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Synthesis and Investigations of Thermo-Mechanical Properties of TiO_2-Water Based Nanofluids.

Mohammed Asim Siddiqui[1*]; Ali Mohammed Said AL Maqbali[2]; Harith Salim Shamis ALfarsi[3]; Mulhim Ibrahim Darwish AL haj safar AL zadjal[4]; Niyaz ahmad[5]; Mushtaq Hussain[6].
[1-6]Engineering department, College of Science and Technology, University of Technology and Applied Sciences, Shinas, Oman

Abstract : Nanofluids are widely used in recent years to enhance heat transfer in several mediums. It has been investigated that thermal performance of the TiO_2 nanofluid is increased. In this study, it is aimed to synthesize TiO_2-Water based nanofluids with different volume fractions (0.01%, 0.02%, 0.03%, 0.04%, 0.05%). Properties like density and viscosity of prepared samples are studied and found to be enhance their thermal performance may be effective for various heat transfer applications.

Index Terms **Nano fluids; Viscosity, Density**

I. Introduction

In many engineering applications, including power generation, electronics, air conditioning, heating, and cooling processes, among others, conventional thermal fluids like water, oil, and ethylene/propylene glycol are essential. However, these fluids' thermal characteristics are inferior to those of solids. Extensive research has been conducted on new technologies that have more potential to improve the thermo-physical properties (density, viscosity, thermal conductivity etc.) of traditional fluids. Numerous research groups across nearly all industries have become more interested in nanomaterials due to their remarkable features. Nanofluids, a type of fluid in which particles smaller than 100 nanometers are suspended in a liquid, have gained attention as a possible option for heat transfer fluid design. In comparison to normal fluids, nanofluids exhibit greater long-term stability, less pressure dips, and perhaps higher thermal conductivity [1-2]. These features of nano fluids lead to find extensive applications such as coolants in automobile transmission, electronic cooling, medical applications, antibacterial activity, drilling fluids, solar water heating, nuclear reactor, radiator etc. [3-6].

II. Experimental Details

Keeping in mind various applications of nanofluids are synthesized in present work. Since Nanofluids do not occur in nature. So, these fluids need to be synthesized in laboratories using various manufacturing methods and techniques. Stable and highly conductive nanofluids are produced by two-step methods. In the present work TiO_2 nano particles (Rutile Nano powder of average size: 50 nm of bulk density 400 kg/m^3) are weighted with different volume fractions (0.01%, 0.02%, 0.03%, 0.04%, 0.05%) and by using magnetic stirrer (approximately 1.5 hours), TiO_2 nano powders are poured slowly into distilled water having pH ~ 8. To achieve the stability, prepared nanofluid are sonicated using ultrasonication water bath for 1 hour and their stability is evaluated after the sonication process. To stabilize these nanofluids for longer period, surfactant (Polyethylene glycol polymer weighted equal to 1/10th of the nanoparticle is added). Eventually thermo-mechanical properties like density and viscosity (using viscometer) are investigated for the prepared nano fluids.

III. Thermophysical Properties of Nanofluids

Thermo-mechanical properties of TiO_2-H_2O nanofluids as reported in the present paper include the density and viscosity.

Density measurement

The values of densities of TiO_2-H_2O nanofluid for different volume concentrations are calculated using equation 1 and tabulated as follows. As the volume fraction $\emptyset$ is changed, there are variations in the values of density for different concentrations of nanofluids samples. The measured density values finally compared with existing model given by Pak and Cho represented as in equation 2. [7].

$$\rho_{nf} = \frac{m_t - m_{ef}}{V_{nf}} \quad \ldots\ldots (1)$$

$$\rho_{nf} = (1 - \emptyset)\rho_{bf} + \emptyset\, \rho_p \quad \ldots\ldots (2)$$

Table 1: Variation of density with volume concentration.

S. No.	Volume concentration (ϕ)	Density value in present work (in kg/m^3)	As per Pak and Cho model (in kg/m^3)
1	0.0	1034	1034
2	0.01	1080	1068
3	0.02	1098	1103
4	0.03	1160	1137
5	0.04	1197	1172
6	0.05	1280	1207

Viscosity Measurement

Viscosity of the synthesized nanofluids were measured at room temperature 295 K using Ostwald viscometer. The viscosity measurement was made for all the samples including pure distilled water. Maximum rise in the viscosity of nanofluid was observed for higher concentration of nano particle. Variation in viscosity with different volume concentration is observed and tabulated as follows in the table 2. The viscosity values finally compared with the Brinkman model given as in equation 3.[8]

$$\frac{\mu_{nf}}{\mu_{bf}} = (1 + 2.5\,\emptyset) \quad (3)$$

Table 2: Variation of viscosity with volume concentration

S. No.	Volume concentration (ϕ)	Viscosity values of present work (in centi-poise)	As per Brinkman model (in centi-poise)
1	0.0	0.978	0.978
2	0.02	1.075	1.002
3	0.02	1.176	1.026
4	0.03	1.303	1.051
5	0.04	1.432	1.075
6	0.05	1.617	1.100

IV. Results and Discussion

The experimental density data is found to be in good agreement with the values found by Pak & Cho with a deviation of ~ 10%. However, deviation is little higher for higher concentration. The obtained viscosity values were compared with the predicted values through Brinkman model and found to agree (with a deviation of ~ 10%.) for lower concentration, although for higher concentration viscosity values are higher in the present studies. So, we can say from the present study the viscosity of nanofluids is significantly higher than the viscosity of conventional fluids. This conclusion is confirmed by various experiments and molecular dynamics simulation. These significant properties leads to use these nanofluids in various mechanical engineering related applications.

V. References

[1] Wei X, Zhu H, Kong T, Wang L. Synthesis and thermal conductivity of Cu2O nanofluids. Int J Heat Mass Transf 2009;52(19):4371–4.

[2] Yu W, Xie H, Chen L, Li Y. Enhancement of thermal conductivity of kerosene based Fe3O4 nanofluids prepared via phase-transfer method. Colloids Surf A: Physicochem Eng Asp 2010;355(1):109–13.

[3] Leong KY, Saidur R, Kazi SN, Mamun AH. Performance investigation of an automotive car radiator operated with nanofluid-based coolants (nanofluid as a coolant in a radiator). Appl Therm Eng 2010;30(17):2685–92.

[4] Yu W, France DM, Choi SU, Routbort JL. Review and assessment of nanofluid technology for transportation and other applications (No. ANL/ESD/07-9). Argonne National Laboratory (ANL); 2007.

[5] Zhang L, Ding Y, Povey M, York D. ZnO nanofluids – A potential antibacterial agent. Prog Nat Sci 2008;18(8):939–44.

[6] Hirota K, Sugimoto M, Kato M, Tsukagoshi K, Tanigawa T, Sugimoto H. Preparation of zinc oxide ceramics with a sustainable antibacterial activity under dark conditions. Ceram Int 2010;36(2):497–506.

[7] B. C. Pak and Y. I. Cho, Exp. Heat Transf. 11, 151 (1998).

[8] H. C. Brinkman, The viscosity of concentrated suspensions and solution, Journal of Chemical Physics, 20 (1952) 571-581.