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# HEAT TRANSFER PERFORMANCE BY NANO POWDER MIX COOLANT

D. N. Kale [1] | D. S. Nakate[2]
[1,2](D.Y. Patil School of Engineering Academy, Pune, Maharashtra, India.)

**Abstract— Radiator has a very important role in engine cooling. Generally,H2Ois beingmixed with ethylene glycol to work as a coolant.H2Omixed ethylene glycol solution has medium thermal conductivity. Heat transfer rate in vehicle radiator will be improved by either increasing heat transfer surface or by rising temperature's differencesthat will begained by reducingthe temperature of the coolant and by improving heat transfer coefficient of coolantthat will be improved by the active or passive method. Nano-powder is generally metals, metal oxides, or non-metals.This paper explains the recent research in Nano-powder coolants on convection heat transfer importance, the effect of coolanttemperature,the mass flow rate of coolant, volume saturationnano-powder, powder size, airflow velocity, etc., In this paper, comprehensive literature on heat transfer of nano-powder mixed coolants is being studied and reviewed.**

**Keywords: Nano-powder coolants; Radiator; Heat Transfer**

## INTRODUCTION:

Note: H= Heat transfer coefficient, K= Thermal conductivity, Nu=Nusseltnumber,Re= Reynolds number

The radiator is very much important equipment forautomobiles. Radiators are efficient heat exchangers using for engine cooling. The cooling system is alsoimportant in engine workings because it removes the high amount of waste heat from the engine to the surrounding for getting good efficiency. Generally, H2O and ethylene glycol is being used for cooling the engine as coolants. H2O mixed ethylene glycol hasmedium thermal conductivity. The heat flow = Q which is directly proportional to h, A, and T, h= heat transfer coefficient, A= heat transfer area, and ΔT= temperature difference. Increased heat transfer can be achieved by high ΔT, high A, highh.

Higher ΔT gives a high amount of heat flow that will be achieved by lowering the temperature of the coolant (Saidur, 2011). Increasing the heat transfer surface A is a common way to improve heat transfer, increasing the heat transfer area will be achieved by increasing the size of the heat exchanger but the weight will increase. Heat transfer performance will be raisedby increasing the heat transfer coefficient = h of coolant that will be improved by the active and passive methods. Inactive method few externalpowerinputsareincluded but in the passive-type, as it will not need any external power input. The addition of nano-powder to the coolant is one method to increase heat transfer. Nano-powder mixed coolants are made by suspending and well-dispersing nano-powder with a particular size of powder particles about 150-50 nm in heat transfer coolants such as H2O, ethylene glycol, oil. Nano-powders are normally metals, metal oxides, or non-metals like CuO,ZnO, TiO2,Al2O3,SiO2.

## REVIEW:

Table 1:Heat transfer rising comparison.

| Research By | Coolant & Nano-powder Volume, Inlet temperatures | Title of Paper | Findings |
|---|---|---|---|
| Goudarzi (Goudarzi, 2017) | Ethylene glycol mixed by Al2O30.08, 0.5, 1% | Heat transfer riseof $Al_2O_3$-EG nano-coolant in a radiator. | Nu at Re 18500<Re<22700 with tube inserts and nano-coolant with different conc. is higher when compared to EG as basecoolant. |

  

| | | | |
|---|---|---|---|
| Hafiz (Ali, 2015) | Water ZnO 0.01,0.08, 0.2, 0.3% 45to 55□ | investigation of convection heat transfer for vehicle radiator using ZnO-water nano-coolants. | Increase in heat transfer rates observed using ZnO- water Nano- coolants compared to base coolant. Heat transfer enhancement up to 46% in 0.2% vol. Nano coolant. |
| Guilherm | Water MWCNT (0.05-0.16)% 50, 60, 70, 80□ | Experimentation on the heat transfer of MWCNT / water nano-coolant flowing in a vehicleradiator . | Results show a maximum enhancement of 54% for Conc. of 0.16% wt.at30℃. |
| Deviredysandhya . (2016) | EG h20 TiO2 0.1, 0.3, 0.5% Around 60□ | Improving the cooling of automobile radiator with ethylene glycol water based TiO2 nano-coolants | At the Conc. of 0.5% the heat transfer rise 35% compared to base coolant .the degree of heat transfer rise depends on the quantity of vol. Conc. of nanoparticles. |
| Naraki | H20 CuO0-0.4% 50-80□ | overall heat transfer coefficient of CuO/h20 nano coolants in a vehicalradiator | 0.15 and 0.4 vol.% conc. of CuO nanoparticles ,overall heat transfer coefficient |
| Adnan .(2016) | H20 TiO2 1, 2, 3 ,4% 60-90□ | Numerical study on turbulent forced convective heat transfer using nanocoolants TiO2 in an coolingsystem | The highest Nusseltnumber obtained for TiO2 nanoparticlesin h20 was 18% better than of purewater. |
| Vahiddelavari (2014) | H20 EG Al2O3 0.1, 0.3, 0.5,0.7, 1%35,40,45,50, and 60□ | CFD simulation of heat transfer rise of Al2O3/water and Al2O3/Ethylene Glycol nano-coolants in a vehicalradiator | The Nusselt number increased as Reynolds number and Conc.of nanoparticles increased. |

## 1. ANALYSIS OF NANO COOLANTS IN VEHICLERADIATOR

Oudarziinvestigated the heat transfer of the vehicle radiator using nano-coolant of Al2O3/Ethylene glycol along with wire coil inserts of a variety of geometry. The results show that Nu. in the defined range of Re. is more with wire coil inserts compared to EG without coil inserts. Nu with tube inserts and nano-coolants with the volume concentration of 0.08, 0.5, and 1% is more when compared to ethylene glycol as a base coolant. For the same above condition Nu. increased with the increasing speed of the cooling fan in the range of 750<Nu<1220. Friction factor at Re. in the range of 18500<Re<22700 with the coil inserts and with different volume conc. is more compared to EG as base coolant. (Goudarzi, 2017) Graphs obtained by Goudarziare shownbelow.

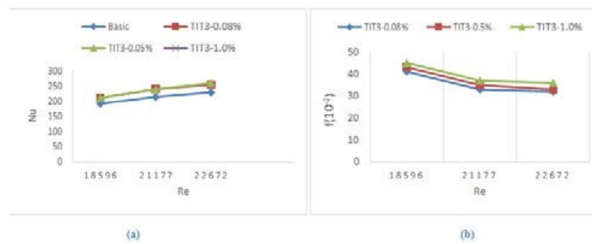


Figure (a) Effect of Al2O3/EG nano-coolant volume conc. on Nu of nano-coolant with tube insert (b) friction factor of EG and variety of vol.concentration of Al2O3 nano-coolant with tube inserts.

Hafiz saw that using ZnO/H2Onano-coolant there is a significant rise in heat transfer rates compared to the base coolant. They observed that the heat transfer rise of nano-coolants are highly dependent on the volumetric conc. of nano-powders in the base coolant. The best heat transfer rises to 46% is achieved using 0.2% volumetric conc. of nano-coolant. They saw that inlet temperature are weakly dependent on heat transfer rates only a 4% increase in heat transfer rate was seen when the coolant inlet temperature was increased from 45 to 55 degrees.This heat transfer rise may lead to smaller and lighter vehicle radiators. (Ali,2015)

Guilherme performed an experimental study on the heat transfer of MWCNT/H2Onano-coolant flowing in a vehicle radiator. They varied conc. between 0.05 and 0.16% and varied mass flow rate from 30 to 70g/s and the inlet temperature maintained constant at 50. 60, 70, and 80 degrees. They saw that the thermal conductivity of nanocoolants resulted slightly high than pure H2O. The experimental results show that the heat transfer rise of nano-coolants is strongly dependent on the conc. The greater heat transfer rates were obtained with distilled H2O instead of nano-coolant, so they concluded that this nano-coolant is not ideal to replace coolant. Heat transfer rates are dependent on the temperature, an increase in the temperature from 50 to 80-degreeincrement in heat transfer rate is observed. (Guilherme, 2016)

Deviredy estimated experimentally the cooling performance of automobile radiator with ethylene glycol H2O based TiO2 nano-coolants. Nano-coolants are prepared to take 40% ethylene glycol and 60% H2O with volume conc. of 0.1, 0.3 and 0.5% of TiO2 nano-powder. They found that the presence of TiO2 can enhance the heat transfer rate inthe automobile radiator. The degree of heat transfer rise depends on the quantity of nano-powders added to the base coolant. At the conc. of 0.5% the heat transfer rise of 35% compared to base coolant was observed. They observed that coolant inlet temperature hasa slight dependence on the heat transfer rate. They also observed that increasing the coolant flow rate increases the heat transfer rate. (sandhya, 2016)

Narakihas donea parametric study on the heat transfer coefficient of CuO/H2Onano-coolant in a vehicle radiator. The nano-coolantis stabilized with a variation of pH and the use of suitable surfactant. They observed overall heat transfer coefficient decreases with increasing inlet temperature. Rise of heat transfer rate is observed when nano- coolants with conc. of 0.15 and0.45% is used and increment in the heat transfer rate is observed 6 and 8%. The rise in air flow rate will enhance the heat transfer rate. Taguchi method used for analysis to and observe the best operating condition includes minimum inlet temperature, maximum conc. of nano-coolant, a maximum flow rate of nano-coolant, and a maximum flow rate of air. The air volumetric flow rate has a 42% contribution tothe overall heat transfer coefficient. Nano coolant volumetric flow rate, inlet temperature, and conc. of nano-coolant have 23, 22, and 13 contributions in the overall heat transfer coefficient. (Naraki,2013)

Adnan has donean experimental and computational study of the heat transfer performance of a vehicle radiator running with TiO2/H2Onano-coolant under turbulent forced convective heat transfer. They used four different nano-coolant volume conc. 1, 2, 3, and 4%. The Re and inlet temperature ranged from 10000 to 100000 and from 60 to 90 degrees respectively. Maximum values of friction factor increased by 12% for TiO2 nano-powders dispersed in H2O at a 4% volume conc. The highest Nu obtained was 18% better than that of pure H2O. Nu behavior of the nano-coolants is highly dependent on the volume conc., inlet temperature, and Re. The potential risk of vehicle engine cooling rates could entail more engine heat being removed and hence reduction in a cooling system leads to smaller and lighter vehicle radiators. (Adnan, 2016)

Vahid used CFD for simulating heat transfer rise of Al2O3/H2O and Al2O3/ethylene glycol nano-coolants in a vehicle radiator. They studied the behavior of nano-coolants numerically in turbulent and laminar flow areas in a flat tube. The numerical results are the same as for the experimentation results, indicating that increasing the conc. of nano-powders in the base coolant increased the heat transfer coefficient and the Nu. The friction factor results shown that the tube friction coefficient increased as the conc. of nano-powders in the nano-coolant increased. (Delavari, 2014)

## 2. CONCLUSION

Increasing volume conc. of nano-powders in a base coolant, it raises the heat transfer coefficient also increasing coolant flow rate rises heat transfer rate. Bythe increase in air flow rate or air velocity increment in heat transfer rate observed.Better effect of inlet temperature on heat transfer rate as in such cases increase in inlet temperature can slightly raise heat transfer rate, in some cases increase in inlet temperature does not change heat transfer rate, and in some cases, there is a decrement in heat transfer rate found when there isthe increase in coolant inlet temperature. Nano coolant in vehicle radiator raises heat transfer rate which leads to the compact and lighter radiator which also improve engine fuel efficiency.

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