Comparative CFD Analysis and Investigation of Automobile Radiator Using Nanofluids

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Abstract: Radiator is employed 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 industy. 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. Automobile radiator main perform is to cool the engine by passing the coolant through cylinder water jackets and fins. Modeling of Aluminium radiator is completed by exploitation solid works 2016 software and CFD analysis is performed on radiator by explo itation solid works flow simulation flow process. CFD analysis is performed on radiator by selecting different flu ids i.e. one regular fluid water and three nanofluids like Titanium oxide (TiO_2), Copper oxide (CuO) and Aluminum oxide (Al_2O_3). Boundary conditions is provided as 90˚C for in let temperature of fluid, which can cooled by radiator pipe and fins by mean 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. By seeing the results we can conclude that nanofluid provide higher convection i.e. better cooling to engine compared to that of water.

Keywords: Automobile Radiator, Heat Transfer Enhancement, Nanofluids, water (H_2O), Aluminum oxide (Al_2O_3), Titanium oxide (TiO_2), Copper oxide (CuO).

1. Introduction:

1.1 Cooling System Working

Motor vehicles mainly consist of two types cooling systems are Liquid cooled and Air cooled system. Air cooled engines square measure found on a number of older cars[1].Several fashionable motorcycles still use air cooling, except for the foremost half cars and trucks use liquid cooled system[2]. The cooling system is created from the passages within the casting and heads to pump the flow into the agent and thermostat to manage the temperature of the cooling systems in cars a radiator to cool the agent a cap to manage the pressure within the system and a few plumbing consisting of interconnecting hoses to transfer the agent from the engine to radiator and additionally to the car's heater system wherever hot agent is employed to heat up the vehicle's interior on a cool day[3].Cooling system works by causing a liquid agent through passages within the casting and heads because the agent flows through these passages, it picks up heat from the engine[4]. The heated fluid then makes its manner through a rubber hose to the radiator

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within the front of the automobile because it flows through the skinny tubes within the radiator compartment, the new liquid is cooled by the air stream getting into the engine compartment from the grill before of the automobile [5].Once the fluid is cooled then it returns to the engine compartment to soak up a lot of heat pump has the work of keeping the fluid moving through this method of plumbing and hidden passages. A thermostat is placed between the engine and therefore the radiator to create certain that the agent stays on top of a definite planned temperature[6]. If temperature is lower then the original temperature of thermostat will block the fluid flow of the radiator, forcing the fluid through bypass to engine directly[7]. The agent can still flow into like this till it reaches the planning temperature, at that purpose, the thermostat can open a valve and permit the agent back through the radiator[8].

1.2 Nanofluid:

Nanofluid is a kind of fluid that has a mixture of nanometer sized particles is nanoparticles. These nanofluids have suspension of colloidal nanoparticles in a base fluid like water, oil etc. Particle used in nanofluid are made of metals, oxides, carbides, or carbon nanotubes. Common base fluids embrace water, glycol and oil. Nanofluids have some basic novel properties that make them most likely useful in many applications in heat transfer in conjunction with little natural philosophy, fuel cells, pharmaceutical method and hybrid powered engine, engine cooling vehicles thermal managements, device, in grinding, machining and in boiler flue gas.

1.3 Solidworks:

Solid works is a mechanical design software tool used to design a product models within a short span of time with accuracy, easily and quickly. It has a good interface model with good features, sketch ideas, dimensions and produce models and detailed drawings.

1.4 Simulation using CFD:

Computational fluid dynamics is a tool which has wonderful flexibility and accuracy in the breadth of application. CFD uses a numerical analysis and information structure that helps to resolve and analyze issues with the involvement fluid flows.

2. Methodology

In this we are doing CFD analysis on aluminium radiator by selecting different fluid i.e. one regular fluid water and three nanofluid such as Titanium oxide (TiO_2), Aluminum oxide (Al_2O_3) and Copper oxide (CuO). 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, has inlet mass flow rate of 15kg/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.

3. Modeling of Radiator

Figure: 1 Design of Radiator in Solid Works

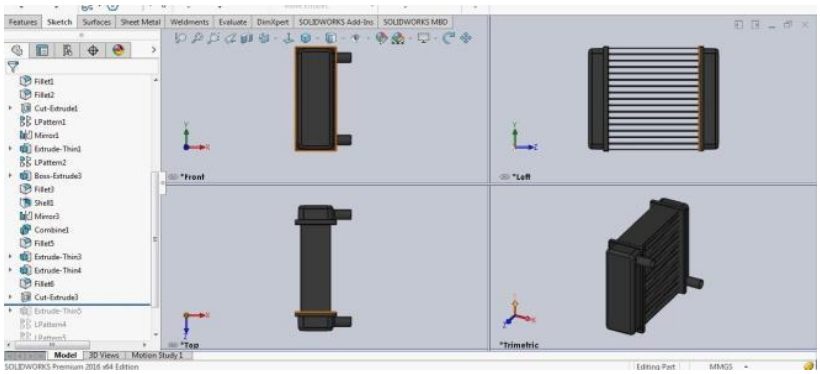

Figure: 2 All Views of Radiator

4. Analysis:

4.1 Water

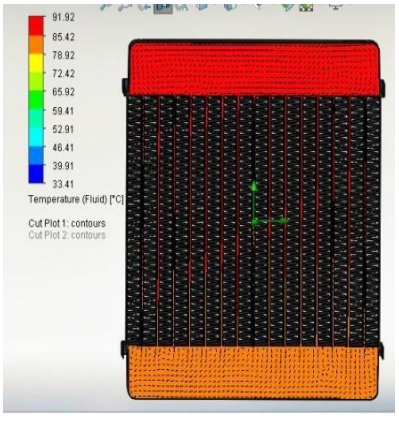

Figure 3: Tempreature

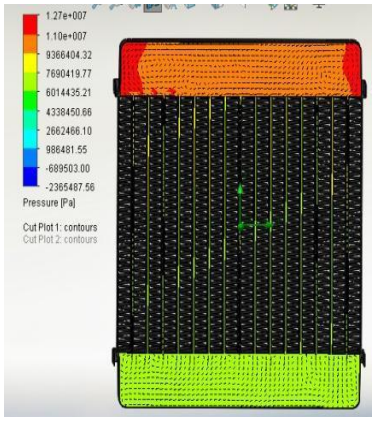

Figure 4: Pressure

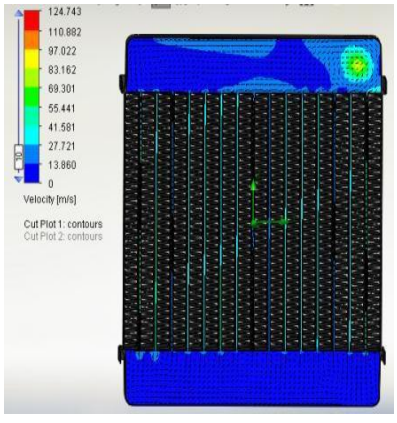

Figure 5: Velocity

From the above figure we know that we have given outlet temperature of water as 90˚C and we can see the decrease in temperature from 90˚C - 33.41˚C and decrease in pressure and velocity.

4.2 Titanium Oxide (TiO_2)

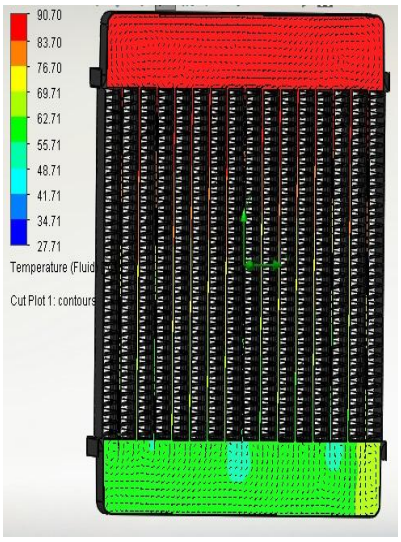

Figure 6: Tempreature

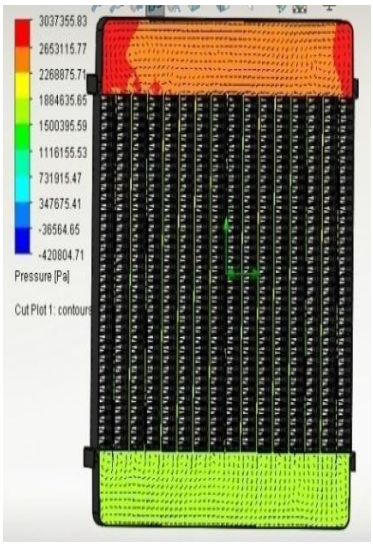

Figure 7: Pressure

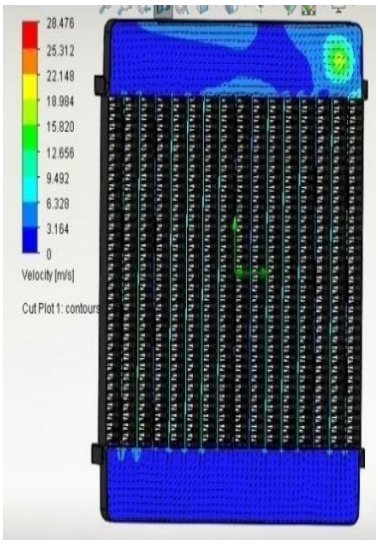

Figure 8: Velocity

From the above figures we know that we have given outlet temperature of TiO2 as 90˚C and we can see the decrease in temperature from 90˚C - 27.71˚C and same decrease in pressure and velocity.

4.3 Aluminum Oxide (Al_2O_3)

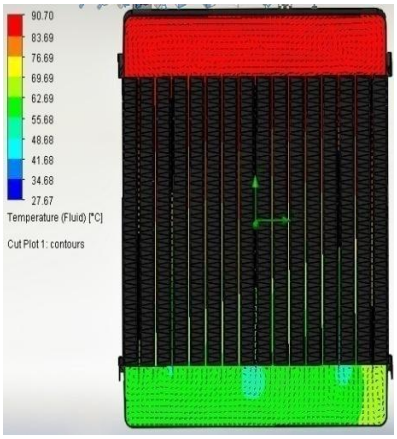

Figure 9 Tempreature

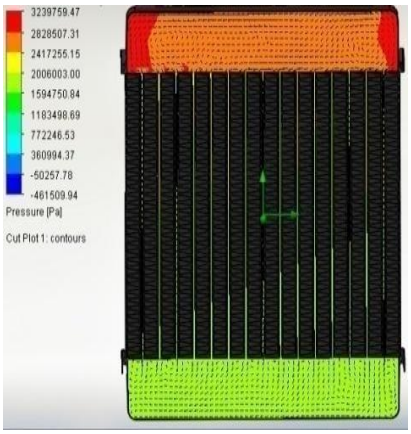

Figure 10 Pressure

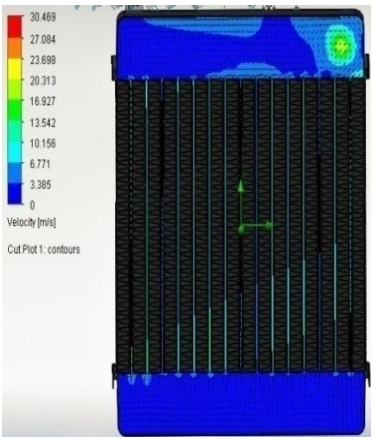

Figure 11 Velocity

From the above figure we know that we have given outlet temperature of Al_2O_3 as 90˚C and we can see the decrease of temperature from 90˚C-27.67˚C and decrease in pressure and velocity.

4.4 Copper Oxide (CuO)

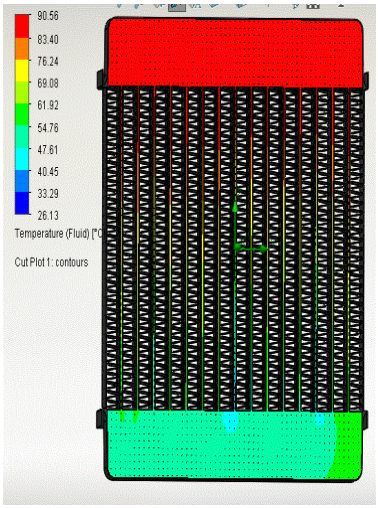

Figure 12 Temperature

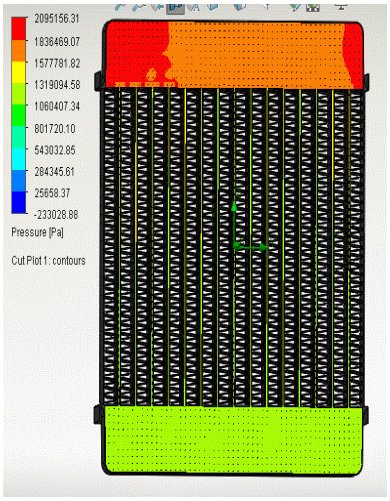

Figure 13 Pressure

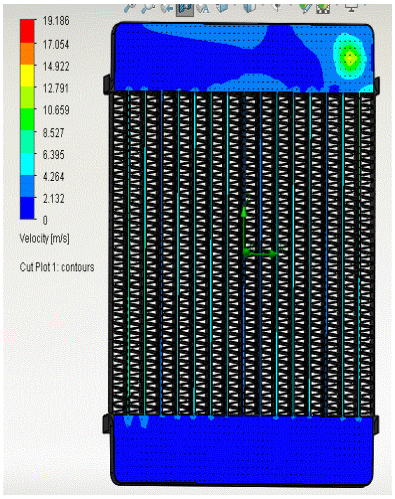

Figure 14 Velocity

From the above figure we know that we have given outlet temperature of CuO as 90˚C and we can see the decrease in temperature from 90˚C - 26.13˚C and decrease in pressure and velocity. By this we conclude that CuO gives better performance than other fluids

4.5 Properties of Nanofluids:

Table 1 Fluid Properties

PROPERTIES	DENSITY (kg/m^3)	DYNAMIC VISCOSITY (Pa*s)	SPECIFIC HEAT J/(kg*k)	THERMAL CONDUCTIVITY W/(m*k)
Aluminium oxide	3970	0.000627	765	40
Titanium oxide	4250	0.000613	656.2	8.95
Copper oxide	6310	0.0006612	385	33

5. Future Scope:

Radiator plays a vital role in industry for the aim of cooling through fins, air and water cooling system. With the application it improves the nanofluid performance rather than water and it enhance thermal performance of the automobile radiator system associated with issues like stability and alluviation. Nanofluids shows promising potential because the agent for automotive radiator and additional ranges of operative and volume concentrations could result in be explored so as to higher perceive its full potentials.

6. Results and Discussions :

6.1 Temperature of Fluid at 90˚C:

Table 2:- Temperature of fluids

FLUID	INLET TEMPREATURE (C)	OUTLET TEMPERATURE (C)
Water	90	33.41
Copper oxide	90	26.13
Aluminium oxide	90	27.67
Titanium oxide	90	27.71

6.2 Pressure:

Table 3:- Pressure of fluids at 90˚C

FLUID	STARTING PRESSURE AT 90˚C (Pascal)	ENDING PRESSURE AT 90˚C (Pascal)
Water	$1.27^{e+}007$	2365487.56
Copper oxide	2095156.31	233028.80
Aluminium oxide	3239759.47	461509.94
Titanium oxide	3037355.83	420804.71

6.3 Velocity:

Table 4:- Velocity of fluids 90˚C

FLUID	STARTING VELOCITY AT 90˚C (m/s)	ENDING VELOCITY AT 90˚C (m/s)
Water	124.743	0
Copper oxide	19.186	0
Aluminium oxide	30.469	0
Titanium oxide	28.476	0

7. GRAPHS:

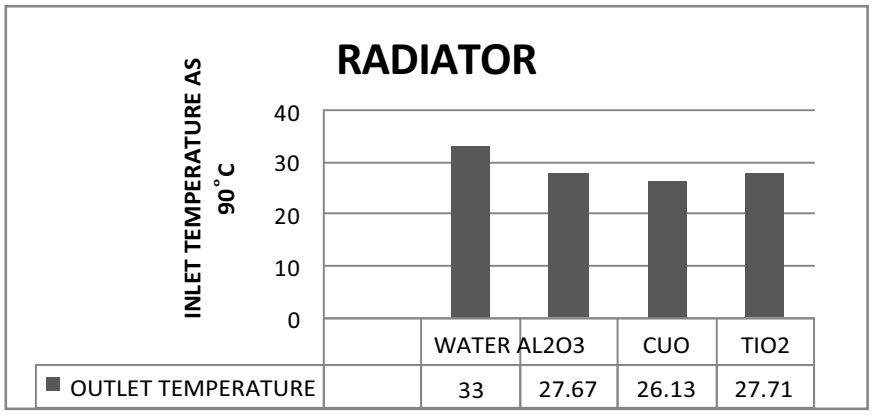

Figure15: Graph showing the outer temperature of fluid at 90˚C

8. Conclusion:

CFD analysis is performed on aluminium radiator by using solid works Flow simulation module and it's analysis is performed on radiator by selecting different fluid i.e. one regular fluid water and three nanofluid such as Copper oxide (CuO) Titanium oxide (TiO_2) and Aluminum oxide (Al_2O_3). 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 radiator.

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