Enhancing the Heat Transfer Rate of Automobile Radiator by Using Nanofluid as Coolant

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***Abstract*- In today's world one of the most important tasks is to handle the energy available and to minimize the usage of it and to improve the alternate ways to save it. Talking about the automobile sector, engine is the prime energy source. Cooling system in any automobile system is of almost importance as it carries the heat from the engine and dispenses it to the atmosphere it also enhances the fuel economy and heat transfer rate which is turn helps in maximizing the engine performance. For this reason, we are proposing a way to increase the heat transfer rate in heat exchanger (Radiator) by using nano fluids.**

We are planning on designing an advanced radiator which is now using in latest automobile vehicles and analyzing the radiator by using base fluid & nano fluid. In this process we are going to compare the both results and we will find out the enhanced results obtained while using nano fluids.

Key words – radiator, nano fluid, ethylene, glycol, propylene, thermal conductivity, heat transfer coefficient, effectiveness.

1. INTRODUCTION

A radiator is a heating device used to transfer heat from a hot surface to the surrounding environment. Radiators are commonly used in central heating systems to warm a room by circulating hot water or steam through pipes that run along the walls, floors, or ceilings. The hot water or steam enters the radiator, which then heats up the surrounding air and radiates the heat into the room.

The earliest radiators were made of cast iron and were used in steam heating systems in the 19th century. These radiators were large and bulky, and often took up significant amounts of space in rooms. Over time, however, radiator designs improved and became more compact, allowing for easier installation and better heat distribution.

Today, radiators come in a variety of shapes and sizes, including traditional column-style radiators, flat panel radiators, and even designer radiators that are designed to complement a room's decor. They can also be made from different materials such as steel, aluminium, or copper. One of the advantages of using a radiator for heating is that it is a very efficient way to distribute heat throughout a room. Because radiators operate by transferring heat through convection and radiation, they can quickly warm up a space and maintain a consistent temperature. Additionally, radiators are generally low-maintenance and can last for many years with proper care.

However, radiators do have some drawbacks. For example, they can be slow to heat up and can take a while to reach their maximum temperature. Additionally, radiators can be unsightly and may take up valuable space in a room. Finally, because they operate by circulating hot water or steam, radiators can be noisy, especially when they are first turned on. Overall, radiators are a reliable and efficient way to heat a room. Whether you are looking for a traditional or modern style, there is likely a radiator that can meet your heating needs while also complementing your decor.

Nano Fluids

A Nano-fluid is a fluid in which nanometre-sized particles, suspended in the base fluid, form a colloidal solution of nanoparticles in a base fluid. The nanoparticles used in Nano fluids are typically made of metals, oxides, carbides, or carbon nanotubes, while the base fluids include water, ethylene glycol, and oil.

Base Fluids

Water with an anti-freezing agent is widely used as a coolant in a typical car radiator for cooling of an engine. The heat transport takes place due to bulk movement of coolant molecules. Conventional coolant consists of water as base fluid along with ethylene glycol in certain ratios.

Why this project...?

In recent years, heavy vehicles have become increasingly important for transportation. This is due to several factors, including the growth of e-commerce and the need for efficient logistics and supply chain management. Heavy vehicles are used to transport a wide variety of goods, including raw materials, finished products, and consumer goods.

Another advantage of heavy vehicles is their versatility. They can be used for a wide range of transportation needs, from moving heavy machinery to delivering groceries to local stores. Additionally, many modern heavy vehicles are equipped with advanced technologies such as GPS tracking, which allows logistics companies to monitor their fleet in real-time and optimize their routes.

However, heavy vehicles typically use downflow radiators for several reasons. First, downflow radiators are simpler and less expensive to manufacture than crossflow radiators, making them a more cost-effective option for heavy vehicle manufacturers. Second, downflow radiators are better suited for heavy-duty applications, where the vehicle may encounter rough terrain or extreme weather conditions. In these situations, a crossflow radiator may be more vulnerable to damage or leaking.

Despite the lower efficiency of downflow radiators, heavy vehicles often compensate for this by using larger radiators or multiple radiators in a series to improve cooling performance. Additionally, advancements in radiator design and technology have led to the development of more efficient downflow radiators that can rival the performance of crossflow radiators.

In order to improve this heat exchange rate, we are using nano fluids in radiator.

2. LITERATURE SURVEY

2.1 EFFECTS OF NANOFLUID ON RADIATOR

Nanofluids are a brand-new elegance of warmth switch fluids that have proven brilliant promise in enhancing the performance of warmth switch in diverse commercial applications. The use of nanofluids in radiators is one such area of research that has gained significant attention in recent years.

Several studies have been conducted to investigate the effects of nanofluids on radiator performance. For example, one study conducted by Khorasan Zadeh et al. (2015) investigated the thermal performance of a car radiator using water-based nanofluids containing alumina nanoparticles. The results showed that the addition of nanoparticles improved the overall heat transfer coefficient of the radiator, leading to a decrease in the coolant temperature and an increase in the overall efficiency of the cooling system.

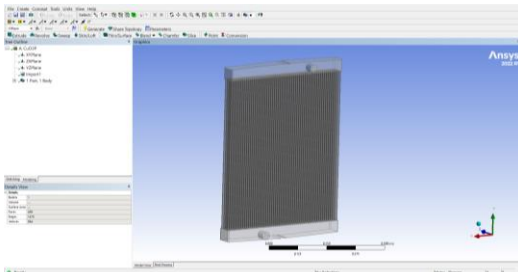
Another study conducted by Sarafraz et al. (2018) investigated the thermal performance of a car radiator using water-based nanofluids containing copper oxide nanoparticles. The results showed that the addition of nanoparticles significantly improved the heat transfer performance of the radiator, leading

In addition to these studies, several other researchers have also investigated the use of nanofluids in radiators for various applications, including electronics cooling, industrial heat exchangers, and power generation systems.

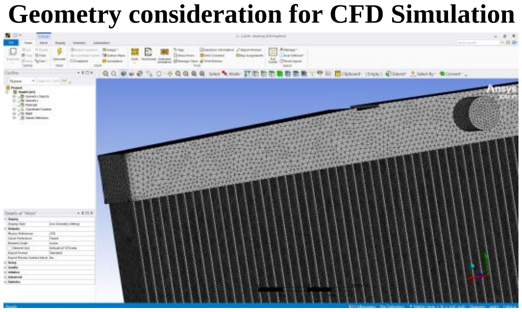
While the use of nanofluids in radiators has shown promising results, there are also some challenges associated with their use, such as the potential for clogging and increased pressure drop. As such, further research is needed to fully understand the effects of nanofluids on radiator performance and to develop effective strategies for their implementation in various industrial applications. personnel, inadequate infrastructure, and limited access to advanced technologies. The DRTS is working to address these challenges through partnerships with other government agencies, private sector organizations, and international development partners.

3. MODELLING AND SIMULATION

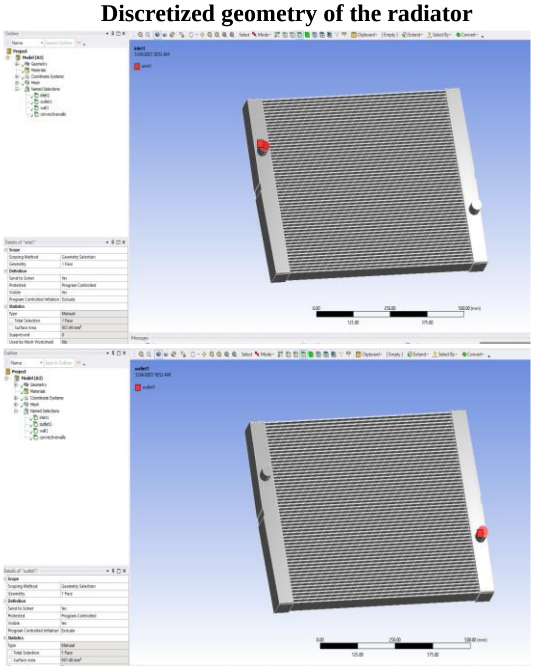
The Radiator model is designed in Solid works and imported it to ANSYS workbench for performing CFD simulation

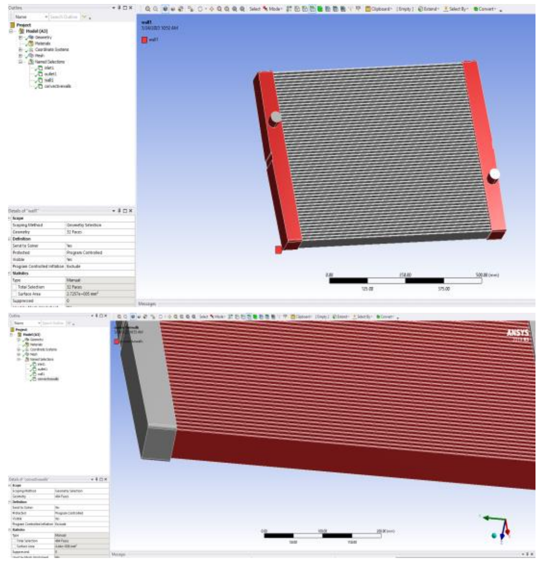


Geometry consideration for CFD Simulation



Discretized geometry of the radiator





Shows named selections created in Ansys fluent

Simulation

In this project we used ANSYS Fluid flow (Fluent) method in ANSYS software. In this analysis we are going to find the outlet coolant temperatures by using input parameters like inlet coolant temperatures and nano fluid properties. We used AL_2O_3 and CuO as a Nano fluid mixed with water in different compositions.

4.1 FORMULAE

The effectiveness (ϵ) of a heat exchanger is defined as the ratio of the actual heat transfer to the maximum possible heat transfer.

- ∈ = actual heat transfer / maximum possible heat transfer

Actual heat transfer

$$Q = m_h C_{ph} (t_{h1} - t_{h2}) = m_c Cpc (t_{c2} - t_{c1})$$

Where,

$m_h . C_{ph} = C_h$ = hot fluid capacity rate

$m_c . C_{pc} = C_c$ = Cold fluid capacity rate

Maximum possible heat transfer

$$= Q_{max} = C_h (t_{h1} - t_{c1}) \text{ or}$$

$$= C_c (t_{h1} - t_{c1})$$

Qmax is the minimum of these two values

$$Q_{max} = C_{min} (t_{h1} - t_{c1})$$

$$\in = C_h (t_{h1} - t_{h2}) / C_{min} (t_{h1} - t_{c1}) \text{ or}$$

$$= C_c (t_{c2} - t_{c1}) / C_{min} (t_{h1} - t_{c1})$$

Determination of overall heat transfer coefficient

To determine the overall heat transfer coefficient U for a given heat exchanger, we use the following relation:

- $NTU = UA/C_{min}$

Where,

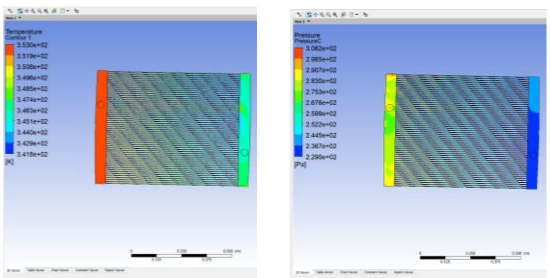
NTU=Number of Transfer Units (Dimensionless)

U=Overall heat transfer coefficient (W/m^2K)

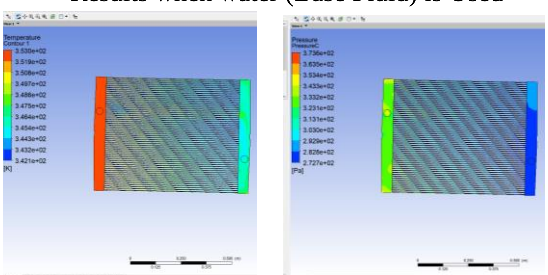
A=Heat transfer surface area (m^2)

C_{min}=Minimum of C_h or C_c (kJ/K)

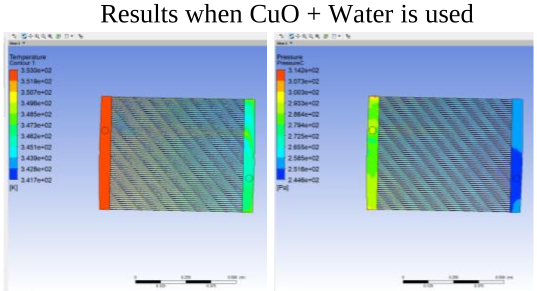
RESULTS



Results when water (Base Fluid) is Used



Results when CuO + Water is used



Results when Al_2O_3 + Water is used

Mass Flow Rate of Inlet Coolant at 4 LPM

Readings of 0.1 % of Al_2O_3 Nano fluid

S. No	Inlet Coolant Temp	Mass Flow rate	Outlet Coolant Temp
Units	^0C	Lpm	^0C
1	35.6	4 LPM	33.2
2	38.4	4 LPM	36.3
3	41.6	4 LPM	39.3
4	44.3	4 LPM	41.3

Readings of 0.1 % of CuO Nano Fluid

S. No	Inlet Coolant Temp	Mass Flow rate	Outlet Coolant Temp
Units	^0C	Lpm	^0C
1	36.5	4 LPM	35.2
2	34.5	4 LPM	33.5
3	42.5	4 LPM	37.8
4	48.3	4 LPM	39.3

Readings of 0.2 % of Al_2O_3 Nano Fluid

S. No	Inlet Coolant Temp	Mass Flow rate	Outlet Coolant Temp
Units	^0C	Lpm	^0C
1	37.5	4 LPM	30.2
2	40.5	4 LPM	31.5
3	43.5	4 LPM	32.8
4	48.3	4 LPM	33.3

Readings of 0.2 % 0f CuO Nano Fluid

S. No	Inlet Coolant Temp	Mass Flow rate	Outlet Coolant Temp
Units	^0C	Lpm	^0C
1	37.1	4 LPM	32.2
2	41.3	4 LPM	32.0
3	45.3	4 LPM	34.2
4	54.6	4 LPM	35.2

CONCLUSION

The performance of the Automobile Radiator with the addition of aluminum oxide nanoparticles & Copper oxide nanoparticles at various weight concentrations and different inlet temperatures with respect to their steady state conditions. The following conclusions were made based on the observation made while the experimentation.

The performance of the Radiator Coolant enhanced with the weight concentration of CuO nanofluid. The outlet temperature of cold fluid and effectiveness of Radiator increases with increase in the concentration of nanoparticles and also the heat transfer coefficient based on the inner and outer surface areas also be increased with the increase of nanofluid concentration compared to base fluid.

The results show that heat transfer rate linearly increases with increase if the mass flow rate also changes and as well as inlet temperature.

The results of the Experiment show that nanofluids transmit heat more quickly than base coolants. When compared to base fluid.

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