A Review on Heat Transfer Augmentation in Nano Fluids

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***Abstract*— Thermal conductivity is crucial aspect for rapid heating and cooling application. Conventional fluid i.e. water, ethylene glycol has low thermal conductivity. Nano fluid is an alternative for enhancing the heat transfer rate. Nano fluid such as carbide and metal oxide and they dispersed into conventional fluid. This paper shows varying aspects which play roles in the thermal conductivity of Nano fluid at varying conditions. All scientists tried to enhance the heat transfer rate by considering thermal conductivity Nano fluid. Thermal conductivity is enhanced with enhancing presence of metal particle within some limit. Thermal conductivity is affected by the various parameters to enhance the thermal conductivity of Nano fluid. Nano fluid is advanced heat transfer fluid for future. Nano fluid contains Nano sized solid particles, as the thermal conductivity of solid particles is higher than that of liquid so the Nano fluid can be used as an alternative to the conventional fluids.**

***Index Terms*—Thermal conductivity, conventional fluid, nano fluids.**

I. INTRODUCTION

A Nano fluid is a fluid which contains small sized solid particles. These fluid are made by colloidal suspension of nanoparticles in conventional fluids. Nanoparticle used in Nano fluids are usually made of metals, oxides, carbides or carbon Nano tube. Conventional fluids include water, ethylene glycol and oil. They exhibit convective heat transfer coefficient and high thermal conductivity as compared to conventional fluid.

II. FORMATION OF NANO FLUID

Nano fluids are formed by two methods. In single stage technique the first step is formation of nanoparticle and in two stage is the suspension of the nanoparticle in conventional fluid. Two stage is more used by utilising the noble gas condensation technique. The main limitation of two stage technique is forming number of things of same kind growing together during formation of Nanoparticle.

III. THERMOPHYSICAL PROPERTIES OF NANOFLUIDS:

1. Higher heat conduction:

The vast area of nanoparticles permits more heat transfer. Particles of 21 nm transfers 21% of their atoms on the surfaceaking them present for thermal carriers. This can be utilised for moving of the particles factor which affects to small sized size to carry out for fluid convection so the enhanced heat transfer occurs. The small convection and enhanced heat transfer may also enhance suspension of heat in the fluid at more. It is observed that thermal conductivity of Nano fluids varies with increase in temp which resulted from above factors.

2. Viscosity:

Viscosity of Nano fluids is a function of volume fraction of suspended spherical solids in conventional or base fluids. Increase in volume fraction of solid particles results in effective viscosity and enhancing heat transfer rate.

3. Specific heat and density:

Specific heat capacity and density considered as function of particle volume suspension.

4. Stability:

Particles are small and less weighted and the possibility of sedimentation is lowered. This decreases sedimentation which may avoid the limitation of suspensions and settling down of Nano sized particles which make the Nano fluids stable.

5. Micro channel cooling with avoiding clogging:

Nano fluids is not suitable medium for heat transfer commonly so they will be novel for small channel applications when there is more heat loads are found. The uniting of small channels and Nano fluids will result both more conducting fluids and vast heat transfer area. Which cannot be obtained with micro particles due to clogging in small channels. Nanoparticles only a few of atoms which of magnitude lesser than the small channels.

6. Reduced possibilities of erosion:

Nanoparticles are very tiny and the mobility they can produce to a solid wall is so much lesser. Reduced mobility decreases possibility of erosion of components like pipelines and pumps and also the heat exchangers,.

7. Decrease in pumping power:

To enhance the heat transfer of base fluid by a some factor of so the pumping power must be enhanced by more factor.

IV. NECESSITY OF NANO FLUID

1. Pressure drop is minimum due to presence of nano sized particles in conventional fluid.
2. High thermal conductivity increases the heat transfer rate in nano fluid.
3. Revised research on Nano fluid will result in compact heat exchanger.
4. Phenomenal change in the chemical properties of conventional fluid, by suspension of Nano fluids.
5. Heat transfer varies with surface volume of nanoparticle in conventional fluid.

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6. They are most efficient for rapid cooling and heating system.

V. APPLICATION OF NANO FLUID

Nano fluid is used to cool automobiles and in welding workshops, appliances and cool device such as microwave tube and laser diode series. Nano fluid passes in the small passage in MEMS (Micro electromechanical systems) to enhance the efficiency.

The unusual and advanced trends of Nano fluids facilites enhancing heat transfer characteristics as compared to conventional heat transfer fluids. There are considerable reviews and performances on advanced heat transfer properties of nano fluids specially on convective heat transfer and thermal conductivity. Applications of Nano fluids in heat exchanging devices appear promising with these novel characteristics.

Nano fluids can be used in following specific areas:

1. Bio and pharmaceuticals Nano fluids
2. Environmental Nano fluids
3. Tribalogical Nano fluids
4. Medical Nano fluids
5. Surfactant and coating Nano fluids
6. Chemical Nano fluids

And some common applications are:

1. Refrigeration
2. Cooling of electronic circuit
3. Solar water heating
4. Bio-medical application
5. Drilling and lubrication
6. Boiler exhaust flue gas recovery
7. Engine cooling
8. Engine transmission oil
9. Nuclear cooling system
10. Defence and space application
11. Thermal storage

VI. PERFORMANCE STUDIES

[1] L.B. Mapa measured increased thermal conductivity of Cu-H2O Nano fluid using shell and tube heat exchanger of dimension of heat exchanger is 250x25x0.24mm, using 38 tubes. The output is rate of heat transfer is enhanced with increasing flow rate and also its presence. By nanoparticle suspended into de-ionized conventional fluid a better result is achieved.

[2]J. Koo analysed the nanoparticle suspension and collection at the surface wall by small channel heat sink. Which has the dimension of 1.1cmx150micometerx302 micrometer, H2O-Cuo and Cuo- ethylin glycol passes the very small channel heat sink. Analysed conventional fluid has high prandtle number which increases heat transfer rate by various conditions of collision. Viscous dissipation effect is crucial factor in small channel due to Nusselt number found high for other conditions.

[3]Shung Wen investigated relation between thermal resistance of nanoparticle by 212micrometre×220 micrometre particle and grooved circular heat pipe and heat pipe maintained at 41^0C temp. The actual thermal resistance is varies with the size of nanoparticle. Reduction of thermal resistance is maximum by using 10 nanometre sized particles due to particle size increases then wall temp also increased. Hence small sized particle can be more efficient for increased heat transfer rate. Thermal resistance varies with increasing heat transfer rate and possession of Nano particle.

[4]Shuichi Torri analysed heat transfer coefficient of diamond like nano fluid by using heat tube equipment in convection medium. Dimension of tube is 4.4 mm for outer diameter and 4.1mm for inner diameter and with 100W power at uniform rate. They found heat transfer coefficient raises with enhancing possession and Reynolds number of Nano fluid. So that instant there is more pressure drop when concentration of Nano particle is increased.

[5]S.J.Kim analysed production of porous layer with wetted property of Nano fluid with some heat flux and SEM photographs. They utilised three various types of nanoparticle with varying dimensions of its diameter like Al_2O_3 (112-214nm), SiO_2 (21-42nm) and ZrO_2 (111-212)and found that the boiling is main aspect which changes heat transfer rate of Nano fluid. Because the nucleate boiling nanoparticle was found deposited onto the wall surface, therefore porous layer was produced on wall surface. Porous layer is changeable with wetted property, cavity and roughness like various properties of wall surface hence heat transfer rate lowered because of boiling of Nano fluid.

[6]Paisarn analysed thermal efficiency of heat pipe with titanium-alcohol Nano fluid of dimensions of 62mm length and 16mm outer diameter. The thermal efficiency enhanced with varying angle in between 60^o angle and possession of nanoparticle.

[7]Anil Kumar found heat transfer increased in fin with AL_2O_3-H2O Nano fluid by using Computational Fluid Dynamics. Rayleigh number enhanced because of Brownian motion aspect in dispersion effect ,ballistic phonon transport, clustering in nanoparticle. Due to which High Rayleigh number brings out flow rate at middle in which circulation which is increased therefore temperature is drop near centre of fin. Due to which the volume of the circulation increases the velocity at centre because of enhancing the solid-fluid heat passage. Low aspect ratio in fin is common for heat transfer increased due to heat which is affected zone is less terms.

[8]. Yu-Tang observed that the thermal resistance in heat pipe with Ag-DI H2O Nano fluid made up of 200cm length and 3mm thickness. Heat resistance varies with enhancing possession of Nano fluid to the 50ppm because of wetted property of nanoparticle number of shapes of wick is formed on to the heat pipe.

[9]. Eed Abdel Hafez analysed that the heat transfer rate of vapour compression system with the CuO- R134 this Nano fluid with 10-40 KW/m^2. Concentration, size and heat flux of particle is important aspect which leads to enhance the heat transfer rate of Nano fluid. Heat transfer rate up to 56% of concentration of Nano fluid and 25nm sized particles is varies with increasing heat flux.

[10]Somchaiwongwises analysed that the heat transfer increased and flow characteristic of Al_2O_3-H2O these nano fluid with small sized channel heat sink. Dimension of equipment section was 6x6mm and 52W heat was applied which resulted heat transfer is increased at high Reynolds number and high possession of Nano fluid due to high Reynolds number will decreases wall temperature and increases pressure drop

[11] Yannar analysed the flow and heat transfer characteristics of helical pipe heat exchanger using various type of Nano fluid having different concentration of solid particles such as Al_2O_3- H2O , TiO_2- H2O, CuO-H_2O Nano fluid with 2% and 4% of concentration respectively. The test section made up of helical coil copper tube had the pitch diameter ratio of 8, mean diameter is 40mm and 1500mm in length. Heat transfer rate enhanced 30% at 0.7% suspension of Nano fluid, because of high suspension shear stress of Nano fluid gets increased. Heat transfer enhancement is high in helical pipe compared with circular pipe, because of the pressure drop is higher in helical pipe, by increasing the axial distance of the nano fluid because of the boundary layer formation , the heat transfer coefficient gets decreased.
[12]Nawaf analysed that air-H2O heat exchanger with TiO_2 nano fluid. Thermal performance of air duct of dimension 102x3x305 mm in which water flows from the pipe having 6mm radius and 305mm length. Air flows through exterior surface of pipe due to the result of heat is transfer. Heat transfer coefficient is varies with enhancing at constant volume Reynolds number of friction up to 0.7% and enhancing possession of not changing Reynolds number limited 1000 so at high possession demands high pumping power. Nusselt number varies due to enhancing Reynolds number so the more heat transfer is found at this condition due to increasing at aerofoil particular angle of attack which then lowers when axial distance is more so at 0-100^0 angle of aerofoil the heat istransmitted.

VII. CONCLUSIONS

1. Heat transferrate varies with enhancing possession of nanoparticle.
2. Heat transfer of Nano fluid varies due to the peclet number and Reynolds number
3. Good category of nano particles has poor stability but it enhances the heat transfer rate.
4. Suspension and Clustering of nanoparticles is aspect which result heat transfer rate of Nano fluid.
5. Increasing the pressure drop will increase Nano fluid possession of nanoparticles.
6. Compared with other shaped nanoparticles spherical shaped nanoparticles enhances the heat transfer rate of Nano fluid
7. To reduce the increase of heat transfer rate boiling is done .
8. Compared with the circular plain tube the spiral pipe has more heat transfer rate.
9. Compared with horizontal tube the inclined tube has low pressure drop.

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