ESTIMATION OF HEAT TRANSFER IN RADIATOR USING DIFFERENT KINDS OF NANO FLUIDS IN CFD

T. Sreedhar[1]
Research Scholar, Department of Mechanical Engineering, VFSTR Deemed to be University, Vadlamudi
Guntur - Andhra Pradesh - 522 213 India

B. Nageswara Rao[2]
Professor, Department of Mechanical Engineering, VFSTR Deemed to be University, Vadlamudi
Guntur - Andhra Pradesh - 522 213 India

M.P. Suresh[3]
Department of Mechanical Engineering, VFSTR Deemed to be University, Vadlamudi,
Guntur - Andhra Pradesh - 522 213 India

M. Sai Sasivanth[4]
Department of Mechanical Engineering, VFSTR Deemed to be University, Vadlamudi
Guntur - Andhra Pradesh - 522 213 India

N.S.R. Surya Prakash[5]
Department of Mechanical Engineering, VFSTR Deemed to be University, Vadlamudi,
Guntur - Andhra Pradesh - 522 213 India

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***Abstract**:* The objective of this work is to enhance the radiator performance through improving the heat transfer rate using nano fluids in an engine cooling system. A radiator is a device which is used to remove the excess heat from the engine cylinder such that the engine operates at designed conditions. Recently the researchers focused on better heat removal techniques like water, water+ ethylene glycol used as the coolants in the radiator. Ethylene glycol is an antifreeze solution and it has medium heat transfer rate and high boiling point (It has a moderate heat transfer & conductivity). A nanofluid is a fluid, which are engineered colloidal suspensions of nanoparticles in base fluids. The nanofluids have excellent thermal properties enhancement than conventional fluids. These fluids containing nanometer-sized particles. The simulation analysis has been carried out to estimate the variation in heat transfer coefficient and heat transfer rate of the taken nanofluids also at the end results were compared.

Keywords: Radiator, Nanofluids, conventional fluids, heat transfer rate and CFD

1. INTRODUCTION

The radiator is the backbone of the cooling system in automobiles because it is the heat exchanger which transfer the excess amount of heat generated inside the cylinder to the outside atmosphere, and it provide a chilling effect to the engine cylinder.

The radiator is a device used to transfer heat energy from one medium to another for the purpose of cooling and heating based upon our requirements. Most of the radiators transfer heat in the mode of convection.

Radiators are classified into two types based on the direction of fluid flow. They are

1) Down flow type radiator

2) Cross flow type radiator

In this work, we used down flow type radiator for calculating thermal properties

Many types of coolants are used in automotive radiators such as water, Betaine, Poly alkylene glycol, Mineral oils, Polyphenyl ether, Diphenyl ether and biphenyl, Polychlorinated biphenyls and polychlorinated terphenyls, Ethylene glycol.

Nowadays most of the research is going on nanofluid which can be used as a coolant in the radiator. Because of nanofluids as good thermal properties like high thermal coefficient and high heat transfer rate. Depending upon the rate of cooling the engine performance may vary. In this work, we analyzed that by using nanofluids as a coolant in engine radiator so the efficiency of the engine is increased due to high heat transfer rate as compared with normal radiator coolant that is water.

2. NANOFLUIDS- INTRODUCTION

The nano sized particles in mixture of liquid gives them the ability to interact with liquids at the molecular level. So that they conduct heat better than today's heat transfer fluids depending on these particles. Frequently used nanoparticles include metals (Cu, Al, Zn, Ni, Si, Fe, Ti, Au, Ag etc.,), metal oxides (Al_2O_3, CuO, MgO, ZnO, SiO_2, Fe_2O_3, TiO_2 etc.,), metal carbide (SiC), metal nitride (AlN) and carbon materials (CNTs, MWCNTs, diamond, graphite).

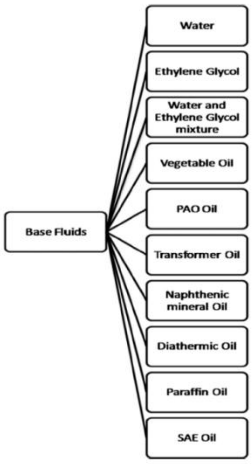


Fig.1. Conventional Fluids used in Nano Fluids

3. LITERATURE SURVEY

Siraj ali ahmed et al [1] concluded from his work, by using TiO_2 nanofluid as a coolant in engine radiator he observed that the overall efficiency of the engine is increased. And also due to the presence of TiO_2 particles in the nanofluids heat transfer coefficient is significantly increased by 0.2% nanoparticle concentration by checking with pure water. Manikandan et al[2] concluded from his work, the Heat transfer rate is increased by using nanofluids as coolants in the radiator but we have to maintain it correct concentration otherwise it leads to increased pumping work. For maintaining stable thermophysical properties also we have to make nanofluids with suitable proportions. M. Ali et al [3] stated from his work, as the heat transfer increases by using nanofluids in radiators with a concentration of 0.01% nanoparticles by volume. The concentration of 0.01 nanoparticles is the optimum value. When concentration increases beyond that value, heat transfer will reduce. T. Sreedhar et al [4] stated from his work that heat transfer coefficient is increases along with the volume fraction because of its fluid thermal conductivity of nanofluid is increased. Masuda et al [5] has investigated and obtained from her work as the Al_2O_3 nanoparticles are added to the fluid by dispersing them (i.e., 4.3 vol%), the thermal conductivity of the nanofluid is increased by 30%.Choi and Eastman [6] from his investigation that the nanofluids have good thermal properties, stability, and rheological properties. Eastman at al [7] through his investigation showed that the nanofluids have excellent thermal properties by considering CuO nanoparticles (0.3% vol) and by using ethylene glycol as the base fluid. He considered the nanoparticles of size 10nm.Das et al [8] has investigated and observed from his work that the thermal conductivity increases with temperature by using water as base fluid and nanoparticles as Al_2O_3 or CuO. He observed that the enhancement with Al_2O_3 as well. K. S. Suganthi et al [9] observed from her work by using ZnO nanoparticles in propylene glycol that, the heat transfer is considerably increased by 16 %, using of 2% volume of ZnO of 70nm.Peyghambarzadeh et al [10] has investigated on forced heat transfer by using Al_2O_3 nanofluid of water-based, he observed that the nanofluids of 1 vol% concentration increased heat transfer by 45% as compared with normal water. T. Sreedhar et al [12] did a simulation in ANSYS on the double pipe heat exchanger and achieved a good performance of heat transfer rate by using MWCNT in base fluid (volume fraction = 0.35)

4. BOUNDARY CONDITIONS

- The inlet temperatures of the radiator are: 343k, 353k and 363k
- Fluids used in radiator: water, (water + ethylene glycol), (water+ TiO_2), (water +Al_2O_3), (water +Cuo)
- The radiator is designed in the software Creo 2.0 Here, number of fins and tubes are modeled including fluid body and assemble in the software. To design this radiator we used extrude, pattern and revolve options. The dimensions are in mm.

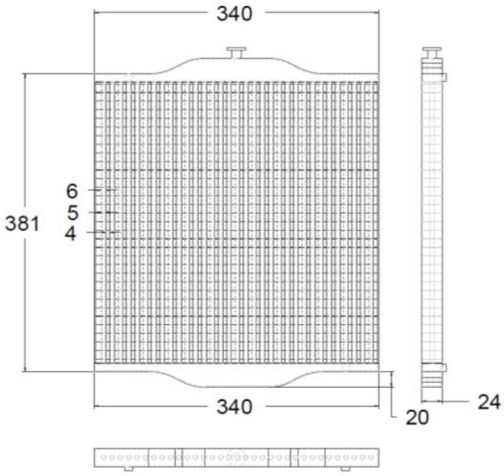
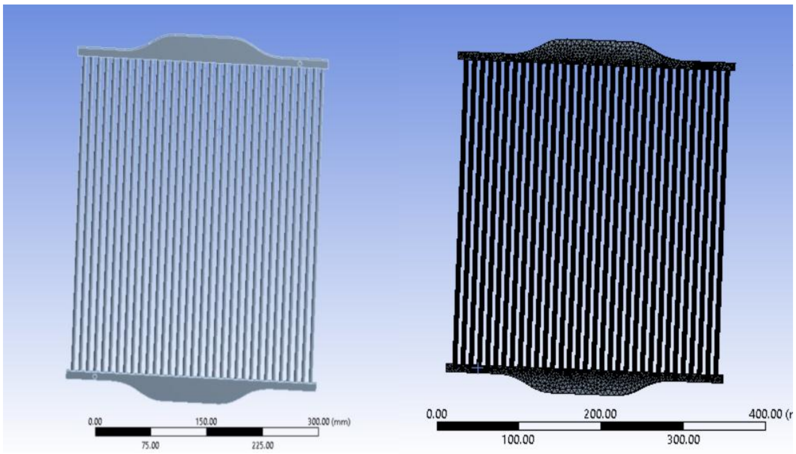


Fig: 2. -Drafting of the radiator with help of creo2.0 software and all dimensions are in mm

5. RESULTS & DISCUSSIONS

The step. File is created in the creo2.0 for radiator. This model is exported to the Ansys 18.2 to identify the heat transfer rate and temperature distribution.



(a) (b)

Fig: 3. - (a) imported feature from the creo2.0 (b) meshed body

Quality of meshing taken from the fluent.1) Minimum orthogonal mesh quality is 0.15346, Maximum orthogonal mesh quality is 0.99444, Average orthogonal mesh quality is 0.77978, Standard deviation of orthogonal mesh quality is 0.11327. 2)Minimum Aspect ratio of mesh quality is 1.1595, Maximum Aspect ratio of mesh quality is 13.481, Average Aspect ratio of mesh quality is1.8307, Standard deviation Aspect ratio of mesh quality is 0.44121. 3)Minimum skewness mesh quality is 6.0085e-05, Maximum skewness mesh quality is 0.84654, Average skewness mesh quality is 0.21904, Standard deviation skewness mesh quality is 0.11479. 4)Minimum Element mesh quality is 0.17495, Maximum Element mesh quality is 0.99997, Average Element mesh quality is 0.84213, Standard deviation Element mesh quality is 9.1813e-02.

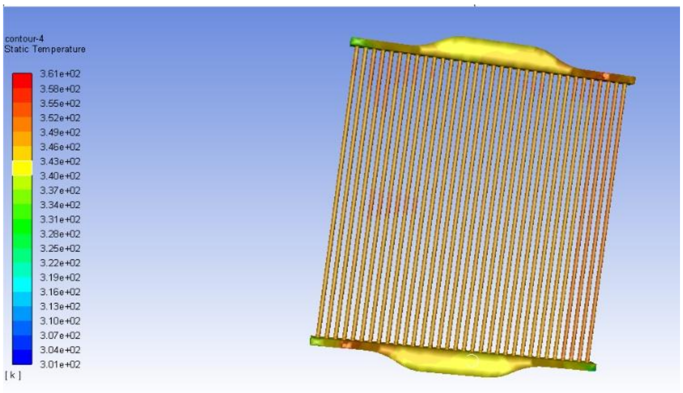


Fig: 4. - Temperature distribution across the radiator

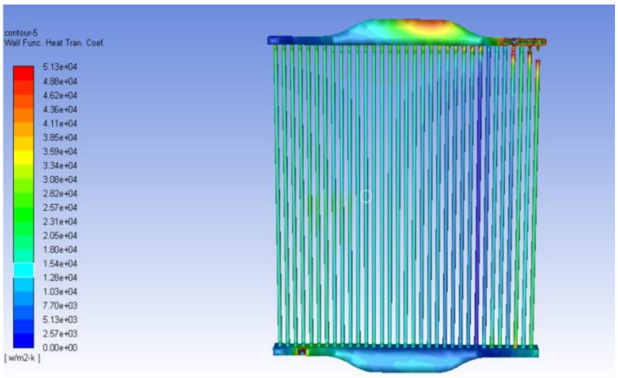


Fig: 5. - Wall function heat transfer coefficient across the radiator

After the completion of the simulation in Ansys18.2 noted down the results of all the inlet temperatures and drawn the graphs as shown below.

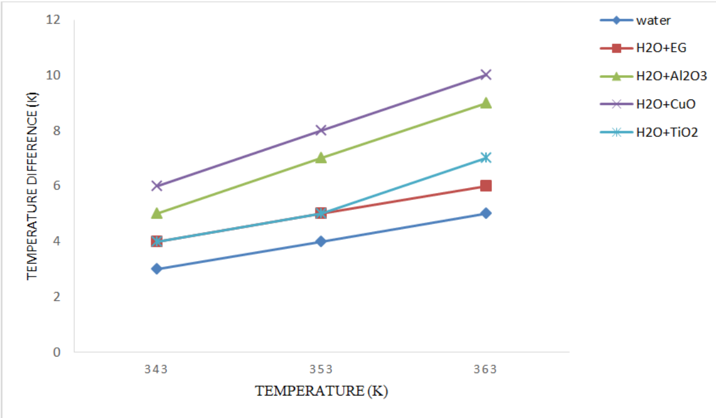


Fig: 6. Inlet temperature versus Temperature difference.

It is observed from above graph different fluids are used in the radiator and noted the results. From the results, we can say H_2O+CuO has a high change in temperature i.e., high-temperature drag from the engine. When we compared base fluid like water, the H_2O +CuO has 52% increment in temperature. Remaining fluids H_2O +Al_2O_3 has 43%, H_2O +TiO_2 has 28% increments in temperature were observed.

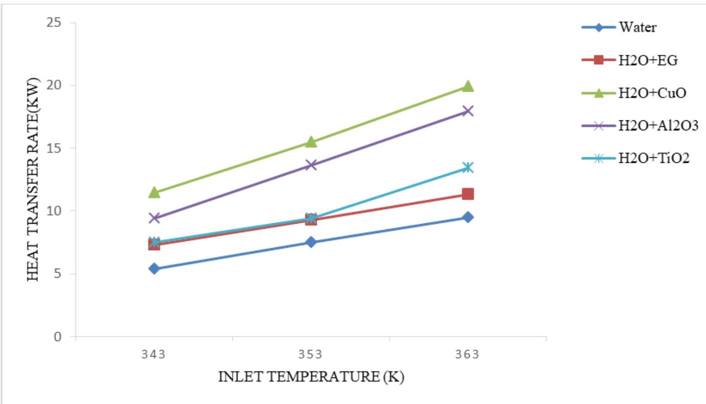


Fig: 7. Inlet temperature versus Heat transfer rate (Theoretical)

We observed from above graph different fluids are used in the radiator and noted the results with help of above equation. From the results, we can say H_2O +CuO has a high change in heat transfer rate i.e., high-temperature drag from the engine. When we compared base fluid like water, the H_2O +CuO has 53.4% increment in heat transfer rate. Remaining fluids H_2O +Al_2O_3 has 39 %, H_2O +TiO_2 has 26.05% increments in heat transfer rate were observed.

6. CONCLUSIONS

In the present work, different categories of nanofluids (i.e., Al_2O_3, CuO and TiO_2) are used to identify the heat transfer rate and compared with the base fluid.

Based on the simulation analysis it is observed that, by utilizing the Al_2O_3 nanofluid in the radiator, 39% increment in heat transfer rate when compared to regular usage of water. the H_2O +CuO has 53.4% increment in heat transfer rate. Remaining fluids H_2O +Al_2O_3 has 39 %, H_2O +TiO_2 has 26.05% increments in heat transfer rate were observed. Also, for the same nanofluid Peyghambarzadeh et al [10], investigated on forced heat transfer analysis and observed that the nanofluids of 1% vol concentration increased heat transfer by 45% as compared with normal water.

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