"HEAT TRANSFER INTENSIFICATION USING NANOFLUIDS"

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INTRODUCTION

The nanolayer acts as a thermal bridge between a solid nanoporticle about less than in dimension 100nm. and a bulk liquid and so is key to enhancing thermal conductivity. Nanofluids are dilute liquid suspensions of nanoparticles . The thermal behavior provide a basis for an enormous innovation for heat

Transfer intensification the nsnofluid structure consisting of nanoparticles, Bulk liquid, and nanolayers at solid/liquid interface.

- <u>Base fluids include:</u>

Water

Ethylene – or tri- cthylene – glycols and other coolants

Oil and other lubricants

Bio – fluids

Polymer solutions

Other common fluids

Conacept of Nanofluids

The heat transfer fluids have inherently poor thermal conductivity compared to solids. That contain mm-or µm-sized particles do not work with the emerging "miniaturized "technologies Nanofluids are a new class of advanced heat-transfer fluids engineered by dispersing nanoparticles smaller than 100nm (nanometer) in diameter in convenational heat transfer fluids.

Methods for Producing Nanofluids

Two nanofluids production methods has been developed in ANL to allow selection of the most appropriate particular application. A patented one-step process simultaneously makes and disperses nanoparticles directly into base fluid; best for metallic nanofluids.

Chem. Vapor Evaporation; “Kool-Aid” inert-gas condensation processing, and then dispersed in base fluid.

Characteristic of nanofluids

1. Increased thermal conductivity at low nanoparticle concentrations
2. Strong temperature dependent
3. Non –linear increase in thermal conductivity
4. Increase in boiling critical heat flux

Feature of nanofluids :

These features of nanofluids make them suitable for the next generation of flow and heat transfer fluids. At Room temperature thermal conductivity measured

- Hot – wire method
- Conventional heat conduction cell method
- There are also a few recent reports on the measurements.

The 3-Q method

The 3-Qmethod is relatively new and accurate, and uses a metal wire suspended in nanofluids. The wire acts as both heater and a thermometer then sinusoidal current is passed through metal wire of its temperature rise, can be reduced by voltage most be decrees then thermal conductivity of the fluid is determined by from graph resistance against temperature rise of the metal wire.

MECHANISMS OF THE THERMAL CONDUCTION ENHANCEMENT

A number of mechanisms have been proposed for interpreting the thermal conduction,

- Brownian motion of nano-particles
- Interfacial liquid layering
- Nanoparticles structuring/networking

The Brownian motion of nanoparticles contribute to the thermal Conduction enhancement through two ways,

- Direct contribution
- Indirect contribution

The Brownian motion of nanoparticles in nanofluids captures the concentration and temperature-dependent conductivity, and it predicts that water-based nanoparticles containing 6nm for Cu nanoparticles are much more temperature sensitive than those containing 38 nm Al_2O_3 particles, with an increase in conductivity of nearly a factor of two at 325 kelvin. When particles size is relatively small in comparison with the characteristic length scale due to the interfacial. Resistance, nanoparticles act as insulators. This leads to deterioration of the thermal conduction of nanbofiuids.

The above explain that neither Brownian motion nor interfacial liquid layering can be a dominant mechanisms

Convective Heat Transfer of Nanofluids :

It refers to heat transfer between a fluid and surface due to the macroscopic motion of the fluid relative to the surface. It can be divided into

- Natural convective heat transfer
- Forced convective heat transfer

Natural convective heat transfer:

It caused due density difference caused by temperature variation in the fluid, At heating, the density change in the boundary layer will cause the fluid to rise and be replaced by cooler fluid that also will heat rise.

- And it Natural convective heat coefficient depends not only the properties of the fluid but also on the method of heating, configuration and orientation of the heater, as well as heating and cooling surfaces.

Forced convective heat transfer:

Here fluid flow is induced by an external force such as pump, fan or mixer. It can be studies, one for horizontal arrangement and other one for vertically oriented pipe.

Applications :

- Development of methods to manufacture diverse, hybrid nanofluids with polymer additives with exceptionally high thermal conductivity while at the same time having low viscous friction.
- High thermal conductivity and low friction are critical design parameters in almost every technology requiring heat- transfer fluids (cooling or heating).
- Another goal will be to develop hybrid nanofluids with enhanced lubrication properties.
- Application range from cooling densely packed integrated circuits at the small scale to heat transfer in nuclear reactors at the largescale.
- Nature is full of nanofluids, like blood, a complex biological nanofluid.
- Many natural processes in biosphere and atmosphere include wide spectrum of mixtures of nanoscale particles with different fluids.
- Many mining and manufacturing processes leave waste products which consist of mixtures of nanoscale particles with fluids.
- A wide range of self- assembly mechanisms for nanoscale structures start from a suspension of nanoparticlesin fluids.
- Little is known about the physical and chemical surface interactions between the nanoparticles and base fluids molecules in order to understand the mechanisms of enhanced flow and thermal behavior of nanofluids.

- Improved theoretical understanding of complex nanofluids will have an even broader impact.
- Development of new experimental methods for characterizing (and understanding) nanofluids in the lab and in nature.
- Nanoscale structure and dynamics of the fluids : using a variety of scattering methods; small –angle X-ray scattering (SAXS), small- angle neutron scattering (SANS), X-ray photon correlation spectroscopy(XPCS), laser based photon correlation spectroscopy (PCS) and static light scattering.
- Development of computer based models of nanofluid phenomena including physical and chemical interactions between nanoparticles and base- fluid molecules.
  - Beyond the primary goal of producing enhanced flow and heat transfer with nanofluids, the research should lead to important developments in bio-medical applications, environmental control and cleanup and directed self-assembly at the nano scale.

  - Possible spectrum of applications include more efficient flow and lubrication, cooling and heating in new and critical applications, like electronics, nuclear and biomedcal instrumentation and equipments, transportation and industrial cooling, and heat management in various critical applications, as well as environmental control and clean up bio-medical applications, and directed self-assembly of nanostructures, which usually starts from a suspension of nanopartcles in fluid.

CONCLUSION

- It covers conduction, convection under both natural and forced convective heat transfer conditions.
- The presence of nanoparticles enhances thermal conduction under macroscopically static conditions.
- The enhancement is a function of particle concentration, particle material type and particle shape.

- The natural convective heat transfer coefficient systematically decreases with increasing nanoparticle concentration.
- Either enhancement or deterioration can occur in the forced convective heat transfer of nanopfluids.
- Enhancement of the boiling heat transfer is observed in the nucleate regime for both alumina and titania nanofluids and the enhancement is more sensitive to the concentration change for TiO_2 nanofluids

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