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# Heat Transfer Augmentation by Using Insert and Nano fluid in Different Coil Geometry

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**Abstract** - During vehicle development, it was challenging to prevent excess heat from generating within the engine cylinders.

A cooling system prevents engine failure due to melting and damage. The cooling system of an equate degree automotive significantly impacts its performance. Currently, all automotive companies use atomic number 13-based radiators. The quality radiator provides partial temperature reduction and does not fulfill the needs of high engine power. This study aims to analyze the convective heat transfer constant of vehicle radiators using various nanofluids. Ethylene glycol mixed with water is commonly used as engine fluid in automotive radiators. Despite having lower heat transfer rates, f-MWCNT nanofluid outperformed DI water due to greater thermal properties. Nanofluid outperformed DI in terms of heat transmission by up to 40%.

***Key Words***: ANSYS, CFD, Velocity, Heat Exchanger, Fluent, Radiator

## 1. INTRODUCTION

A car radiator's thermal performance is crucial for its cooling system and other related systems to function properly. For many years, this half has received little attention in terms of aggregating value, operations, and pure mathematics. To improve the efficiency of a radiator, several researches are conducted on additional components such as an oblong blade, plate, spherical tube, tier tube, elliptic tube, and spine balance. Spine fin radiators are often used in commercial vehicles.

Although spine fin radiators have a fast heat transfer rate, they might cause friction issues due to their unclear fluid section. The spine balancing radiator consists of two geometric elements: intricate stream sections for improved heat exchange and a significant difference in scale between the radiator and balance component.

Improved heat transfer is crucial for automotive performance, since it impacts cooling rates. New innovations and propelled liquids have the potential to improve heat transfer rates. The gift essay focuses on the latter option.

Liquids with poor heat transmission, such as refrigerants, water, motor oil, and ethanediol, require large and effective heat transfer systems to provide the desired heat transfer. Efforts to increase heat transmission sometimes include adding chemicals to fluids. Technological advancements have led to the development of nanofluids, a new kind of liquid. These liquids are fluid suspensions with particles smaller than 100 nm and heat conduction between solids and fluids. Nan fluids are created by floating alumina or non-metallic nanoparticles in heat transfer fluids.

Nanofluids have superior thermal characteristics as compared to liquids commonly used for heat exchange and containing micrometer-sized particles. Pak Associate in Nursing Cho conducted an exploratory study on the convective turbulent heat transfer properties of nanofluids (Al2O3-water) with 1-3 vol.%. The Nussle variety of nanofluids increases with increased volume fixation and Reynolds variety. Veeranna sridhara and Lakshmi Narayan Satapathy developed Nan fluids, which suspend nanoparticles smaller than 100 nm in heat transfer liquids such water, oil, diesel, and ethanediol. Innovative heat transfer liquids are created by suspending nanometer-sized solid particles, whether metallic or non-metallic.

Corundum (Al2O3)-based nanofluids exhibit improved heat conductivity, thickness, and heat transfer properties. Al2O3 nanoparticles ranging from 13 to 302 nm were added to produce nanofluids, resulting in a two to twelve-month boost in thermal conductivity. Nan fluids are becoming a popular choice for heat transfer fluids in automobile cooling due to their exceptional thermal properties. Recent analyses show that nanofluids have improved heat transmission capability.

This study examines the heat transmission properties of a spline fin automotive radiator using a combination of water-based Al2O3 nanofluids as

coolants. The thermal performance of a vehicle radiator using nanofluids is compared to that of a radiator using conventional coolants. The study examined how the volume percentage of Al2O3 nanoparticles in base fluids affects thermal performance and radiator size reduction.

## 2. Literature Review

[1].Wiryanta and Adiaksa conducted an experimental and numerical study on thermal radiators' performance as a heat source in dryer simulation design. This research aimed to test the temperature performance of tube and fin automobile radiators via both experimental and computational methods. The experiment used a simulation design with a reservoir water tank, heater, pump for hot water circulation to radiators, and cooling fan. The geometry and meshing were developed with ANSYS Workbench and post-processed with Fluent. The simulation outcome was consistent with the experimental investigation. This paper suggests ways to improve radiator performance based on experimental and numerical analytical results. The first step is to optimize system design by optimizing cooling fan speed and hot water flow rate from reservoir to radiators. This allows for better heat rejection by the radiators.

[2].P.Natarajan Results of "Heat Transfer Analysis in Light Passenger Car Radiators with Various Geometrical Configurations "The research focuses on designing and analyzing single-phase convective heat transfer. This study examines how different geometric configurations affect the performance of staggered fin and tube radiators.

The method for heat transmission is illustrated using fins-tubes, but it may also be used to other geometrical configurations. This study examines how different geometrical designs of radiator tubes affect their performance. The study found that circular and oval tube-III had similar outlet temperatures and maximum velocity to other oval tubes, whereas oval tube-I and oval tube-II have lower values. Pressure is higher in oval tube-III than in circular tube.

[3].Sudalai Suresh Pungaiah and Chidambara Kuttalam Kailasanathan conducted "Thermal Analysis and Optimization of Nano Coated Radiator Tubes Using Computational Fluid Dynamics and the Taguchi Method."
This study tested three alternative coolant flow rates, coating thicknesses, and top surface coatings on radiator tubes. Thermal analysis is conducted at three temperatures to condition the heat input for CFD. The Taguchi technique and CFD analysis offer a straightforward and effective approach to optimizing process parameters. ANOVA results demonstrated 95% confidence and were validated for the most important variable. The copper nano-coating on the radiators' aluminum core improves their heat transmission efficiency. The heater core uses copper particles coated on aluminum tubes to transmit heat.
To reduce the front section of the car, copper-coated aluminum tube radiators can be used instead of typical aluminum radiators to cool the high-power engine for optimal performance. The inner layer of aluminum maintains typical qualities, while the outside layer of copper coating is rust-free and lighter than real copper alloy radiators.

[4].C. Uma Maheswari, C. Suresh Reddy, C. Rajeshwara Reddy, A.T. Kiran Sai Naidu, C. Saradhi, and A. Chenna Kesavulu conducted "CFD ANALYSIS OF RADIATORS."
This study discusses the thermal and CFD analysis of vehicle radiators. Theoretical calculations were performed in MAT Lab with varied coolant mass flow rates.
Temperature distribution and heat transfer rates for various coolant velocities have been studied for tube materials including copper, aluminum, and stainless steel. After comparing numerical findings, copper was shown to have the highest heat transmission rate and efficiency.
They found that increasing the coolant mass flow rate leads to higher output temperatures. Copper offers the greatest outcomes, whereas aluminum outperforms stainless steel. Copper is an ideal material for tubes due to its resistance to corrosion.
Research Gap: They covered radiator tubes composed of copper, aluminum, and stainless steel. They did not include the radiator fins in the CFD analysis.

5]. Sai Kiran.S and Dr.M.V.A.Raju conducted "Modelling and Analysis of Louvred Fin Radiators with Nan fluids Using CFD."
This study uses the ANSYS computational analysis tool to conduct CFD analysis on radiators with no

louvered fins at various mass flow rates. CFD study will be done on radiators with and without louvered fins. Modeling and analysis are done in CFD. Computational results align well with experimental findings. To increase heat transfer, a fluid flow and heat transfer investigation of automobile radiators (louvre fin) using nanofluid was conducted successfully.
This analysis examines pressure, temperature, and velocity fluctuations in coolant and airflow directions. Increasing the mass flow rate of air and coolant leads to higher cooling capacity. Cooling capacity decreases as inlet air temperature rises, but increases with inlet coolant temperature.

[6].Kola David and Abhishek Kumar conducted "CFD and Heat Transfer Analysis of Automobile Radiators Using Helical Tubes." This study examines how Nanofluids combined with base fluid water behave in helical and straight tube radiators. The radiators are 3D-modeled using CREO parametric software.
CFD analysis is performed on radiators for all fluids, whereas thermal analysis is conducted in Ansys. In this project, several fluids are applied to the radiators. The study found that increasing the mass flow intake leads to higher heat transfer coefficient values, as shown using CFD analysis. When compared to other fluids, aluminum oxide Nanofluid has a higher heat transfer rate. Thermal study reveals that copper alloys produce higher heat flux than aluminum alloys. Helical type tube radiators outperform other geometries in terms of heat transfer rate.

## 3. MATERIAL AND METHOD

### 3.1 THERMOPHYSICAL PROPERTIES OF NANOFLUID

The Al2O3 nanofluid solid particles and water (H2O) were

various applications include nanofluid solid particles and basic liquid fluids. They were combined at varying concentrations.Organise nanofluid material for radiator agents. Nanofluids have much higher heat transfer compared to normal fluids. Several nanofluid characteristics were examined and used in simulations.

### 3.2 Model Characteristics

This investigation utilized CFD simulation with ANSYS Fluid Flow Fluent software suite. This study began with a literature review on hypotheses related to nanofluid analysis. Additionally, the construction of fluid pure mathematics is completed using the Autodesk Artificer 2020 software suite. Radiator style refers to the AN's current style. ANSYS software was used for planning and meshing, followed by modeling using the Fluid Flow Fluent. Figure 1 illustrates radiator planning.


Fig 3.1 Radiators full view

### 3.3 Boundary Conditions

This work assumes an intake velocity of 0.4 m/s and a temperature of 130°C.Calculating the Reynolds number reveals a transition in fluid flow. When the Reynolds number is between 3000 and 4000, the assumption for viscous flow is k-epsilon realizable.

## 4 METHODOLOGIES

- Create a Radiators geometry using Solid works
- Export to ANSYS Workbench for preparing the model for Flow Analysis
- Meshing geometry using Tetra element with the Skewness value
- < 1 Define the wall condition
- Export the meshed model to fluent
- Assigning fluid and Solid Domain
- Defining fluid and solid properties
- Fluid and Solid Boundary condition
- Run the iteration
- Export the results to CFD Post –Postprocessor

- Post-process temperature results in the inlet, Fin Surface, Pipe outer surface, and outlet
- The same will be repeated with coating Material
- Compare the results between both coating and without coating

Software methodology was adopted for the progress of the work. Here Modeling is done with Solid works and analysis done with ANSYS CFD.

### 4.1 DESIGN AND ANALYSIS

The radiators of a commercially existing vehicle are chosen for the analysis to bring practicality to the study. the details of the geometry of the radiators were obtained by the process of reverse engineering. The dimensions of individual components of the radiators were measured using suitable measuring instruments then used to generate the Gambit model. Discrediting the fluid domain, simulation of the fluid flow with heat transfer at steady-state, and post-processing the results, and drawing suitable conclusions.

## 5. CONCLUSIONS

Computational fluid dynamics simulations were used to study the effectiveness of a nanofluid made from a blend of Al2O3 and water for radiator cooling. This study examines how nanoparticle concentration affects heat transmission and fluid temperature at the radiator output. Increasing the concentration of nanoparticles in the working fluid, while maintaining the same velocity and inlet temperature, increases heat transfer to the environment. As a result, the temperature of the working fluid dropped along the radiator pipe.
Nanofluids have higher heat conductivity than water, which contributes to this phenomenon. Adding 1% Al2O3 to the nanofluid was shown to be effective.

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