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Nano fluids to Enhance Automobile Engine Cooling

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Abstract: *This paper addresses in automotive radiator plays a key role in engine cooling system it extracts heat from engine and operates in safe temperature. To extract heat form engine coolant will be plays a key role, and in this paper we derived an a formulae for finding total heat transfer rate and observed the metallic fluids exhibits more thermal conductivity when the average particle and volume concentration increased and for non-metallic the average particle size , volume fraction and thermal conductivity differed based on particles used and we observe nano fluids exhibit excellent heat transfer capability with the increase the Reynolds number ,volume concentration and peclet number and overall heat transfer coefficient at different loads and exhibit excellent capability at different engine speeds.*

Key words: *Nano particles, Reynolds number, heat transfer coefficient, peclet number, engine coolant*

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I. Introduction

Nano particle: The paricles which have 1-100nm size is called nanoparticles. A partical defined as a small object which represent the whole object is called nanotechnology.
There are different types of nanoparticles:

1. Metallic nano particles are Cu, Fe, Au, Ag.
2. Non-Metallic are Al_2O_3, CuO, SiC, TiO_2, Fe_3O_4.
3. Multi Walled Carbon Nano Tubes.

Cooling technologies using automobile radiator:
There are two types

1. Air cooling system
2. Water cooling system

1. Air cooling system:
In air cooling systems is used in small engines. It consist fin surrounded on the surface of cylinder it conducts heat and carried out by air. When air flow through the touches the fins heat will be dissipated to air

Advantages:

1. Radiator or pump is not required so weight will be decreased
2. Anti freezing or coolant is not necessary
3. No corrosion problem

Disadvantages:

1. Less efficient
2. It is used in aeroplanes and motor engines where the engine is exposed to air

2. **Water cooling system:**
In this method water jackets are present on the cylinder head the water is circulated in jackets the heat absorbed by water followed to the radiator further cooled by fan and circulator continuous.

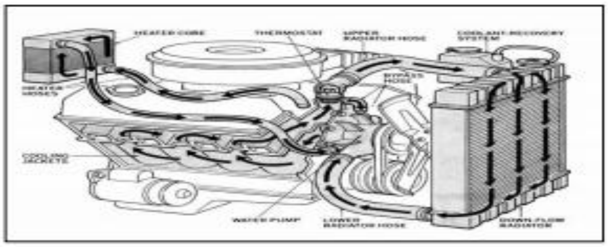
Advantages:

l. Less noisy compared to air cooling
2. Specific fuel consumption of engine improves

Disadvantages:

1. If the water system fails there will be severe damage in engine
2. Water system is more expensive and should have more maintenance and complex parts

Coolants: Coolant commonly called anti freeze which is used to decrease the engine temperature .generally ethyl glycol or propane glycol and water is used in 1:1 ratio. To increase the rate of heat transfer, nano particles are added into water or ethylene glycol or propane glycol, now a days each every automobile have a heat exchanger know as radiator. Radiators play a key role in automotive engine cooling system that can be seen in figure ref(future of nono kit)



Measuring heat transfer rate: A Review on applications and challenges of Nano-fluids as coolant)
The flow of heat transfer can be calculated by

$$Q = ha\Delta T$$

Where Q is the heat flow h is the convective heat transfer, A is the crossection area , ΔT is change in temperature.

When Δt increases heat flow will increase but Δt is depends on materials used To increase Δt the coolant temperature should be decrease .By maximizing area can increase the heat transfer but in automobile the increase in area cause unwanted weight. The heat transfer coefficient can be increased by enhancing the properties of the coolant for a given method of heat transfer. Additives like glycols are added to water to decrease the freezing point of water and will increase the boiling point of water and also to improve specific .The heat transfer coefficient can be improved via the addition of solid particles to the liquid coolant (i.e. nanofluids)

Lower specific heat- From the references, specific heat of nanofluids is lower than base fluid. Namburu et al. [28] reported that CuO/ethylene glycol nanofluids, SiO2/ethylene glycol nanofluids and Al2O3/ethylene glycol nanofluids show lower specific heat compared to base fluids. Ideal coolants have high specific heat further it leads to the more heat transfer

High cost of Nanofluids: To produce nano fluids the equipment which are used will be very high cost this will be main reason the researches are more but no body interested in production involvement of high cost. Nanofluids can be produced by either one step or two steps methods. However both methods require high cost equipments.

Problems in production process: To manufacture the nano fluids we have two types one is single step process other is double step process. After producing from this process nonofluids involve reduction reaction or ion exchange. Furthermore, the base fluids contain other ions and reaction products that are impossible to separate from the fluids. Another difficulty encountered in Nanofluids manufacture is nanoparticles' tendency to agglomerate into larger particles, which limits the benefits of the high surface area nanoparticles. To counter this tendency, particle dispersion additives are often added to the base fluid with the nanoparticles. Unfortunately, this practice can change the surface properties of the particles, and Nanofluids prepared in this way may contain unacceptable levels of impurities. Most studies to date have been limited to sample sizes less than a few hundred milliliters of Nanofluids.
The following are the observations for shows the positive effect of metallic nanofluids when added to base fluid

A Review on applications and challenges of Nano-fluids as coolant in Automobile Radiator. The thermal conductivity showed a significant change when there is a change in the average particle size, volume fraction and base fluid.

Metallic fluids:

Particle	Base fluid	Average particle size	Volume fraction	Thermal conductivity	Reference
Cu	Ethylene glycol	10nm	0.3%	48%	Choi et al. (2001a)
Cu	Water	100nm	7.5%	78%	Xuan and Li(2000)
Fe	Ethylene glycol	10nm	.55%	18%	Hong et al. (2005)
Au	Water	10-20nm	.026%	21%	Patel et al. (2003)
Ag	Water	60-80nm	.001%	17%	Patel et al. (2003)

But it is not the same case when coming to the non –metalic nano fluids. We observed that the researcher's showed that thermal conductivity changed when any one of the compared properties are changed .

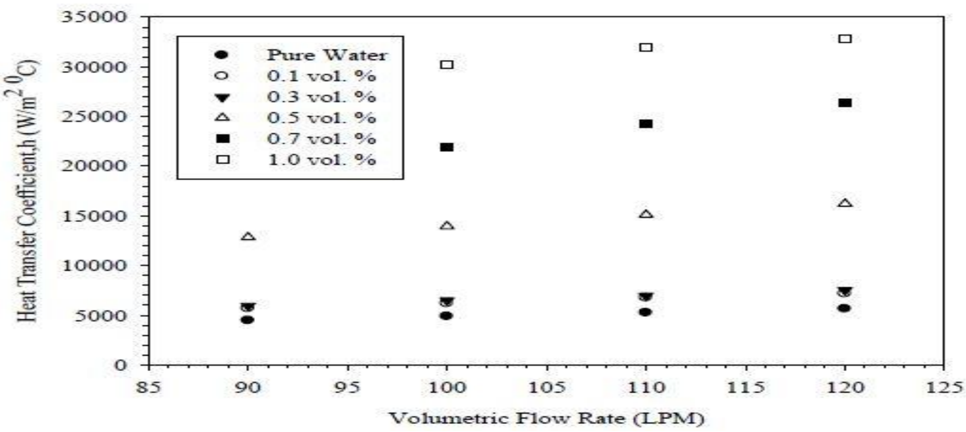
Non Metallic fluids:

Particle	Base fluid	Average particle size	Volume fraction	Thermal conductivity	Reference
Al_2O_3	Water	13nm	4.3%	30%	Masuda et al. (1993)
Al_2O_3	Water	33nm	4.3%	15%	Le at. (1999)
Al_2O_3	Water	68nm	5%	21%	Xie et al. (2002a)
CuO	Water	36nm	5%	60%	Eastman et al. (1997)
CuO	Water	36nm	3.4%	12%	Le at. (1999)
CuO	Water	50nm	0.4%	17%	Zhou and Wang (2002)
SiC	Water	26nm	4.2%	16%	Xie et al. (2002a)
TiO_2	Water	15nm	5%	30%	Masuda et al. (2005)

Experimental observations of heat transfer water based Nanofluids as a new coolant for car radiators:

According to analysis of experimental observations of heat transfer water based Nanofluids as a new coolant for car radiators, the presence of nano particles in water enhanced the heat transfer coefficient considerably to 40-45 % compared to water. And also proved that there is minute effect on heat transfer, when physical properties are changed.

We studied that the flow rate is directly proportional to heat transfer rate in both working fluids, water and nonofluids.



Nano fluids side calculation :(a new generation coolants)

Parameters:

Heat transfer coefficient
Nano fluid heat capacity rate
Heat exchanger effectiveness for cross flow un mixed fluid
Heat transfer coefficient based on air side
Pressure drop
Pumping power
Total heat transfer rate

Equations required for calculation:

1. Expression for Heat transfer coefficient

$h_{nf} = Nu_{nf} * k_{nf}/D_{h,nf}$

$Nu_{nf} = 0.023 * Re_{nf}^{0.8} * Pr_{nf}^{0.3}$

$Re_{nf} = G_{nf} * D_{h,nf} / \mu_{nf}$

Where $G_{nf} = \frac{m_{nf}}{A_{o,nf}} = \frac{m_{nf}}{\sigma_{nf} A_{fr,nf}}$

$m_{nf} = \rho_{nf} * v_{nf}$

$Pr_{nf} = \frac{\mu_{nf} * c_{p_{nf}}}{k_{nf}}$

2. Heat capacity rate:

$c_{nf} = m_{nf} * c_{p\,nf}$

3. Heat exchanger effectiveness:
$\varepsilon = 1 - \exp\left(\frac{1}{r}\right)(NTU)^{0.22[\exp\{-R(NTU)^{0.78}\}-1]}$
4. Overall heat transfer coefficient:

$$\frac{1}{U_a} = \frac{1}{n_o * h_a} + \frac{1}{\left(\frac{\alpha_{nf}}{\alpha_a}\right) * h_{nf}}$$

5. Pressure drop:

$$\boldsymbol{DP_{nf}} = \frac{G_{nf}^2 * f_{nf} H}{2\rho_{nf(\frac{D_{h,nf}}{4})}}$$

6. Pumping power:

$$P = V_{nf} * DP$$

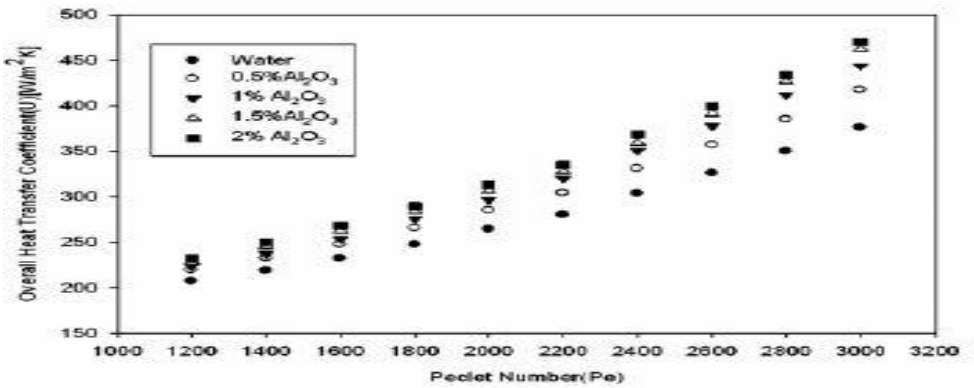
7. Total heat transfer rate:

$$Q = \varepsilon C_{\min}(T_{nf,in}-T_{a,in})$$

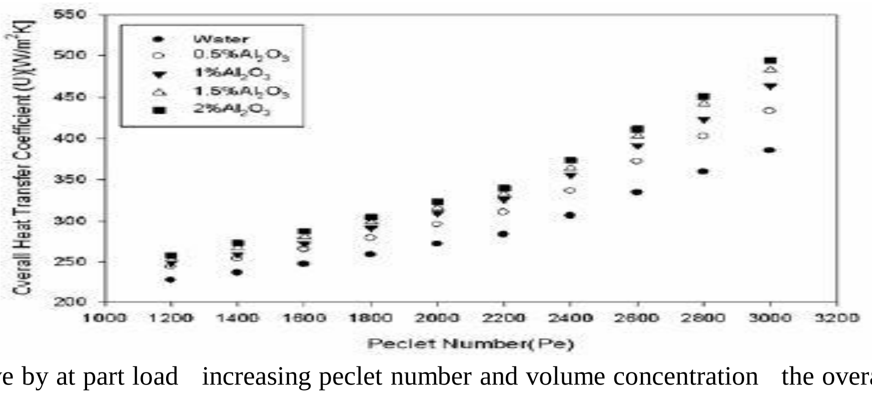
Demerits of NanoFluids:
1. The development of field is hindered by
- Lack of agreement of results obtained by different researchers.
- Poor characterization of suspensions.
- Lack of theoretical understanding of mechanisms responsible for changes in properties.

2. Many issues, such as thermal conductivity, the Brownian motion of particles, particle migration, must be carefully considered with convective heat transfer in nanofluids.

The graph is plotted between the overall heat transfer of Al_2o_3 / water and peclet number at no load condition:
From the graph we can observed by increasing peclet number (pe) the overall heat transfer coefficient increases and also by increasing volume concentration simultaneously with peclet number the overall heat transfer coefficient is increases at no load condition. At 2% of volume concentration the overall heat transfer is highest .This helps to improve the efficiency of coolant



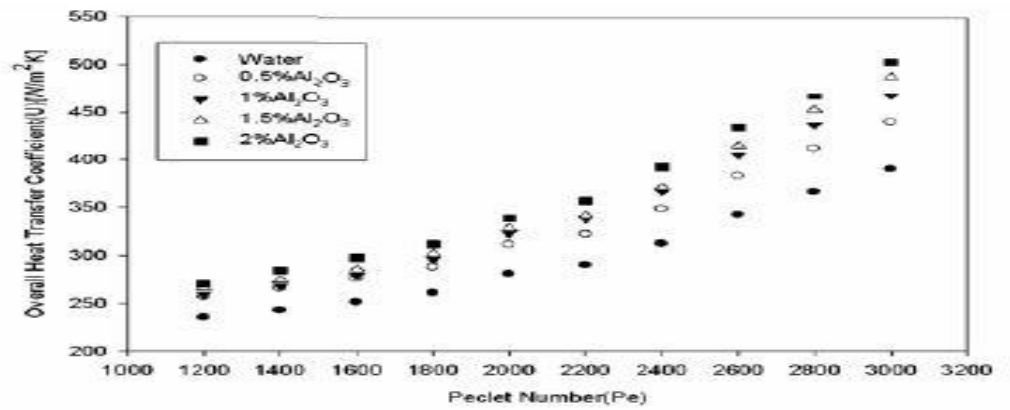
Graph between overall heat transfer of Al_2o_3/ water nano fluid versus peclet number for various volume concentration at part load:



Here we observe by at part load increasing peclet number and volume concentration the overall heat transfer coefficient increasing. At 2% of volume concentration the overall heat transfer coeffcient is more .This helps to improve the efficiency of coolant.

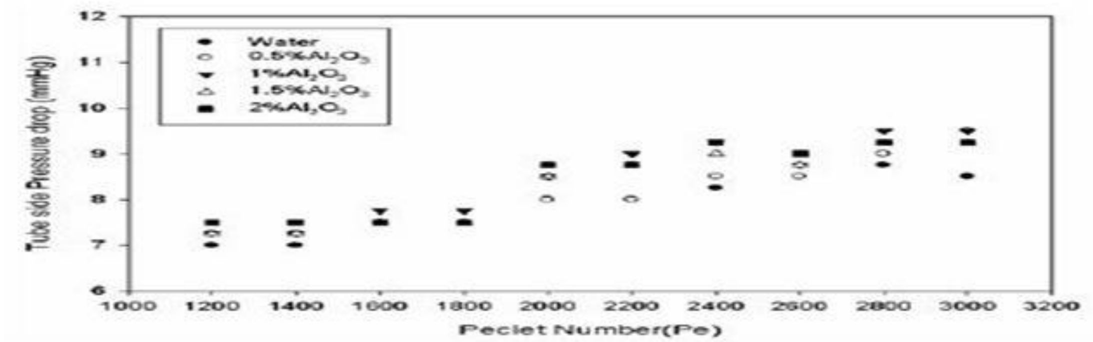
Graph between overall heat transfer coefficient of Al_2o_3/ water nono fluid versus peclet number for various volume concentrations at full load:

Here we observe by at full load increasing peclet number and volume concentration the overall heat transfer coefficient increasing. At 2% of volume concentration the overall heat transfer was more. This helps to improve the efficiency of coolant



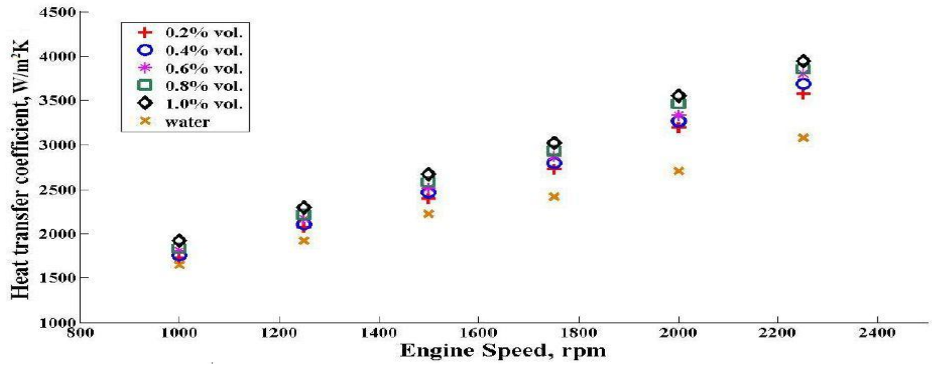
Below the Graph plotted between the tube side pressure drop and peclet number:

In the below graph at 1200 and 1400 the volume concentration tube side pressure drop is increased by increasing the volume concentration. At 1600 and 2000 the tube side pressure drop is constant at 2% of volume concentration but volume concentration at 1% had more tube side pressure drop than tube side drop at 2% volume concentration

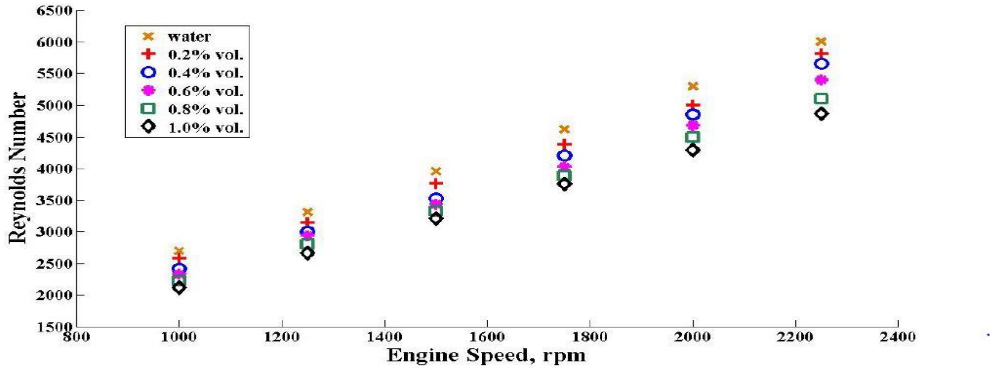


Influence of nono particles on heat tranfer coefficent :

The heat transfer coefficient of nano fluids depends on the engine speed as well as the volume fraction of nano particles and it is larger than the base lquid at the same engine speed. When engine speed increases the heat transfer coefficient also increases for different volume fractions when water is used as coolant then heat transfer coefficient shows very less.



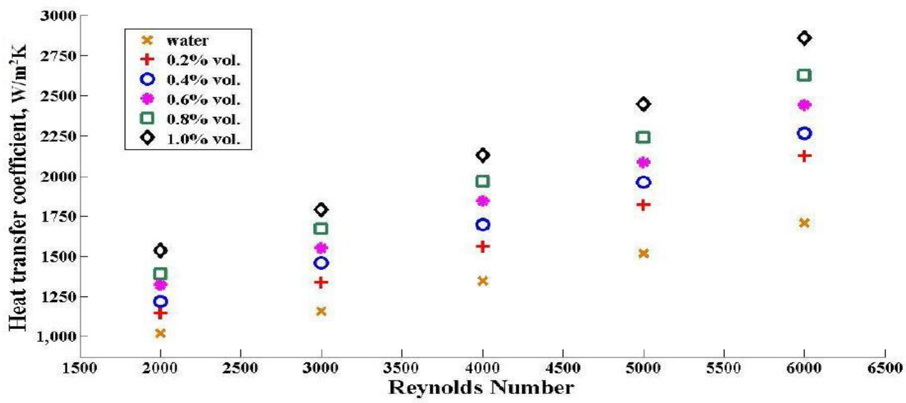
Influence of nano fluids on Reynolds number:



The above graph shows the Reynolds number decreases with particle loading due to increasing density and viscosity to the reduction in the mass flow rate . Hence pressure drop increases with particle loading than Reynolds increases with increasing the engine speed

Variation between heat transfer coefficient and Reynolds number:

By increasing Reynolds number with volume fraction the heat transfer coefficient increases steadily. by addition of 1% of volume fraction of Al_2O_3 nano particle into water yields 63% enhancement at low Reynolds number in comparison with water is more prominent at higher value .when Reynolds number is varied from 2000 to 6000 the heat transfer coefficient of water is 53% and for 1% volume fraction of Al_2O_3 nano particles the enhancement is 87%



II. Conclusion

In this paper a detail introduction about Nanofluids and Cooling technologies using automobile radiator, We derived an a formulae for finding total heat transfer rate and observed the metallic fluids exhibits more thermal conductivity when the average particle and volume concentration increased and for non-metallic the average particle size , and experimental observations of heat transfer water based Nanofluids as a new coolant for car radiators was listed, volume fraction and thermal conductivity differed based on particles used and we observe nano fluids exhibit excellent heat transfer capability with the increase the Reynolds number, volume concentration and peclet number and overall heat transfer coefficient at different loads and exhibit excellent capability at different engine speeds.

References

[1] Peyghambarzadeh, S. M., Hashemabadi, S. H., Hoseini S. M., Seifi Jamnani, M.,"Experimental study of heat transfer enhancement using water/ethylene glycol based nanofluids as a new coolant for car radiators", International Communication in Heat and Mass Transfer, 2011.

[2] Beck, M.,"Thermal conductivity of metal oxide nanofluidsPhD thesis", Georgia Institute of Technology, 2008.

[3] Yu, W., France, D. M., Smith, D. S., Singh, D., Timofeeva, E. V., Routbort, J. L.,"Heat transfer to a silicon carbide/water nanofluid", International Journal of Heat and Mass Transfer".

[4] Bhogare, R. A., Kothawale, B. S.,"A Review on applications and challenges of Nano-fluids as coolant in Automobile Radiator", International Journal of Scientific and Research Publications, Vol. 3, Issue 8, 2013, pp. 435-441.

[5] Vasu, V., Rama Krishna, K., Kumar, A. C. S.,"Heat transfer with nanofluids for electronic cooling", International Journal of Material Production Technology, Vol. 34, Issue 2, 2009; pp. 158–71.
[6] Jadhao, J. S., Thombare, D. G.,"Review on Exhaust Gas Heat Recovery for I.C. Engine", International Journal of Engineering and Innovative Technology, Vol. 2, Issue 12, 2013, pp. 214-227.
[7] https://en.wikipedia.org/wiki/Fan
[8] https://en.wikipedia.org/wiki/Radiator

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