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EMBRACING NEW TECHNOLOGIES FOR THERMAL CONTROL THROUGH NANO FLUIDS

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ABSTRACT

Nano fluids are the new generation coolants that are used or added with existing coolants for getting optimum thermal controls .Due to the smaller size particles, hyper thermal conductivity and abrasion résistance. These fluids are replacing the existing Nano-fluids have some inherent properties like: Viscosity, Density, thermal conductivity, diffusivity, heat transfer coefficient. but thermal conductivity is the important property for Air conditioning, Refregeartion,oil industry, chemical industry, automobile etc.This compact research paper reviews the mode of working, application and optimum enhancing results of heat transfer over existing conventional approach.

Key words: *Nanofluids, Thermo-Physical Properties, refrigeration & air Conditioning*

I. INTRODUCTION

Heat transfer is often required in automobile, refinery and air conditioning system, chemical and Processing plants, electronic devices, space shuttle. when we consider fluid as a medium for transferring heat and accordingly the mode of heat transfer is convection and Newton's law of cooling is implemented there.[5]

$$q=hA\Delta t$$

Where:
q=rate of heat transfer
h=coefficient of convective heat transfer
A=surface area
ΔT=temperature difference across which the transfer of thermal energy transfer
From above equation we get that

1. Increasing T
2. Increasing A
3. Increasing h

Thermal conductivity prestige h_A (heat transfer coefficient in direct way which governs thermal transportation at micro scale level. Due to large surface area of radiators, plate and frame heat exchanger are made for maximize heat transfer area. This technique is not implemented to microprocessors and micro electro mechanical system (MEMS) because the area cannot be increased but in automobile and aerospace system, heat transferred is increased by increasing the exchanger area.

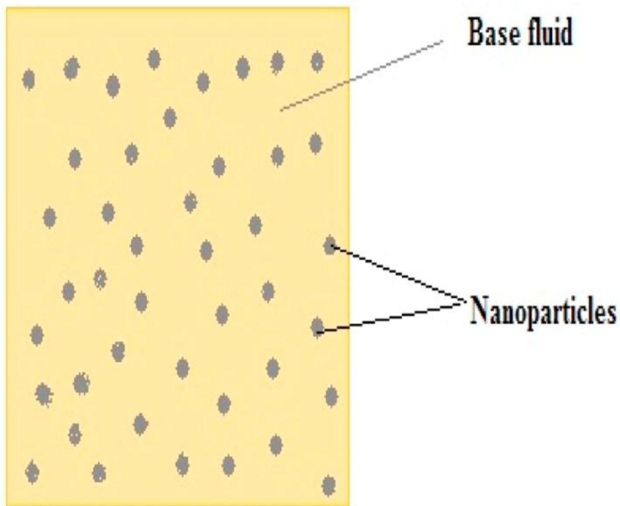


Fig. 1. Nanoparticles dispersed in base fluid.

Nanotechnology provides new area of research to process and produce the materials with average crystallite sizes below 100nm called nanomaterals. The nanomaterials is envelop of materials including nanocrystalline, materials, carbonnanotubes, nanocomposites and quantum dots. There are four types of nanomaterials:

1. Metal based Nanomaterials (Metal oxides such as Aluminum oxides)
2. Carbon based nanomaterials (e.g Carbon nanotubes).
3. Composites (Nano- sized clays)
4. Dendrimers (nanosized polymers)[6].

These fluids are engineered colloidal suspensions of nanoparticles in a base fluid**.[13]-[14].**The nanoparticles used in nanofluids are typically made of metals, oxides, carbides, or carbon nanotubes. Common base fluids include water, ethylene glycol and oil **[14].**

Nanofluids have novel properties that make them potentially useful in many applications in heat transfer,[15]including microelectronics, fuel cells, pharmaceutical processes, and hybrid-powered engines, engine cooling/vehicle thermal management, domestic refrigerator, chiller, and in the flue gas temperature reduction in boiler. They exhibit enhanced thermal conductivity and the convective heat transfer coefficient compared to the base fluid.[6] Nanofluids also have special acoustical properties and in ultrasonic fields display additional shear-wave reconversion of an incident compressional wave; the effect becomes more pronounced as concentration increases. **[17]**

II. LITERATURE REVIEW

Nan fluids have novel properties that make them potentially useful in many applications in heat transfers [4] A nano fluid is a fluid containing nanometer sized, Particles, called nanoparticles. These fluids are engineered colloidal suspensions of nano particles in a base fluid. The nano particles used in nanofluids are typically made of metals oxides. Carbides, or carbon nanotubes common base fluids like water, oil ethylene glycol.

Elena V. Timofeeva, Wenhua Yu et. al. [2] presented a paper on “Nanofluids for Heat Transfer: An Engineering Approach”. In this paper the factors contributing to the fluid cooling efficiency were discussed first, followed by a review of nanofluid engineering parameters and a brief analysis of their contributions to basic thermo-physical properties.

Sandip Kumar Sonawane, Kaustubh Patankar, Ankit Fogla et.al.[3] This paper Review on "An Experimental Investigation of Thermo physical Properties and heat transfer performance of Al_2O3-Aviation Turbine Fuel Nan fluids". This paper focuses on the Al_2O_3 metal oxide a nanoparticle is taken as nanomaterials and distilled water is taken as base fluid. Two-step method is taken for preparing Al_2O_3 /water nanofluid This is because the two-step method is better for oxide particles and this method gives higher stability and less agglomeration.They experimentally measured the thermo physical properties of aviation turbine fuel - Al_2O3 nanofluid. They varied volume concentration of Al_2O3 nanoparticle between 0 to 1%. They found that at 1% particle volume concentration the enhancement in the thermal conductivity was 40% and the increase in the viscosity was found to be 38%.

A.K.Singh [4] Defense Institute of Advanced Technology, Pune presented a paper on Thermal Conductivity of Nanofluids. This paper review of nanotechnology with focus on nanofluids and its thermal conductivity property. They concluded that nanofluids have great potential for thermal management and control involved in a variety of applications such as electronic cooling, microelectro mechanical systems (MEMS) and spacecraft thermal management.

Lalit B.Chintamani, Prof.N.C.Ghuge [5] In this Research Paper it provides an experimental review on the historical evolution of nanofluid concept, heat transfer enhancement of base fluid with nanoparticles,scope of applications of nanofluids and It is determine the property of heat transfer are the thermal conductivity, viscosity, specific heat and density, due to their excellent properties nanofluids find wide application in enhancing heat transfer.

Gupta H.K, Agarwal G.D, Mathur.J [6]
The aim of this paper is to focus on the wide range of nanofluid based current and future application. Some challenges and barriers are also focused for implementing these new class of working fluids.

Vajjha and Das [7] This Paper is focused on the thermal conductivity depend upon the nanoparticles concentration as well as temperature.Aurthors concluded that it will be more beneficial if it is used for high temperature application. it has been observed that many authors agreed that nanofluids provide higher thermal conductivity compared to base fluids, for determing thermal conductivity of nanofluids,Particlesize,dispersion,stability,concentration and temperature.

Sreelakshmy K .R Aswathy S.Nair, Vidhya K.M, Saranya T.R, Sreeja C Nair [8]
The main theme of this paper is its excellent thermal conductivity and they have various application in the field of science and technology.Nanofluids have thermo-physical properties such as thermal counductivity, diffusivity, viscosity and heat transfer coefficient as compared to based fluid.

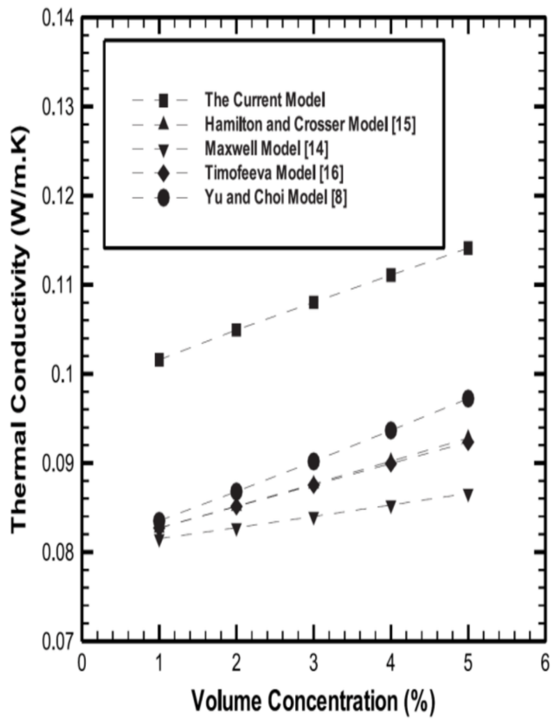
III. COMPARSION BETWEEN THERMAL CONDUCTIVITY OF NANOFLUIDS AND BASE FLUID

Increased the thermal Conductivity of Nanofluid in comparison to base fluid by suspending particles**[6].**

Table 1: thermal Conductivity of some materials, base fluids and nanofluids

	Material	Thermal Conductivity(W/mk)
Metallic Material	Copper	401
	Silver	429
Non-metallic Material	Silicon	148
	Alumina	40
Carbon	Carbon nano tubes(CNT)	2000
	Water	0.613

Base fluids	Ethylene glycol	0.253
	Engine oil	0.145
Nanofluids (Nanoparticles Concentration %)	Water/Al_2O_3	0.629
	EG/ Al_2O_3	0.278
	EG-Water/ Al_2O_3	0.382
	Water/TiO_2	0.682
	Water/CuO	0.619

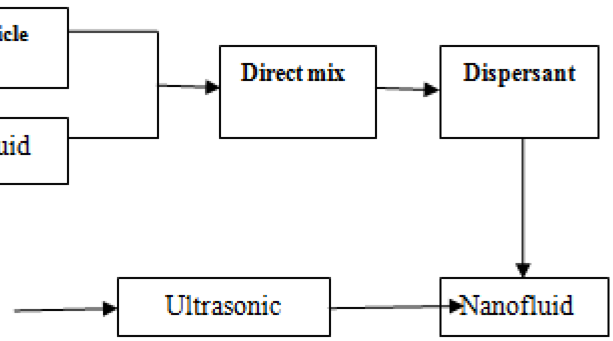


Figuer.1: Thermal Conductivity of Nanofluids

IV. PREPARATION

There are two methods for the preparation of nanofluids.

Two Step-methods: Two-step method is most widely used method for preparing nanofluids in this method, nanoparticles, nanotube and nanofibers are made by dry powder form by physical as chemical method. The next procedure is the dispersion of nano-sized powder into a base fluid with the add of ultrasonic agitation, magnetic force agitation, high shear mixing and ball milling. A two-step method gives large scale production of nanofluids whereas; single-step method is limited. The main drawback in two-step method is large agglomerations whereas single-step method is limited agglomerations. The only one disadvantage in single step method is that the base fluid must have low vapor pressure and oxidation may occur at the surface of pure metallic particles. [8]-[12]



Figuer.2: Prepartion method of different nanofluids

One step-method: One step method was developed by Eastman it as to reduce aggregation of nano particles. This method combines the production of nanoparticles and dispersion of nanoparticles into base fluid in a single step. In this process following steps are away like: Drying, storage, transportation and dispersion of nanoparticles. So that agglomeration of nanoparticles reduces and stability of nanofluid is increased.
This method provide the greater stability due to the dispersing of the nanoparticles uniformly and cannot synthesize nanofluids in large scale and production is also high, so that one-step method is developing rapidly.[8]-[12]

V. ADVANTAGE OF USE OF NANOFLUIDS

Nanofluids have the following advantages as compared to conventional fluids:

1. Nanofluid has unique Properties of thermal conductivity as compared to base fluids The suspended nanoparticles increases the surface area and the heat capacity of fluid due to the very small particle size.
2. The effective thermal conductivity of the fluid is enhanced.
3. The collision and interaction among particles, the surface of flow passageϖ and base fluids are intensified.
4. Absorpation of solar energy will be maximized with change of shape, size, material, and volume fraction of the nanoparticles.
5. Reduction of particle clogging rather than conventional slurries.
6. To make suitable for different applications, properties of fluid can be changed by varying concentration of nanoparticles.
7. The Properties of nanofluids can be varied with change in their concentration.

VI. LIMITATION OF USE OF NANOFLUIDS

Nanofluids have a few physical and chemical limitations **[9].** The long term stability of nanofluids is a very important issue. Nanofluids may not be physically or chemically stable for a long period of time. The homogeneity of nanofluids is depends upon the cluster of nanoparticles. The cluster of nanoparticles is occurred by the strong vanderwaals forces of attraction between nanoparticles. Physical or chemical property and its stability of nanofluids can be increased by adding surfactants, but it can lead to further complications **[10].** The boiling characteristics of nanofluids are poor. If increase the concentration of nanoparticles the boiling performance gets degraded due to an increase in the surface temperature of the nanofluids. This imposes a severe limitation on the design of cooling system with nanofluids and can cause overheating.

VII. APPLICATION OF NAN FLUIDS

Nanofluids can be used in broad range of engineering applications due to their improved heat transfer and energy efficiency in a variety of thermal system. The following section gives a brief idea of different areas of nanofluid applications based on available literature.

1. Automobile: Nano fluids have greater potential application as lubrication, coolant, engine oil, grese and transmission fluid to improve automotive and heavy-duty engine cooling rates by increasing the efficiency, lowering the weight and reducing complexity.

2. Nanofluids in Fuel: The combustion of diesels fuel mixed with aqueous aluminum nanofluids increased the total combustion heat while decreasing the concentration of smoke and nitrous oxide in the exhaust emission from the diesel engine. It is due to high oxidation activity of pure Al which allows for increased decomposition of hydrogen from water during the combustion process.

3. Nanofluids in Domestic Refrigerator:

In present, HFC134a is used as a refrigerant in refrigeration Equipment. Conventional mineral oil is skipped from lubricant due to the strong chemical conflict of HFC134a in refrigeration equipment. When Polyester oil is considered as lubricant then it also has the problems of flinty friction in the compressor well as flow obstruct. So nanoparticles can be used to amplify the operative fluid properties and energy competency along with focused on reduction in CO_2 emission.**[6]**

4. Nanofluid detergent: Nanofluid are very different from base fluids and they do not behave like the classical approach of surface tension and adhesion. this property provide the possibility of exploring the chance of using nanofluids as a detergent and lubricant**[8].**

5. Nanofluids in Electronics Application: The high thermal conductivity of nanofluids is effectively used in the cooling of microchips very fastly.nanofluids can be used to control micro fluidic system and control the wettability of a surface and its surface tension **[8].**

6. Nanofluids in Medical Science: Nanofluids plays an efficient role in cancer imaging and drug delivery. Radiations can be administered to the cancer patients using iron based nanoparticles. Nanoparticles have magnetic properties can be used as biomarkers and can help in the targeted delivery of anticancer drugs without causing damage to the healthy cells nearby, Magnetic nanoparticles stick to tumor cells easily and not to healthy cells, this helps in the selective targeting of tumor cells**.[8]**

VIII. FUTURE ASPECT

Looking towards the future we have to throttle us for a new fast and effective engineering, Nanofluids are one of the potent engineering marvel which will change the with highly efficient results especially in automobile, manufacturing and Refrigeration and Air Conditioning sectors, the application of these fluids results high rate of cooling within less space and in a short of time, which is needed for future engineering application. Use of these nano fluids will transform the conventional engineering solutions to the new era turbulent and revolutionized technology.

IX. CONCLUSION

Nan fluids having wide prospects in the application of Science and technology affecting macro engineering parameters like advanced cooling mechanism, high thermal conductivity ability which play major and important role in advanced manufacturing processes, due to the shape, size and volume of the nano fluid particles are able to exchange more thermal potential with the same discharge ratio. in comparison of the conventional fluid flow heat exchanging. In the Present and future era where manufacturing processes are more competitive, nanofluids will play vital role in throttling the effectiveness. Beside all these features nanofluid particles size, shape, volumes are non skippable factors which affect the effectivenes.

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