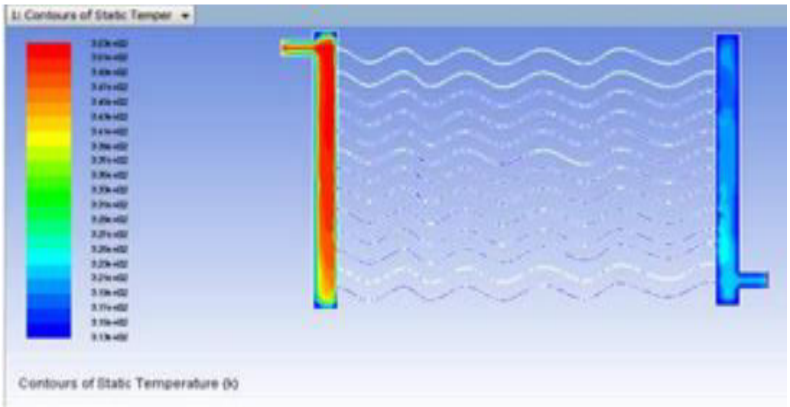

Fig 13: Static temperature

According to the above contour plot, the maximum static temperature magnitude of the air at corners of narrow plate, because the applying the boundary conditions at inlet of the boundary of the radiator helical tubes and minimum static temperature magnitude at around edges of the narrow plate. According to the above contour plot, the maximum static temperature is 5.01e+02m/s and minimum static temperature is 2.50e+01m/s.

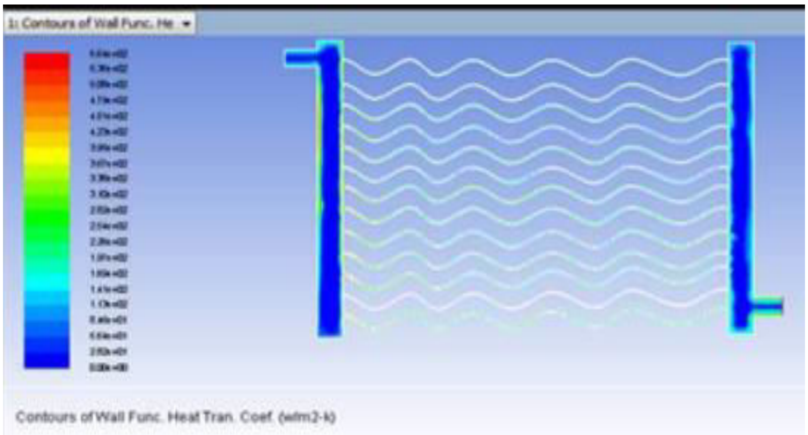

Fig 14: Heat transfers co-efficient

According to the above contour plot, the maximum heat transfer coefficient of the air at edges of the radiator helical tubes and minimum heat transfer coefficient between around the boundary edges and radiator helical tubes edges. According to the above contour plot, the maximum heat transfer coefficient is 4.93e+02w/m2 -k and minimum heat transfer coefficient is 2.47e+01w/m2 -k

FLUID-WATER STATIC PRESSURE

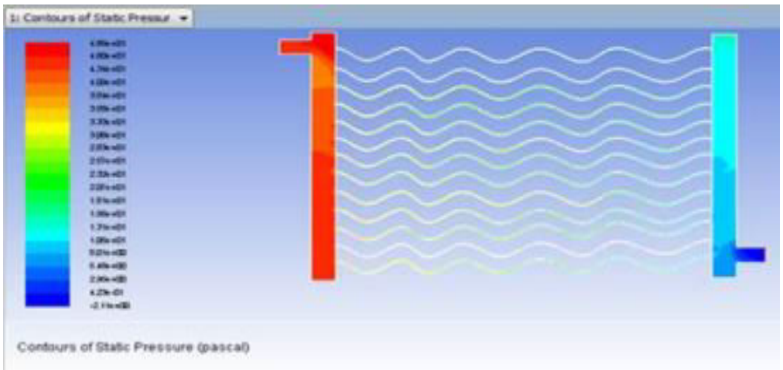

Fig 15: Static pressure

According to the above contour plot, the maximum static pressure at inlet of the radiator helical tubes because the applying the boundary conditions at inlet of the boundary and minimum static pressure at the adjacent sides of the narrow plate. According to the above contour plot, the maximum pressure is 4.65e+05Pa and minimum static pressure is -3.47e+05Pa.

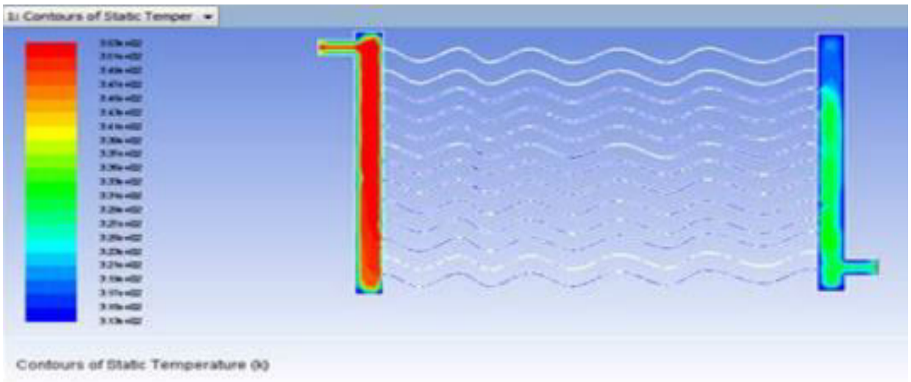

Fig 16: Static temperature

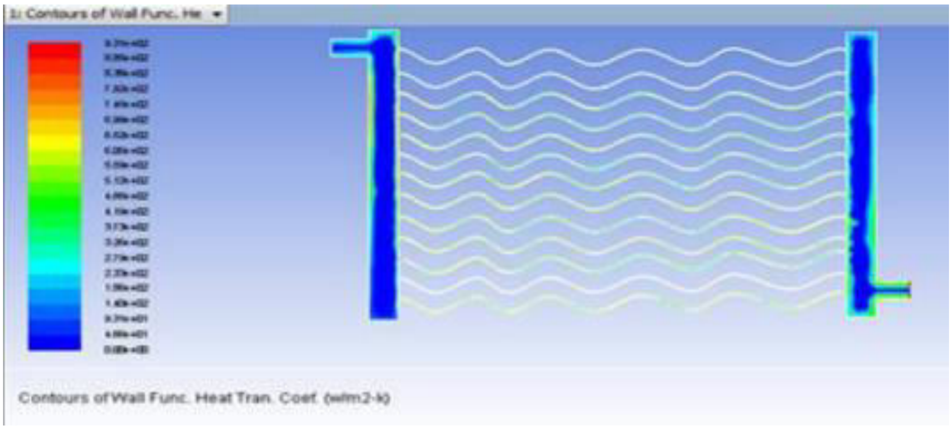

Fig 17: Heat transfer co-efficient

According to the above contour plot, the maximum heat transfer coefficient of the air at edges of the radiator helical tubes and minimum heat transfer coefficient between around the boundary edges and radiator helical tubes edges. According to the above contour plot, the maximum heat transfer coefficient is 8.55e+02w/m2 -k and minimum heat transfer coefficient is 4.28e+01w/m2 -k.

AT MASS FLOW RATE-1.5 Kg/sec FLUID-CuO STATIC PRESSURE

The results revealed that CuO acted as a reactant, while as-formed copper carbonate could act as a catalyst in this reaction. The electrolytes influenced CuO phase change and product selectivity, helping to elucidate the ways in which the CO_2 photoreduction process was assisted by this material by convection process on ambient temperature of 25˚C, has inlet mass flow rate of 1.5kg/s, 2.8 kg/s with static pressure 150000 Pa. In this project we are giving the inlet temperature of fluid coming from engine to radiator i.e. 90˚C and calculating the outer temperature of fluid from radiator

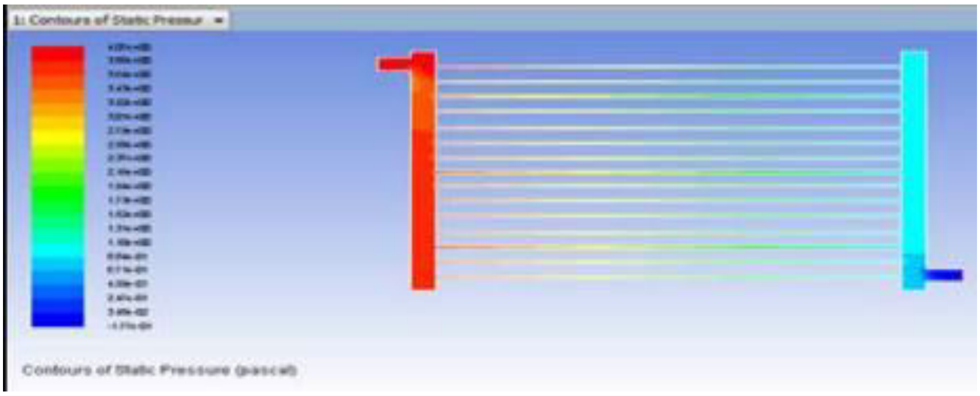

Fig 18: Static pressure

In the contour plot above, the maximum static pressure is at the inlet of the thermostat helical tubes since the boundary conditions are applied at the inlet and the minimum static pressure is at the adjacent sides. According to the above contour plot, the maximum pressure is 2.37e+05Pa and minimum static pressure is -2.41e+05P.

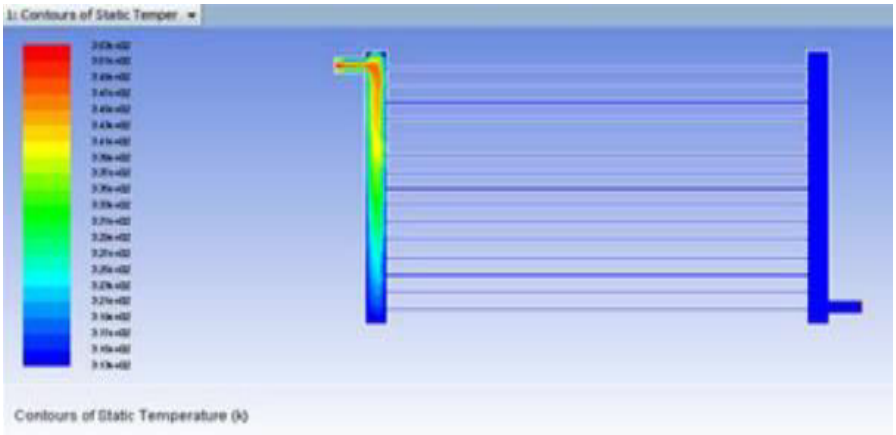

Fig 19: Static temperature

The contour plot above indicates that the air temperature at the corners of a narrow plate is maximal because the boundary conditions are applied at the inlet of the radiator helical tubes and at the edges of the narrow plate are minimum. According to the above contour plot, the maximum static temperature is 6.60e+02m/s and minimum static temperature is 3.20e+01m/s.

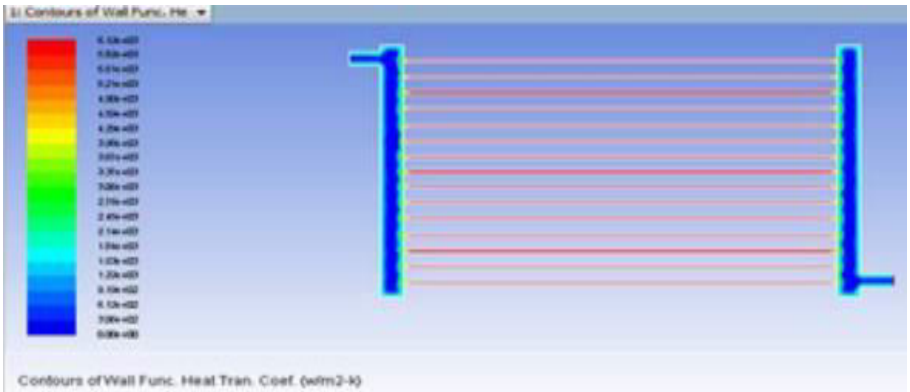

Fig 20: Heat transfer co-efficient

This contour plot shows that the maximum heat transfer coefficient of air is at the edge of the radiator helical tubes and the minimum heat transfer coefficient is between the boundary edges and the edge of the radiator helical tubes. According to the above contour plot, the maximum heat transfer coefficient is 7.07e+02w/m2 -k and minimum heat transfer coefficient is 3.35e+01w/m2 -k.

HELICAL TUBE AT MASS FLOW RATE-2.8 KG/SEC FLUID- CuO

FLUID-CuO STATIC PRESSURE

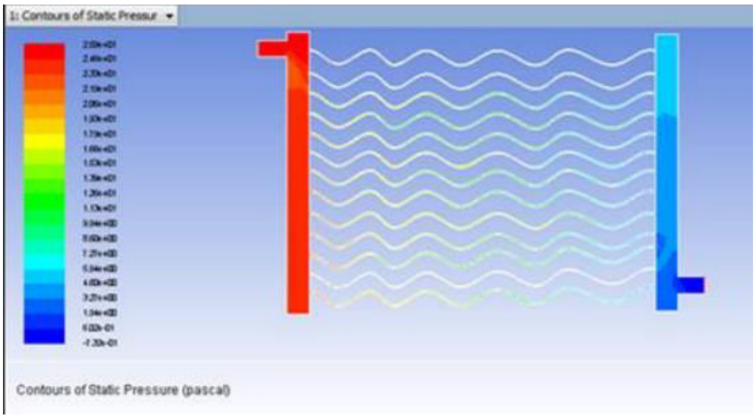

Fig 21: Static pressure

It is clear from the above contour plot that the static pressure is at its highest at the inlet of the radiator's helical tubes due to the boundary conditions at the inlet, and its lowest at the side of the narrow plate opposite it. According to the above contour plot, the maximum pressure is 1.25e+05Pa and minimum static pressure is -8.48e+04Pa.

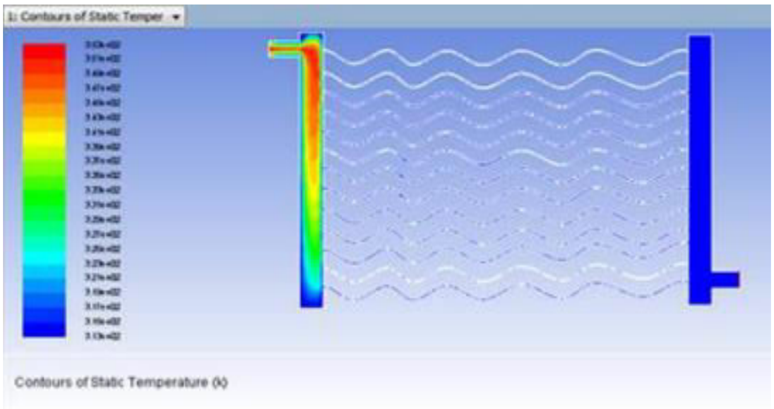

Fig 22: Static temperature

According to the above contour plot, the maximum static temperature magnitude of the air at corners of narrow plate, because the applying the boundary conditions at inlet of the boundary of the radiator helical tubes and minimum static temperature magnitude at around edges of the narrow plate. According to the above contour plot, the maximum static temperature is 5.02e+02m/s and minimum static temperature is 2.30e+01m/s.

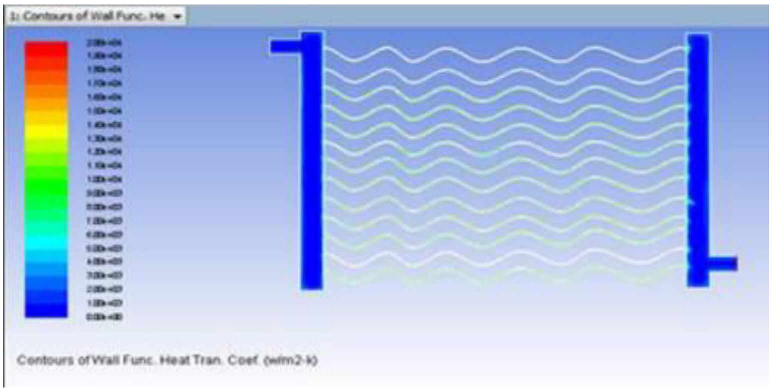

Fig 23: Heat transfer co-efficient

According to the above contour plot, the maximum heat transfer coefficient of the air at edges of the radiator helical tubes and minimum heat transfer coefficient between around the boundary edges and radiator helical tubes edges. According to the above contour plot, the maximum heat transfer coefficient is 4.73e+02w/m2 -k and minimum heat transfer coefficient is 2.27e+01w/m2 -k.

FLUID-CuO STATIC PRESSURE

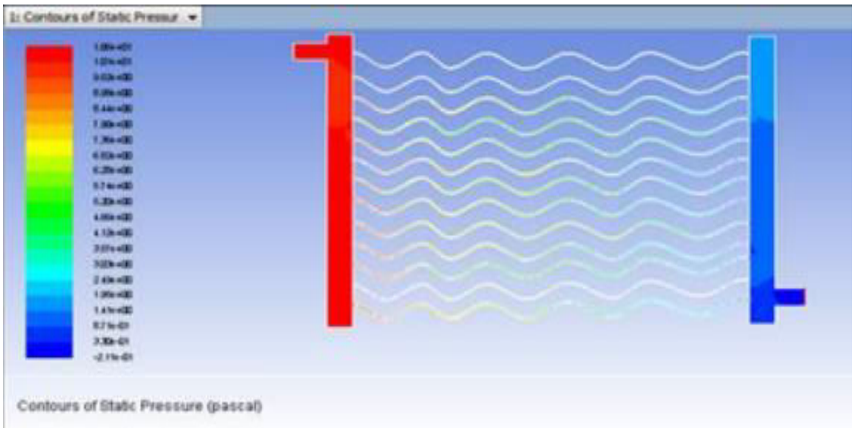

Fig 24: Static pressure

The contour plot is a graph used to visualize how a dependent variable (usually on the y-axis) changes along an independent variable (usually on the x-axis). A contour plot can be created for a function of two variables. According to the above contour plot, the maximum pressure is 4.35e+05Pa and minimum static pressure is -3.27e+05Pa.

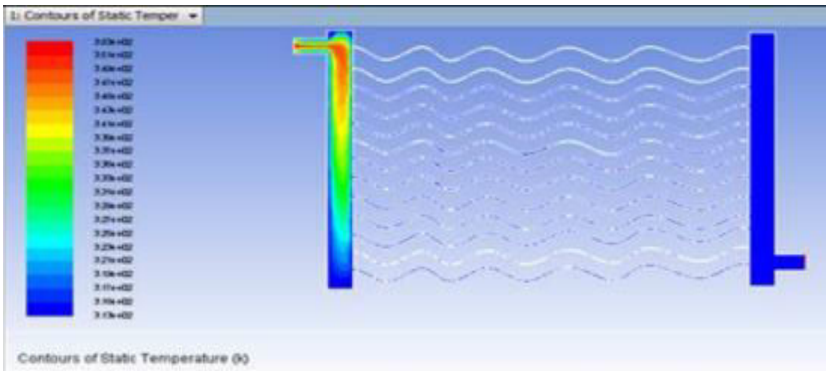

Fig 25: Static temperature

According to the above contour plot, the maximum static temperature magnitude of the air at corners of narrow plate, because the applying the boundary conditions at inlet of the boundary of the radiator helical tubes and minimum static temperature magnitude at around edges of the narrow plate. According to the above contour plot, the maximum static temperature is 1.00e+03m/s and minimum static temperature is 5.01e+01m/s.

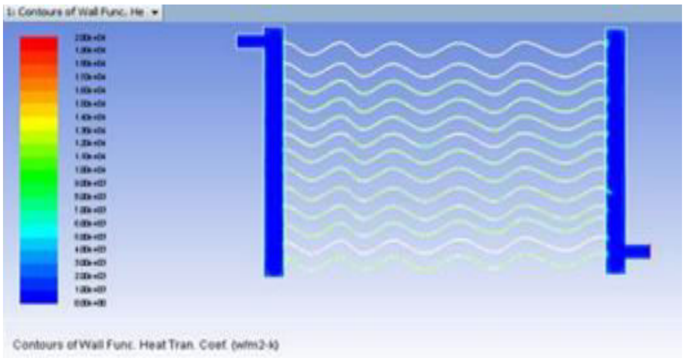

Fig 26: Heat transfer co-efficient

According to the above contour plot, the maximum heat transfer coefficient of the air at edges of the radiator helical tubes and minimum heat transfer coefficient between around the boundary edges and radiator helical tubes edges. According to the above contour plot, the maximum heat transfer coefficient is 4.73e+02w/m2 -k and minimum heat transfer coefficient is 2.27e+01w/m2 -k.

Table: result tables Case 1-straight tube

	Fluid	Pressure (Pa)	Temperature (k)	Heat transfer coefficient	Mass flow rate (Kg/sec)	Heat transfer rate (w)
2.8	**Air**	1.36e+04	3.53e+02	5.14e+02	0.000474	18.53125
	Water	2.09e+01	3.53e+02	9.08e+02	0.0003764	61.984
	Al_2O_3	1.00e+01	3.53e+02	6.09e+03	1.47e-05	0.32815
	CuO	1.20e+01	3.33e+02	6.07e+03	1.27e-05	0.30815
1.5	**Air**	3.94e+03	3.53e+02	2.94e+02	0.002113	7.007
	Water	7.25e+00	3.53e+02	5.23e+02	0.000204	32.406
	Al_2O_3	4.03e+00	3.53e+02	6.12e+03	6.55e-05	0.722
	CuO	4.13e+00	3.33e+02	6.32e+03	6.35e-05	0.522

Table: Case 2 -helical tube

MASS FLOW (Kg/sec)	Fluid	Pressure (Pa)	Temperature (k)	Heat transfer coefficient	Mass flow rate (Kg/sec)	Heat transfer rate(w)
2.8	**Air**	2.56E+04	3.53E+02	5.64E+02	8.60e-05	273.25
	Water	4.85e+01	3.53e+02	9.31e+02	2.16e-05	463.468
	Al_2O_3	2.59e+01	3.53e+02	2.00e+04	7.39e-06	0.83959
	CuO	2.39e+01	3.33e+02	2.00e+04	7.19e-06	0.81959
1.5	**Air**	7.53e+03	3.53e+02	3.23e+04	2.33e-05	150.17
	Water	1.82e+01	3.53e+02	7.84e+02	1.15e-05	55.031
	Al_2O_3	1.06e+01	3.53e+02	1.97e+02	3.96e-06	0.277
	CuO	1.16e+01	3.33e+02	1.77e+02	3.76e-06	0.257

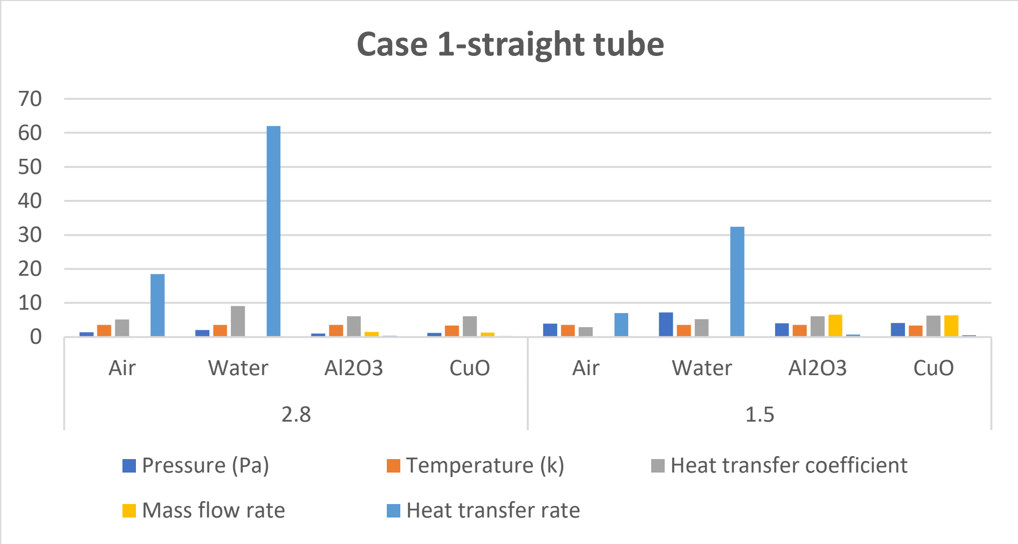

Fig 27 : Straight tube CFD Results Variations in different parametric conditions

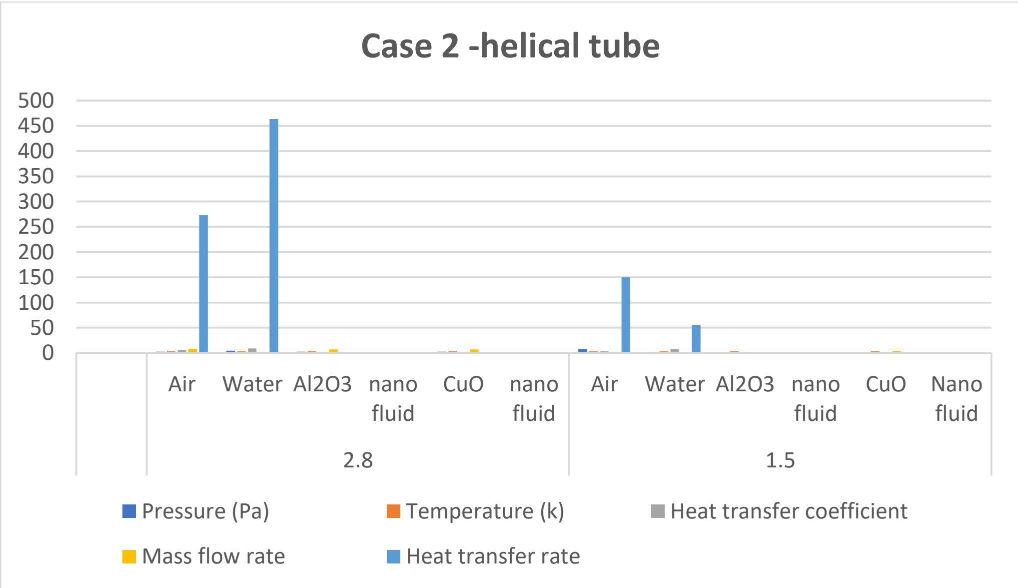

Fig 28: helical tube CFD Results Variations in different parametric conditions

CONCLUSION:

In this project concluded that different nano fluids mixed with base fluid water are analyzed for their performance in the thermostat applied to the different types of fluids. The fluids are water, air and aluminum oxide nano fluid. 3D model of the radiator is done in CREO parametric software. CFD analysis is performed on aluminium radiator by using ANSYS Flow simulation module and its analysis is performed on radiator by selecting different fluid i.e. fluid water and Air with two nanofluid such as Copper oxide (CuO) and Aluminium oxide (Al2O3). Boundary conditions is provided as 90˚C for inlet temperature of fluid, which will cooled by radiator pipe and fins by means of convection process on ambient temperature of 25˚C. Due to convection temperature of fluid flow inside radiator there will be decrease in values of temperature, pressure and velocity of fluid. From the above table we can conclude that Nanofluids give better convection i.e. gives better cooling to engine compare to water. Copper oxide (CuO) gives best result compare to all fluid used for analysis. Hence, we can conclude that Copper oxide (CuO) gives better performance economically, least cost and availability. So, copper oxide is the best nanofluid for Thermostat.

Future work:

The thermostat is just one of several devices in which human interaction contributes to energy consumption. A similar debate will take place in the future about in-home energy displays, lighting controls, and household appliances (such as televisions) that enhance user interfaces and transparency in energy consumption.

REFERENCES:

[1] G.S. Sharma and B. Sharma. ―Duct designing in air conditioning system and its impact on system performance‖. VSRD International Journal of Mechanical, Automobile and Production Engineering, Vol. 2 No. 9 November 2012.

[2] R. Whalley, A.A.Ameer. ―Heating, ventilation and air conditioning system modeling‖. Building and Environment 46 (2011) 643-656.

[3] Tengfang T. Xu, Francois R. Carrie, Darryl J Dickerhoff, William J. Fisk. ―Performance of thermal distribution systems in large commercial building‖. Building and Environment 34 (2002) 215-226.

[4] C. Aydin, B.Ozerdem. Air leakage measurement and analysis in duct systems. Energy and Buildings 38 (2006) 207–213.

[5] M. Krajcík, A. Simonea, B. W. Olesena. ―Air distribution and ventilation effectiveness in an occupied room heated by warm air‖. Energy and Buildings 55 (2012) 94–101.

[6] W. J. Fisk, W.Delp, R. Diamond, D. Dickerhoff, R. Levinson, M. Modera, M. Nematollahi, D. Wang. Duct systems in large commercial buildings: physical characterization, air leakage, and heat conduction gains. Energy and Buildings 32 (2000) 109–119.

[7] L. Pang, J. Xu, L. Fang, M. Gong, H. Zhang, Y. Zhang. Evaluation of an improved air distribution system for aircraft cabin. Building and Environment 59 (2013) 145- 152.

[8] K. Srinivasan. Measurement of air leakage in air-handling units and air conditioning ducts. Energy and Buildings 37 (2005) 273–277.

[9] H. R. Shiu, F. C. Ou, S. L. Chen. Optimization design of exhaust duct system in semiconductor factory using dynamic programming method. Building and Environment 38 (2003) 533 – 542.

[10] W. R. Chan, J. Joh, M. H. Sherman Environmental. Analysis of air leakage measurements of US houses. Energy and Buildings 66 (2013) 616–625.