Characterization and Preparation of Zinc Oxide (Zno) Nano Fluids for Solar Thermal Applications

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Abstract -- This work is attempted to prepare nano fluids for solar thermal Application like Solar Still, Solar Water Heater etc. For that Zinc Oxide (Zno) Nano fluids with different weight concentration level have been tested for zeta potential, particle size of dispersion by using Horiba Zeta Sizer and Absorbency by using UV- vis-Spectrophotometer. Thermal conductivity of the prepared Nano fluids have been calculated using KD2 Thermal property Analyzer and compared the thermal conductivity of the various concentrations of nano fluids.

Indexed Terms: Solar thermal, Nano fluids, Stability, thermal conductivity

I. INTRODUCTION

Nano fluids are a new class of fluids engineered by dispersing nanometer-sized materials (nanoparticles, nanofibers, nanotubes, nanowires, nanorods, nanosheet, or droplets) in base fluids. In other words, nanofluids are nanoscale colloidal suspensions containing condensed nanomaterials. They are two-phase systems with one phase (solid phase) in another (liquid phase). Nanofluids have been found to possess enhanced thermo physical properties such as thermal conductivity, thermal diffusivity, viscosity, and convective heat transfer coefficients compared to those of base fluids like oil or water. It has demonstrated great potential applications in many fields. For a two-phase system, there are some important issues we have to face. One of the most important issues is the stability of nanofluids, and it remains a big challenge to achieve desired stability of nanofluids. In this paper, we will review the new progress in the methods for preparing stable nanofluids and summarize the stability mechanisms. In recent years, nanofluids have attracted more and more attention. The main driving force for nanofluids research lies in a wide range of applications. Although some review articles involving the progress of nanofluid investigation were published in the past several years [1–6], most of the reviews are concerned of the experimental and theoretical studies of the thermo physical properties or the convective heat transfer of nanofluids. The purpose of this paper will focus on the new preparation methods and stability mechanisms, especially the new application trends for nanofluids in addition to the heat transfer properties of nanofluids. We will try to find some challenging issues that need to be solved for future research based on the review on these aspects of nanofluids.

II. CHARACTERIZATION OF NANOFLUIDS

A. PREPARATION OF NANOFLUIDS:

Preparation of nanofluids is the key step in the use of nanoparticles to improve the thermal conductivity of fluids. Generally, nanoparticles are hydrophobic in nature, prone to agglomerate together and settled quickly. To maintain a stable and even suspension surfactants such as sodium dodecyl benzene sulphonate (SDBS) is used. fig.1 [8]. At first 0.1g of SDBS is dissolved in 50 ml water in two beakers separately in that calculated amount of Zno nanoparticles (fig.2) is added for 0.05% and 0.1% concentrations. The prepared samples were stirred by using Magnetic Stirrer shown in figure.3 for 15 Minutes and ultrasonicated for 1 hours using Ultrasonicated shown in figure.4. Then the pH value of solution is maintained as 8 by adding HCL and NaOH to get maximum thermal conductivity. [9]. the pH value of Nanofluids after preparation is tabulated in table.1.

The amount of Nanoparticles to be added is calculated by the formula

Amount of nano particle in gms = concentration (%) /100 x water sample taken x density of the nano particle.

Fig. 1: SDBS

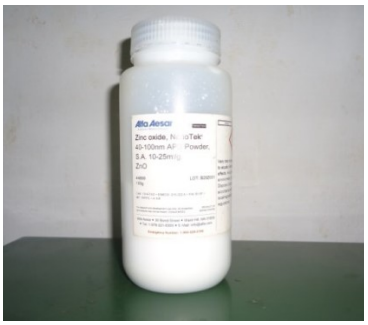

Fig. 2: Zno Nanoparticles 100grams

Nano material	Density (g/cm^3)	Amount of nanoparticles added with 50ml of water (gms)		pH Adjustment
		0.05%	0.1%	
Zno	5.61	0.14025	0.2805	8

Table 1: Nanofluids Sample Preparation details

Nanomaterial	pH	
	0.05 %	0.1%
ZINC OXIDE (Zno	7.42	8.32

Table 2: pH Value of Nanofluids Sample after preparation

The pH value of the of the prepared Nano fluids sample were measured. The pH value of the Zinc

Concentration (%)	Zeta potential(mV)	Best concentration
0.05	60.2	0.1%
0.1	152.4	

Table 3: Stability results

Oxide for 0.1% of concentration is 5 and for 0.1% of concentration are 6. It is adjusted to 8 to get good thermal conductivity.

B. STABILTY EVALUATION METHODS:

The prepared Nano fluids are then evaluated for stability to choose the good concentration which gives better stability.

C. ZETA POTENTIAL AND PARTICLE SIZE ANALYSIS

The zeta potential and particle size of the dispersion in the nanofluids is measured by using Horiba zeta Analyzer. The results of the Nano fluids are shown table 3. The figure 3 and Figure 4 shows zeta potential results for 0.1% and 0.05% concentration respectively.

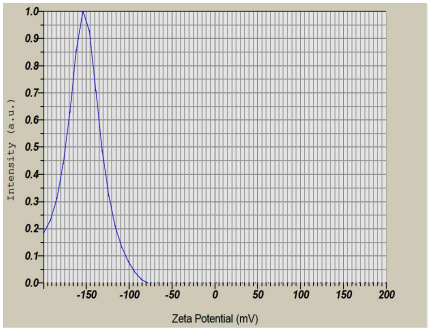

Fig. 3: Zeta Potential Zno (0.1%)

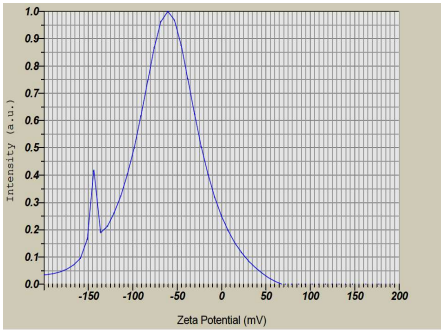

Fig. 4: Zeta Potential Zno (0.05%)

D. UV-VIS-SPECTROPHOTOMETER:

Then the prepared Nano fluids have been tested for Absorbency by using UV-vis-spectrophotometer. The fig.5 and fig.6 shows result obtained from uv- vis-spectrophotometer for 0.05% and 0.1 % concentration levels. The result shows 0.1% of Zno has good Absorbency level compared to 0.05% of concentration.

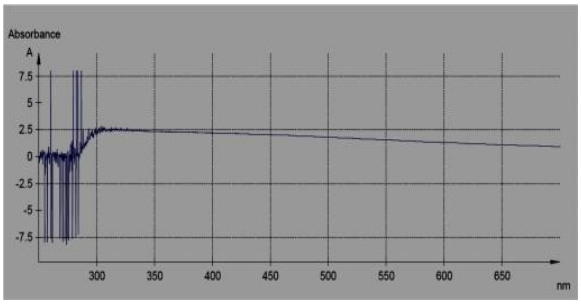

Fig. 5: Zno (0.05%)

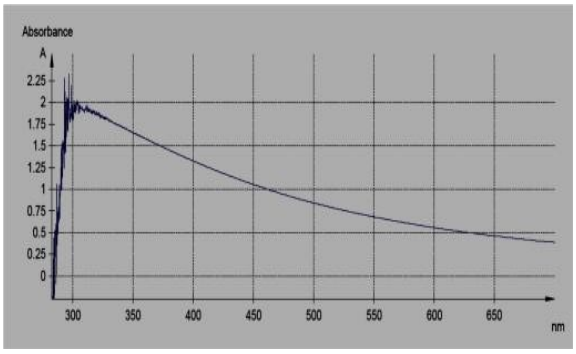

Fig. 6: Zno (0.1%)

E. PHOTOGRAPHIC METHOD:

In final stage the stability is evaluated by photographic method. The figure 5 and 6 shows photographs of nano fluid samples after 2hours and seven days of preparation respectively. After seven days there is some visible sedimentation in the bottom of the carrying bottle.

Fig. 7: After two hours (Zno (0.05%) Zno (0.1%))

Fig. 8: Zno After three days (Zno (0.05%) Zno (0.1%))

III. THERMAL CONDUCTIVITY RESULTS

After tested Zeta Potential and Particle size it shows good concentration of Nano fluids to be tested with the Nano fluids. The 0.1% concentration of Nano fluids is tested for Thermal conductivity by using KD2 Thermal property Analyzer. The Results are tabulated in table 4.

Nanofluids	Concentration	Thermal Conductivity W/m.K	Percentage of increment
Zno	0.1%	0.625	4.16
	0.05%	0.615	2.5

Table 4: thermal conductivity results

IV. RESULTS

The Thermal conductivity of the Zno has been calculated and it is concluded that the 0.1% concentration is very much suitable for solar thermal Applications. Hence in this work Characterization of Nano fluids have been done. In future we can directly use of Nano fluids in solar thermal Applications without any characterization work.

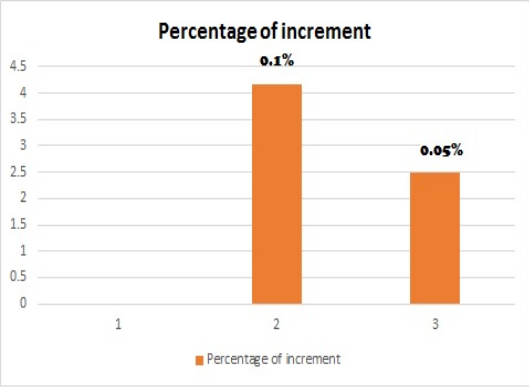

Fig. 9: Percentage of Increment

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