

## HEAT TRANSFER ENHANCEMENT IN RADIATOR BY NANO FLUIDS -A REVIEW

Mr. Pratik T.Patil<sup>1</sup>, Mr. Mukund Pande<sup>2</sup>, Mr. Dattatray Chopade<sup>3</sup>

<sup>1</sup>PG Student, G.H.Raisoni College of Engineering,  
North Maharashtra University, Jalgaon

<sup>2</sup>Assistant Professor, G.H.Raisoni College of Engineering,  
North Maharashtra University, Jalgaon

<sup>3</sup>Assistant Professor, G.H.Raisoni College of Engineering.,  
North Maharashtra University, Jalgaon

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**Abstract:** The Nano fluids are fluids made by dispersing the metallic Nano sized particle of size (1-100 nm) with based fluids. the Nano fluids having excellent thermal properties enhancement than conventional fluids. this paper focuses on different techniques for preparation of Nano fluids and thermal properties enhancement by using Nano particles with base fluids.

**Keywords:** Nano particles, Heat transfer, Radiator, Thermal Conductivity, Al<sub>2</sub>O<sub>3</sub>.

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### I. Introduction

The air cooled heat exchangers found in automobile vehicle like radiator, AC condenser and evaporator have an important parameter in its weight design and its front end module, having large impact on car aerodynamic behavior. for these challenges the optimization process is necessary to obtained best design having moderate parameters like performance, shape, size & Weight. This optimization tools describe the advanced design tools for performance improvements. the radiator is one of the most necessary part of vehicle. normally, it is used in cooling system of engine possessing water as a cooling medium. the coolant is passed from pumps for acceleration and then heat is carried away by the heat exchangers. Continuous improvement in design of heat exchangers is carried out for performance improvement. high efficient engine cannot be described as only by performance but also with fuel economy & less emission. Nowadays, increasing the efficiency of vehicle by reducing weight & optimized design is most essential for making world green. Addition of fins is most common example for increasing the vehicle performance due to increase in heat transfer rate. Also the efficiency of the engine can be increased due to increased flow rate of coolant but it increases the pump power results in low cyclic efficiency. The use of these methods for increasing the efficiency has many limitations. Conventional heat transfer fluids such as water, ethylene glycol etc. are play an important role in domestic devices such as air-conditioning. The performance of these conventional heat transfer are having restrictions because of there low thermal conductivities. Hence research is on increasing the heat transfer characteristic over last few decades. it is well known that the metallic solids are possesses high amount of thermal conductivity than conventional fluids. For example the thermal conductivity of copper is more than 700 times of water and 3000 times of engine oils. The fluids having suspended metallic particles are having more thermal conductivities than conventional fluids. The fluids having suspended metallic, nonmetallic particle of Nano meter sized is called as Nano fluids. in Nano fluids the heat transfer surface area is increased due to Brownian motion and inter particle surface so as to increase the heat transfer characteristics. The Nano fluids are first discovered by choi. The Nano fluids are described by two distinguish parameters one as geometry which gives the particle size and other is the fluid being used. A Nano fluid has wide attention due to their excellent heat transfer properties. In this paper different method for preparation of Nano fluids are explained followed by their influence on varying inlet temperature, varying flow rate and different concentrations of Nano fluids with their stability.

### II. Literature Survey

M. Gajendran et al. [1] has experimentally studied that, the Nano fluids made from Cu Nano metered size particles with Transformer oil having excellent heat transfer characteristics as compared with conventional fluid as water. He uses the ultrasonic vibrator for preparation of a Nano fluid because density of Nano particle is more than transformer oil. He prepared Nano fluid by 0.1% & 0.3% of Cu Nano particles. in experimental work, he varies the engine speed & flow rate he found after calculation that, the 0.1% of Cu particle Nano fluids are less heat transfer characteristics than 0.3%. But the pumping power is increases as we increase the Nano particles concentration in fluid. Thus, result in low efficiency of engine.

R.J.Bhatt et al. [2] has concluded that various types of Nano fluids .he also described the theoretical formulae's for determining the heat transfer characteristics of Nano fluids. He also described the mathematical formulation of Nano fluids followed by air side calculations, Nano fluid side calculations thus, he proved the substantial impact of Nano fluids on heat transfer units.

Peyghambarzadeh [3] has experimentally determined the heat transfer enhancement from Nano fluid as concentrations of  $Al_2O_3$  with based fluid as water. He uses the 1% of  $Al_2O_3$  Nano particles concentration and thus he found the heat transfer enhancement by 45% followed by increased in thermal conductivity as 3% compared with conventional fluids.

Arjun A. et al. [4] conclude that preparation of Nano fluid from  $Al_2O_3$  Nano particle with base fluid as water in different concentrations with  $Al_2O_3$  Nano particles powder. He heated the fluid in range of 50-60° c.after taking required reading he found that heat released by Nano fluid is 56% more than as compared to conventional fluids. also, he found increase in effectiveness of heat exchanger with Nano fluids as more than 85% than conventional fluids.

Gupta et al.[5] concluded the different methods for preparation of Nano fluids such as, addition of acids or base in fluids to change its pH value of suspension, adding activators or surfactants in suspension and using ultrasonic vibration. Also he gives the various advantages, applications, research scope in Nano fluids.

M.S.Wadd et al.[6] experimentally studied the heat transfer characteristics of Nano fluid. he made the Nano fluid by copper & Titanium oxide Nano particles of size 10-20nm. he made the validation of fluids by Dittus-Boelter equation and he found that as flow rate & Reynolds no. increases the Nusselt number is increased. Thus increased in heat transfer characteristics. Such as for 0.1% Cu concentration the heat transfer coefficient is increased up to 7%

T.Ganeshan et al.[7] experimentally studied the Nano fluids effect on heat transfer rate. he used the  $Al_2O_3$  Nano powder in different concentration with base fluid as lemon juice. He varies the inlet temperature of radiator with flow rate. After readings he found that for 0.09%,1 %,1.5% Concentrations of Nano powder, the heat transfer rate can be increased up to 16%,34%,35% respectively.

Laxman P. Dhale et al.[8] experimentally studied the thermal properties of Nano fluids .he used  $Al_2O_3$  Nano metered size particles with Water for preparation of Nano fluid.by various calculations he found that for 1% of  $Al_2O_3$  Nano particles concentration the heat transfer rate is increased up to 40% at constant flow rate of 0.167 kg/s. and effectiveness of radiator is increased up to 24% for 1.2%  $Al_2O_3$  particles .

J.R. Patel et al.[9] Experimentally studied the effect of Nano fluids on engine performance. He made the Nano fluid with concentration with particles of  $Al_2O_3$ ,  $TiO_2$ , CuO and base fluid as Ethylene Glycol, Water. He conducts the results for varying flow rate. he found that, Cu O- water Nano fluids has best heat transfer characteristics as compared to water-Ethanol and  $TiO_2$ -Water.he proved his result with CFD Software.

V. L. Bhimani et al.[10] Experimentally calculated the heat transfer properties of Nano Fluids. he made the Nano Fluids with  $TiO_2$  particles with water. After experimental work he found the result that for 1% of concentrations of Nano particles, the heat transfer rate increased up to 45% as compared to conventional cooling fluids.

Hafiz Muhammad Ali et al.[11] Experimentally studied the performance of Engine with Nano fluids .he prepared the Nano fluids with the concentrations of MgO in water. He found the MgO increases the heat transfer characteristics of fluids. for 0.12% of Concentration of Mgo particles the heat transfer rate can be increased up to 31% than conventional fluids.

Mahendra Godley et al. [12] experimentally studied the Nano fluids performance. he made the Nano fluids with concentrations of CuO-Water. He found that the density & viscosity of fluids increased with addition of CuO Nano particles in water. He also concluded that up to 4.2% heat transfer rate increased by 2% of CuO particles. He suggested that for ethylene glycol-water concentration (50:50) with 2% CuO Nano particles the pumping power is increased up to 14.8%.

M. Ebrahimi et al.[13] Concluded that  $SiO_2$  based Nano particle with water fluid for temperature range 43° c-60° c.he uses Nano particle in concentrations of 0.4% as increasing volume fraction the Nusselt no. is increased so as to improve thermal properties of fluids.

### III. Preparation methods for Nano Fluids

The preparation methods for Nano fluids are first described by Wei yu.et al.[18].he describes following two methods.

#### A. One step method

In this method the produce powder Nano particles is disperse directly in base fluid. This technique consist the direct evaporation. In this method, the Nano fluids are prepared by solidification phenomenon. This method is not suitable for mass production and thus not economical, not used commonly.

## B. Two step Method

In this method the Nano particle, Nano fibers are first produced in dry powder form by chemical or physical methods. After that it disperse with base fluids with magnetic, ultrasonic agitation high shear mixing, homogenizing, and ball milling. This method is most simple method for producing Nano fluid .so it can be used widely and for mass production it can be significantly used. The table for Preparation methods for Nano Fluids with stability is described in appendix.

## IV. Thermo physical properties of Nano fluids

Thermo physical properties of Nano fluids like Density,specific heat, Dynamic viscosity, Thermal conductivity can be calculated by using following formulae's

$$\rho_{nf} = \phi\rho_p + (1 - \phi) \rho_w \quad (1)$$

$$(\rho C_p)_{nf} = \phi(\rho C_p)_p + (1 - \phi) (\rho C_p)_w \quad (2)$$

$$\mu_{nf} = \mu_w(123 \phi^2 + 7.3 \phi + 1) \quad (3)$$

$$K_{nf} = \frac{k_p + (n - 1)k_p - \phi(n - 1)(k_w - k_p)}{K_p + (n - 1)k_w + \phi(k_w - k_p)} K_w \quad (4)$$

Where,

$\phi$  = Percentage of nano particle concentration

from equation no-1 We can easily determine the density of Nano fluid, Similarly equation no-2, 3, & 4 gives the Specific heat, dynamic viscosity and thermal conductivity of Nano fluids respectively.

## V. Conclusion

The different techniques for preparation of Nano fluids are discussed in this paper. Also, the effect of various concentrations is discussed .the concentration of Nano particles plays an important role in heat transfer. Increase in percentage of concentration of Nano metered size particle inside the Nano fluid increases the heat transfer rate but it increases the pumping work. So optimum concentration is to be used with suitable additives for stable thermo physical properties.

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### Author Profile



Pratik T. Patil completed the Diploma in Mechanical Engineering, from G.D.C.O.E. Jalgaon after he completed the Bachelor of Engineering in Mechanical Engineering from G.H.Raisoni C.O.E. Jalgaon. Presently he is Pursuing Master in Thermal Engineering From G.H.Raisoni College of Engineering, Jalgaon.

### Appendix

**Table:** Preparation methods for Nano Fluids with stability.

Sr.No	Nano fluid Type	Method	Surfactant	Stability	Reference.
1.	Al <sub>2</sub> O <sub>3</sub> +Water	Two-Step	-	24h	[14]
2.	TiO <sub>2</sub> -Water	Two-Step	Oleic acid and CTAB	-	[15]
3.	Cu-water	Two-step	Laurate salt	30h	[16]
4.	MWCNT-Water	Two-step	SDS		[17]
5.	Ag-water	Two-step	-	24h	[18]