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Effect Of Nanofluids In Engineering Processes

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Abstract - *A wide variety of engineering processes involve the transfer of heat energy from one system to another system. Throughout any engineering application, heat might be added, removed, or moved from one process stream to another and it has become a major task for engineering system. The enhancement of heating or cooling in an engineering process may create a saving in energy, reduce process time, raise thermal rating and lengthen the working life of equipment. Some processes are even affected qualitatively by the action of enhanced heat transfer. Heat transfer efficiency can also be improved by increasing the thermal conductivity of the working fluid. Nanofluid is a new kind of heat transfer medium, containing nanoparticles (1–100 nm) which are uniformly and stably distributed in a base fluid. These distributed nanoparticles, generally a metal or metal oxide greatly enhance the thermal conductivity of the nanofluid, increases conduction and convection coefficients, allowing for more heat transfer.*

The development of high performance thermal systems for heat transfer enhancement has become popular nowadays. In this paper the application of nanofluids in different engineering process has been given and their various properties are also studied. Nanofluids have been considered for applications as advanced heat transfer fluids for almost two decades. However, due to the wide variety and the complexity of the nanofluid systems, no agreement has been achieved on the magnitude of potential benefits of using nanofluids for heat transfer applications. As compared to conventional solid liquid suspensions for heat transfer intensifications, nanofluids having properly dispersed nanoparticles possess the wide application.

Keywords - *Nanofluid, Nano particle, Nano Materials, Application of Nano fluids*

I. Introduction

Utilizing nanofluids as an advanced kind of liquid mixture with a small concentration of nanometer-sized solid particles in suspension is a relatively new field, which is less than two decades old. Nanofluids are two phase mixtures engineered by dispersing nanometer sized particles with sizes ranging below 100 nm in base fluids. The nanometer sized particles which are used for the dispersion in base fluids are nanoparticles, nanofibers, nanotubes, nanowires and nanorods. Materials generally used as nanoparticles include metal oxides (e.g., alumina, silica, zirconia, titania), oxide ceramics (e.g. Al2O3, CuO), chemically stable metals (e.g. gold, copper), carbon in various forms (e.g., diamond, graphite, carbon nanotubes, fullerene) metal carbides (e.g. SiC) and functionalized nanoparticles. The base fluid types include oils, water, organic liquids such as glycols, refrigerants, polymeric solutions, bio fluids, lubricants and other common liquids.[3]

Advantages of nanofluids:

Particle size is the major physical parameter in nanofluids, since it can be used to attune the nanofluid thermal properties as well as the suspension stability of nanoparticles. Hence, nanofluids can able to flow freely through mini or micro channels with the dispersion of nanoparticles. The nano suspensions show high thermal conductivity which is mainly due to enhanced convection between the nanoparticles and base liquid surfaces. Another potential benefit is that the nanoparticles have lower dimensions so that the dispersed nanoparticle seems to be like a base fluid molecule in suspension. The advantages of suspending nanoparticles in base fluids: The surface area and heat capacity of the fluid are increased. The effective thermal conductivity of the fluid is enhanced. The collision and interaction among particles, the surface of flow passage and base fluids are intensified. Reduction of particle clogging rather than conventional slurries. The combination of these factors makes nanofluids highly preferable for designing heat transfer fluids.

Methods of nanofluids preparation:

The initial key step in experimental studies with nanofluids and the optimization of nanofluid thermal properties requires successful preparation methods for producing stable suspensions of nanoparticles in liquids. Some special requirements are essential (i.e.) negligible agglomeration of particles, uniform, durable and stable suspension and no chemical change of the fluid, etc. There are two main techniques adopted for the preparation of nanofluids: single-step method and two-step method.

Single step method Single step method simultaneously produces and disperses the nanoparticles directly into the base fluid medium which is suitable for metallic nanofluids. The aggregation problem can be much reduced with direct evaporation condensation method. This inert-gas technique involves the vaporization of source material in a vacuum. In this process of preparation, the condensation forms nanoparticles through direct contact between the base fluid and vapor.

Effect of Nanofluids in Engineering Processes:

The aim of this paper is the investigation of the nanofluids' applications in different engineering systems. The shortage of fossil fuels and environmental considerations it is essential to use alternative energy sources such as solar energy, nano technology, renewable energy, etc. So it is essential to enhance the efficiency and performance of the existing engineering systems.

A nanofluid is a new class of heat transfer fluids that contain a base fluid and nanoparticles. The use of additives is a technique applied to enhance the heat transfer performance of base fluids. The thermal conductivity of ordinary heat transfer fluids is not adequate to meet today's cooling rate requirements. Nanofluids have been shown to increase the thermal conductivity and convective heat transfer performance of the base liquids. Nanofluids are suspensions of submicronic solid particles (nanoparticles) in common fluids. The term was coined by Choi. The characteristic feature of nanofluids is thermal conductivity enhancement, a phenomenon observed by Masuda et al. This phenomenon suggests the possibility of using nanofluids in advanced nuclear systems. A comprehensive survey of convective transport in nanofluids was made by Buongiorno, who says that a satisfactory explanation for the abnormal increase of the thermal conductivity and viscosity is yet to be found. He focused on further heat transfer enhancement observed in convective situations. Very recently, Kuznetsov and Nield have examined the influence of nanoparticles on natural convection boundary-layer flow past a vertical plate using a model in which Brownian motion and thermophoresis are accounted for. The authors have assumed the simplest possible boundary conditions, namely those in which both the temperature and the nanoparticle fraction are constant along the wall. Furthermore, Nield and Kuznetsov have studied the Cheng and Minkowycz. problem of natural convection past a vertical plate in a porous medium saturated by a nanofluid. The model used for the nanofluid incorporates the effects of Brownian motion and thermophoresis for the porous medium. The Darcy model has been employed. Nearly all of the former works conducted on the applications of nanofluids in solar energy is regarding their applications in collectors and solar water heaters. Therefore, a major part of this review paper allocated to the effects of nanofluids on the performance of solar collectors and solar water heaters from the efficiency, economic and environmental considerations viewpoints. In addition, some reported works on the applications of nanofluids in thermal energy storage, solar cells, and solar stills are reviewed. Subsequently, some suggestions are made to use the nanofluids in different solar thermal systems such as photovoltaic/thermal systems, solar ponds, solar thermoelectric cells, and so on.[1]

Thermal conductivity enhancement in nanofluids, which are liquids containing suspended nanoparticles, has been attributed to localized convection arising from the nanoparticles' Brownian motion. Because convection and mass transfer are similar processes, the objective here is to visualize dye diffusion in nanofluids. It is observed that dye diffuses faster in nanofluids compared to that in water, with a peak enhancement at a Nanoparticle volume fraction of 0.5%. A possible change in the slope of thermal conductivity enhancement at that same signifies that convection becomes less important at higher. The enhanced mass transfer in nanofluids can be utilized to improve diffusion in micro fluidic devices [2].

II. Conclusion

The use of nanofluids seems attractive in a broad range of applications. But the development in the area of nanofluid application is hindered by many factors in which long term stability of nanofluid in suspension is major reason. An ideal heat transfer fluid should possess higher value of specific heat so the fluid can exchange more heat.

The nanofluids exhibit lower specific heat than base fluid. It limits the use of nanofluid application. Nanofluids are prepared by either one step or two step methods. Both methods require advanced and sophisticated equipments. This leads to higher production cost of nanofluids. Nanofluids employed in experimental research have to be well characterized with respect to particle size, size distribution, shape and clustering so as to render the results most widely applicable. Once the science and engineering of nanofluids are fully understood and their full potential researched, they can be reproduced on a large scale and used in many applications. Colloids which are also nanofluids will see an increase in use in biomedical engineering and the biosciences. Further research still has to be done on the synthesis and applications of nanofluids so that they may be applied as predicted. Nevertheless, there have been many discoveries and improvements identified about the characteristics of nanofluids in the surveyed applications and we are a step closer to developing systems that are more efficient and smaller, thus rendering the environment cleaner and healthier.

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