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A Comparative Study of Nanofluids for Tuneable Filter Operation

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Abstract: Nanofluids are engineered colloidal suspensions of nanoparticles in a base fluid[1]. The nanoparticles used in nanofluids are typically made of metals, oxides, carbides, or carbon nanotubes. …..

Keywords: Nanoparticles, basefluid, nanofluid, transmittance, tunable optical filter.

I. Introduction & Background of study

The first decade of nanofluid research was primarily focused on measuring and modelling fundamental thermo physical properties of nanofluids (thermal conductivity, density, viscosity, heat transfer coefficient). Early research on nanofluid. **Please include**

Research Question

Research Gap

Aim

Objectives

Scope

Limitations of the study

II. Literature Review

Nanofluids can be defined as a solid-liquid composite materials consisting of nanometer sized solid particles, fibers, rods or tubes suspended in different base fluids. Some examples of nanoparticles are pure metals (Au, Ag, Cu, Fe), metal oxides (CuO, SiO2, Al2O3 , TiO2, ZnO, Fe3O4), Carbides (SiC, TiC), Nitrides (AlN, SiN) and different types of carbon (diamond, graphite, single/multi wall carbon nanotubes). Classical liquids, such as water, ethylene glycol and engine oil are some examples of base fluids. Choi [1] from Argonne National Laboratory in Unites States was the first person which was invented this fluid in 1995. He observed experimentally that the addition of high thermal conductivities metallic/non-metallic nano- particles into the base fluid was increased the thermal conductivity of these fluids dramatically and thus enhancing their overall heat transfer capability . For example, the thermal conductivity of copper at room temperature is about 700 times greater than that of water and about 3000 times greater than that of engine oil [2]. Nanofluid was used for various industrial applications. Some of these applications including nuclear reactors, transportation industry, electrical energy , solar absorption and biomedical fields [3]. Nanofluid have a good properties of radiation absorption and it has a high thermal conductivity. For example, the thermal conductivity at the room temperature of individual multi-walled carbon nanotubes (MWCNTs) were found to have values greater than 3000 W/ m.K [4]. Moreover , Assael et al. [5] indicated that about 1% volumetric fraction of MWCNT was enhanced the thermal conductivity of water by about 40%. In order to prepare nanofluids by dispersing nanoparticles in a base fluid, a proper mixing and stabilization of the particles is required. The size of nanoparticles is very small and in the range of 1–100 nm. It is highly recommended not to add large solid particles in the base fluids (more than 100 nm) due to the following main problems [6].

Identification of the research gap from the study should be clearly stated here.

III. Methodology (Mathematical Models used if any should be discussed here)

Proper dispersion was achieved by (1) First mixing nano powder with distilled water. (2) Using ultrasonic vibration until proper dispersion is obtained. The volume of the solid mixed with the base fluid was determined by (1) Considering true density to find equivalent weight of the solid (2) That weight was used to made the suspension. (3) Then ultrasonic vibration was given for 12 hours to get complete dispersion. For about next 12 hours no sedimentation was observed and thereafter it was proved that no sedimentation was observed for 1% and 2% volume suspensions. Minor sedimentation was observed in the case of 3% and 4% volume suspensions. But in practical applications it is not possible to stabilize the particles without any third agent like oleic acid or laurate salts. Even the thermal conductivity of the base fluid may be influenced due to the addition of third agent. But the authors have conducted experiment with in 1.5 to 2 hours with no sedimentation without adding any third agent. They have estimated the thermal conductivity is based on energy equation for conduction is given by

Mie theory was used to calculate the scattering and extinction efficiency factors of a single homogeneous sphere particle. In this study the relative refractive index was applied because the nanoparticle was immersed in the base fluid. The relative refractive index is defined as:

$$m=\frac{n_p+ik_p}{n_m} \qquad \text{---------(1)}$$

IV. Results & Discussion

The following section analyses the transmittance spectrum for the different types of nanofluids considered and compares them on the basis of the range of transmission wavelengths, the linearity of the graphs and also the controlling parameters such as particle size, volume fraction and the thickness of the fluid layer. The chart given below is the key to interpreting the information in the following tables.

A. Transmittance for varying nanofluid layer thickness

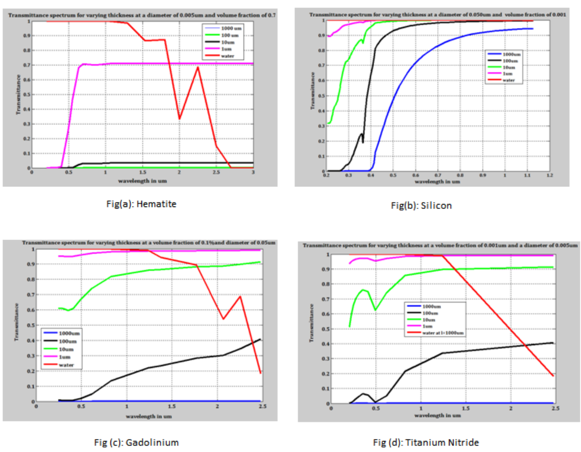

Fig1: Showing the effect of varying thickness on transmittance for a. Hematite b. Silicon c. Gadolinium and d. Titanium Nitride.

Table 1: Details of Nanofluids Wavelengths, Volume Fraction & Diameter

Nanofluid	Percentage Transmittance at different wavelengths at a fluid layer thickness of 100 um				Volume Fraction (%)	Diameter in (um)
	Wavelength (um)					
	0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	70	0.005
Hematite	0%	0%	0%	0%	0.1	0.05
Silicon	0-92%	92-100%	100%	100%	0.1	0.05
Gadolinium	0-1%	1-18%	18-25%	25-30%	0.1	
Titanium Nitride	0-3%	0-29%	29-35%	35-39%	0.1	0.005

Source:

V. Conclusion

In general the main advantages of nanofluid optical filter are (a) it is suitable for selecting wavelengths in the ultraviolet, visible and infrared regions[(b) a single filter can be used for a range of central wavelengths, where …..

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