

Imminent of Nano Coolant

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Abstract: *In this paper author takes the review of different types of nano fluids. Studied different nano materials and its t engineering applications with their different properties. By this study one can use Al₂O₃ as nano coolant for future automobile engine. Using this nano fluid increase the performance of automobile engine which is today's requirement, and increase fuel economy and emission by increasing thermal conductivity. As mentioned below different investigators explained their theories and they found various properties like electrical, physical, thermal etc. They have also prepared nanofluid of various nono-particles. Relevant literature is available based on these studies. The current work is an attempt to manufacturing of zinc oxide nanopowder, preparation of nanofluid and evaluates its thermal and physical properties. The outcomes of experimental work under different volume fraction will be analyzed to have conclusions regarding to viscosity, thermal conductivity, heat transfer rate, thermal diffusivity analysis. Forced convective heat transfer in a water based nano fluid has compared to that of pure water in vehicle radiator. When nano particles of Al₂O₃ added in to water heat transfer coefficient increased and circulation rate of fluid increased which improve heat transfer efficiency some of researches are to be needed on drawbacks of nanofluid.*

Keywords: Nanotechnology Nanofluid, Coolant, Nanoparticles, Thermal conductivity

1. Introduction

Now a day nanotechnology plays vital role in our daily life. It is an interdisciplinary subject. Nanotechnology works more efficiently in different fields. In automobiles also, due to nanofluid, the demand of high efficiency engines are full filled. These types of engines include less emission, better fuel economy, improvement of heat transfer rate. New technology applied vehicles becomes light weight, size of radiator becomes compact, cooling rate increases, improves heat transfer area and air convective heat transfer coefficient. Cooling rate improvements by micro channel and fins have some boundary. Some natural coolant like water and ethyl glycol shows very low thermal conductivity. To improve thermal conductivity some nanofluid plays vital role.

Nanofluids are possible to make by making nanoparticals of different metals, oxides, semiconductors and liquids. Such type of material nanoparticles are added with water by different techniques and produces nanofluid.

In engine, during cooling process 30% losses occur due to cooling phenomenon. These losses can be reduced by using coolants having better thermal conductivity rather heat transfer coefficient. Thus due to use of better coolants thermal efficiency can be increased which means reduction of fuel consumption. Thus energy conservation has done which is essential thing in recent days.

2. Nanotechnology

Nanotechnology is an interdisciplinary subject. Nanotechnology is the technique of controlling matter on an atomic and molecular scale. Generally, Nano is a length where five to ten atoms are stacked in a line.

Nanotechnology works on the structure of atomic level therefore properties of nanoparticles are different than original material. Nanotechnology is a vast area it covers near about all fields like medicine, electronics, biomaterials and energy production, computer, textiles, cosmetics, space, defense, engineering and research area etc. In this nanotechnology, nanoparticles are to be used are very important. Nanoparticles are particles whose diameter is 10⁻⁹ meter. Nanoparticles have different properties than bulk form. Properties are size and shape dependent. Colors of nanoparticles are also size dependent. Nanomaterials have ability to change their properties at nanoscale has opened the door to make new devices, instruments, consumer goods etc. Other side of nanotechnology is that it has adverse effect on human health and it creates pollution.

3. Nanofluid

Nanofluid is a fluid in which nanoparticles are added in water base. These fluids are engineered colloidal suspensions of nanoparticles in a base fluid. Metals, carbides, oxides and carbon nanotubes such type of nanoparticles are used in nanofluid .water glycol and oils are generally used common base of nanofluid. Nanofluids have unique properties it covers the area like hybrid powered engine , management of heat in vehicles, heat transfer, pharmacy, engine cooling, chiller, refrigerator, nuclear reactor, heat exchanger , space , ships defense, grinding that make them possibly useful in many applications in heat transfer, including microelectronics, fuel cells, pharngas temp reduction in boiler etc. nanofluid have large convective heat transfer coefficient and high thermal conductivity. Traditional nanocoolant like water, glycol, and oil can be replaced by nonofluid in cooling system of engine. Advanced research gives outcome that 15 to 40% of heat transfer enhancement

can be possible by nanofluid. Automotive car radiator can reduce size and weight makes superior without affecting performance of heat transfer. This translates into a better smooth feature for design of an automotive car fore area. Coefficient of drag can be minimized and fuel consumption efficiency can be improved. Nanofluid has a caliber to increase the cooling rate of heavy duty engine also.

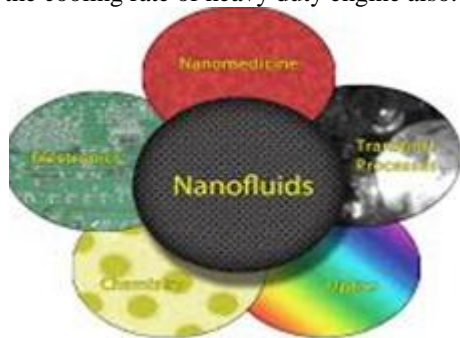


Figure 1: Use of Nano fluids in different fields

Nano coolant-is a fluid which circulates trough or around a device to reduce its overheating, transfer of heat to other device or in the device [1]

Types of Nano fluids-

There are different types of nanofluid are
 $Al_2O_3 + H_2O$
 $TiO_2 + H_2O$
 $CuO + H_2O$
 $CH_3COOH + H_2O$ [2]

4. Present Theories and Practices

There are different types of theories available. These theories are for other nanofluid like copper, Al_2O_3 , H_2O . By taking reference of these theories it is possible to produce a nanofluid of ZnO . These theories are as follows-

4.1 Measurement of convective heat transfer coefficient from a high temp wire crossing in nanofluid

- i. Shinpyo Lee: - Lee reported maximum increase the thermal conductivity of 20% in the study, for 4% CuO particles with average diameter 35nm dispersed in ethylene glycol by using a transient hot wire method. An even greater enhancement was reported for pure metal Cu nanofluids, where only a 0.3% volume concentration of 10nm particles led to an increase of 40% in thermal conductivity. [3]
- ii. Choi:-Observed that the dispersion of a very small amount of carbon nanotubes produces a remarkable change in the effective thermal conductivity of the base fluid, with the thermal conductivity ratio exceeding 250% at just 1% volume concentration[4]
- iii. Juan and Li Wen and Ding:-Showed 47 % increase in the convective heat transfer coefficient for an aqueous based 1.6% of alumina nanofluids. This value is also greater than the thermal conductivity increase of 10%.
- iv. Ding- Studied the heat transfer behavior of aqueous suspensions of multi-walled CNT nanofluids flowing through a horizontal tube. They observed 350% increase of the convective heat transfer coefficient and this enhancement depends on the Reynolds number and CNT concentration.[5]

4.2 The mechanism of heat transfer in nanofluids

Investigated that copper oxide and iron oxide contain nanofluid much heat transfer coefficient than conventional nanocoolant like water.

According conventional eNTU technique Fe_2O_3 and CuO nanoparticles are mixed in water with conc.(0.15, 0.4,0.64 Vol%) liquid Reynolds number varies 50-1000, constant temp range 50,60 and 80 degree of inlet to radiator. Result gets that lower heat transfer coefficient than water up to 9% [6]

4.3 Complex Investigations of hydrodynamics and heat transfer Study on Forced Convective Heat Transfer of Non-Newtonian Nanofluids

An experimental and numerical study has been carried out on the flow and heat transfer behavior of nanofluids flowing through a straight pipe under a laminar flow condition. TNT/H_2O and CNT/H_2O nanofluids are used in this work to investigate the convective heat transfer and flow characteristics. The numerical work is based on a single phase method considering the nanofluid as both a Newtonian and non-Newtonian fluid. The following conclusions are obtained for the considered nanofluids:

- i. Nanofluids are generally a non-Newtonian shear thinning fluid, especially for CNT/H_2O nanofluid.
- ii. The thermal conductivity of nanofluids is sort of thermal dependent parameter, especially for the CNT/H_2O nanofluid.
- iii. Addition of nanoparticles into the base liquid enhances the thermal conduction especially in the entrance region of the tube.
- iv. The flow of nanofluids as a non-Newtonian fluid helps to explain the enhancement of nanofluids convective heat transfer to some degree. Future work is needed to know more about the influence of non-Newtonian characteristics on the flow and heat transfer of nanofluids. In the future more work will be undertaken to further clarify the mechanism of how nanofluids enhance the convective heat transfer.[7]

4.4 Al_2O_3 water based nanofluid for cooling performance of automobile Radiator

In this experimental work in the automobile radiator heat transfer coefficients measured with two separate useful liquids such as pure water and water based nanofluid (minimum Al_2O_3 nanoparticle in water) at different concentrations and temperatures and the following conclusions were made.

- i. Al_2O_3 nanoparticle in water base nanofluid can improve the heat transfer rate of the automobile radiator. The rate of the heat transfer improvement depends on the amount /No. of nanoparticle added to pure water. Finally the heat transfer enrichment of 45% compared to pure water was recorded when concentration of Al_2O_3 1 Vol%.
- ii. Increasing the flow rate of working fluid (or equally Re) improves the heat transfer coefficient for both nanofluid pure water and considerably while the variation of fluid inlet temperature to the radiator (in the range tested) slightly changes the heat transfer

performance.

- iii. It seems that the increase in the effective thermal conductivity (of about 3% in this study) and the variations of the other physical properties are not responsible for the large heat.[8]

4.5 Performance investigation of an automotive car radiator operated with nanofluid-based coolants (nanofluid as a coolant in a radiator)

As volume concentration of nanoparticles (ranging from 0% to 2%) increases Heat transfer rate also improves. About 3.8% heat transfer rate improvement are possible with addition of 2% copper particles at 6000 and 5000 Reynolds number for air and nanocoolant respectively.

- i. In radiator Thermal performance of using nanofluid or ethylene glycol coolant is better with air and coolant. Reynolds number about 42.7% and 45.2% heat transfer enhancement were observed for pure ethylene glycol and ethylene glycol with 2% of copper nanoparticles respectively when air Reynolds number was increased from 4000 to 6000. Only 0.9% and 0.4% heat transfer enhancement were observed for pure ethylene glycol and ethylene glycol with 2% copper nanoparticles respectively when coolant Reynolds number was increased from 5000 to 7000.
- ii. Projected 18.7% reduction of air frontal area is extended by adding 2% copper nanoparticles at Reynolds number of 6000 and 5000 for air and coolant respectively.
- iii. Additional 12.13% pumping power is needed for a radiator using nanofluid of 2% copper particles at 0.2 m³/s coolant volumetric flow rate compared to that of the same radiator using only pure ethylene glycol coolant.[9]

4.6 Application of nanofluids in heating buildings and reducing pollution by,

Nanofluid viscosity decreases exponentially as temperature increases from a subzero value. As the volume concentration of nanoparticles increases, the viscosity of nanofluid increases. From the nanofluids tested, the CuO nanofluid has the highest viscosity followed by the Al₂O₃ nanofluid and then by the SiO₂ nanofluid.

- i. As the volume concentration of nanoparticles (ranging from 0% to 6%) increases, the heat transfer coefficient increases at the same Reynolds number.
- ii. The CuO nanofluid has the highest heat transfer coefficient followed by the Al₂O₃ nanofluid and the SiO₂ nanofluid.
- iii. Pressure loss is also highest for the CuO nanofluid, followed by the Al₂O₃ nanofluid and then the SiO₂ nanofluid.
- iv. Replacing conventional ethylene glycol/ water mixture with nanofluids as heat transfer fluid, one can reduce the volumetric flow rate, mass flow rate and the pumping power for the same heat transfer rate.
- v. Use of nanofluids to heat buildings can reduce the size of the heat transfer system and reduce the accompanying pressure loss and the subsequent pumping power. This will reduce energy consumption that comes from power plants and will thus indirectly reduce environmental pollution.
- vi. Similar benefits can be derived by considering

nanofluids in place of chilled water in building cooling coils. An investigation similar to the one presented in this paper can quantitatively establish the benefits.

- vii. Use of nanofluids will reduce material volume necessary for heat exchanger, pump, piping and associated components plus the fluid inventory, thereby reducing the environmental pollution. [10]

Following is the summary of the applications of nanofluid

1. Diesel engine.
2. Chillers
3. Cooling system
4. Generators
5. Cooling and heating exchanger
6. Power plant generator
7. Ordinary cars. [1]

5. Challenges, drawback and proposed work of nanofluids

The following are the challenges, drawbacks and proposed work of nanofluids.

5.1 Challenges

- Deficiency of agreement of results by researcher.
- Shortage of mechanism understanding.
- Reduced characterization of suspension. [6]

5.2 Drawbacks of nanofluid

- Lack of knowledge at atomic level.
- Some of nanoparticles present in the nanofluid makes toxicity.
- Erosion.
- Some of nanofluids are costly.[11]

5.3 Proposed Work

The work required for preparation of nanofluid includes followings

- Literature review
- Study of various nanofluid using different theories.
- Study of ZnO properties.
- Preparation of nanoparticles.
- Preparation of nanofluid.
- Measurement of thermal properties of nanofluid. (Like thermal conductivity, density, viscosity, specific heat.)
- Compare prepared nanofluid with available synthetic coolants.
- Study the performance & emission analysis parameters.
- Compare the nanofluid by changing concentration of nanofluid testing performance on radiator.

6. Conclusion

It is concluded that Nanofluid such as TiO₂, Al₂O₃, CuO, CH₃CH₂OH are new type of nanofluid which have ability to improve the efficiency of automotive cars especially in and hybrid-powered engines, Engine cooling/vehicle thermal management, heat exchanger, and nuclear reactor mostly in automobiles. When concentration of nanoparticles increases

with different temperature thermoconductive properties, heat transfer rate increases. Therefore they exhibit enhanced thermal conductivity and the convective heat transfer coefficient compared to the base fluid. Research are to be needed to overcome the drawbacks and face the challenges of nanofluid.

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