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Measurement of Density and Specific Heat Capacity of Different Nanofluids

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Abstract: In study paper shows measurement of density and specific heat capacity of different nanofluids. a temperature range of 30°Cto50 °C for a few molecule volume concentrations are displayed. The particular heat estimations of three nanofluids containing alumi-num oxide, zinc oxide, and silicon dioxide nanoparticles. The work has been done at various temperature range313K to 353K (30 to 80°C) with differing distinctive volume concentration (1%,2%3%,4%). Which is the typical scope of operation of car coolants and building heating fluids. The measured qualities are contrasted and existing conditions for the particular heat of Nanofluids. In this manner, again broad connection was produced for the particular heat as elements of particle volumetric, temperature, and the particular heat of both the molecule and the base liquid from the present arrangement of estimations. The effect of nanoparticle connection was tried for both CUO also, Al2O3, ZNO in eutectic blend of sodium and potassium nitrate. Results demonstrated an improvement in particular heat limit (CP) for both kinds of nanoparticles.

Keywords: Volume Concentration, Mixture Modal, Density, Temperature, Specific Heat and Heat Transfer.

I. INTRODUCTION

Nano-fluids help in saving heat energy and heat exchanger material. The essential parameters which impact the heat exchange attributes of nano-fluids are its properties which incorporate heat conductivity, thickness, particular heat and thickness. The thermo physical properties (density, specific heat capacity) of nano-fluids additionally rely on upon working temperature of nano -fluids. Nanofluids are another class of heat exchange liquids containing irregular of nanometer-sized particles under 100 nm in routine liquids. They have increased critical significance in the past decade because of their upgraded heat exchange abilities.

II. THEORY

Thermo physical properties of nano fluids are pre necessities for estimation of heat exchange coefficient and the Nusselt number. Lee et al (1998), Das [7] et al. (2000), Xuan [1] and Roetzel (2003) and Choi [2] et al. (2003) have investigated on properties of nano fluids containing metals and metal oxides nanoparticles . They have studied the parameters which influence nano fluid properties. Heat transfers are used in much industrial area. Natural Convective Heat Transfer by Nano Fluids is nothing but exchange of thermal energy and heat between the physical systems by nano fluids. Convective heat transfer is the transfer of heat by movement of fluids. Nano fluids, a name conceived by Dr. Choi [2], in Argonne National Laboratory, to describe a fluid consisting of solid nano particles with size less than 100nm suspended on it with solid volume fractions typically less than 4%. A sample of known mass is heated or cooled and the changes in its heat capacity are tracked as changes in the heat flow Harryet al. [8].

To improve the heat transfer rate of base fluid by adding nano particles. To determine the heat transfer coefficient of natural convection of nanofluids in a tube. Water/oil has been chosen as base fluid. By varying volume concentration of nanofluids, various specific heat and thermal conductivity rate can be obtained.

Volume Concentration:
Nanofluids technology becomes a new challenge for the heat transfer fluid since it has been reported by Tavman et al. [3] that the thermal conductivity of nanofluids is anomalously enhanced at a very low volume concentration. The amount of nanoparticles required for preparation of nanofluids is calculated using the law of mixture formula. The volume concentration for nanofluids is calculated by (Φ)[2]

$$\frac{Wnp / \rho np}{Wnp/\rho + wbf/\rho bf}$$

III. NANOFLUID PREPARATION USING NANOPARTICLES

There are three different steps for synthesis methods.

1. **By mixing of nano powder directly in base fluid:** In this method, the nanoparticles are specifically blended in the base fluid and completely mixed. Nanofluids arranged in this technique give poor suspension steadiness, on the grounds that the nanoparticles settle down because of gravity, following a couple of minutes of nanofluid arrangement. The molecule settlement relies on upon the sort of nanoparticles utilized, thickness and consistency properties of the host liquids.

2. **By acid treatment of base fluid:** The PH estimation of the base liquid can be brought down by including a appropriate corrosive to it. A stable Nanofluid with uniform molecule scattering can be set up by blending nanoparticles in a corrosive treated base liquid. Be that as it may, corrosive treated nanofluids may bring about erosion on the channel divider material with delayed utilization of nanofluids by acid treatment of base fluid. By adding surfactants (surface active agent) to the base fluid.

3. **By adding surfactants (surface active agent) to the base fluid**: In this method a small amount of suitable surfactant, generally 1/10 of mass of nano powder is added to base fluid. Some surfactants are ethylene oxide, soap, natural oil, etc. It gives stable suspension with uniform particle dispersion Suspension state for long time without settling down can obtain. Nanofluids of five different volume concentrations in range of 1%, 2%, 3%, and 4% are prepared for measuring the temperature dependent thermal conductivity and viscosity of all the nanofluids concentration considered in the present work. Normally agglomeration of nanoparticles takes place when nanoparticles are suspended in the base fluid. All the test samples of nanofluids used subsequently for estimation of their properties were subjected to magnetic stirring process followed by ultrasonic vibration for about five hours. The photographic view of nanofluid sonication process using a Ultrasonic Cleaner is shown in the below.


Ultrasonic Cleaner apparatues for sonication process

IV. DETERMINATION OF NANOFLUID PROPERTIES

The most critical properties required for estimation of convective heat exchange coefficient of nanofluids are its thermal conductivity, density, and specific heat. The thermo properties properties of different nanofluids are evaluated tentatively for every one of the focuses and the outcomes acquired in the trials are compared and the hypothetical conditions which anticipate

Nanofluid properties. But here only measurement and heat change of specific heat (Cp) and density only discussed.

Density of Nanofluids:

The base fluids comprises of water-Propylene glycol mix. The thickness of nanofluids for all the volume concentration under scrutiny are measured by utilizing Hygrometer and the density information acquired is contrasted and the qualities got utilizing the thickness connection condition created by Pak and Choi [1998] [2] for nanofluids. The density data for water- propylene glycol (70:30 by volume percent) blend as a function of temperature is taken from ASHRAE (2009)[4] Hand Book. In this journal Direct mixing modal is used.

Data processing:

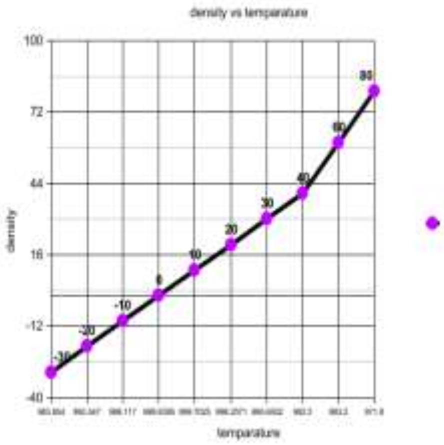
The nanofluid presented equations are calculated by using of the Pak and Cho which are defined as follows:
Equation

$$\rho_{nf}=(1-\emptyset)\rho_{bf}+\emptyset\rho_{pf}$$

Basic fluid of density is given below.

Graph between temparature and density

Density of liquid water at 1 atm pressure	
Temp. (°C)[note 1]	Density (kg/m³)
−30	983.854
−20	993.547
−10	998.117
0	999.8395
4	999.9720
10	999.7026
15	999.1026
20	998.2071
22	997.7735
25	997.0479
30	995.6502
40	992.2
60	983.2
80	971.8
100	958.4
1.Notes:Jump up^ Values below 0 °C refer to supercooled water.	



Specific Heat of Nanofluids:

The specific heat is one of the important properties and plays an important role in influencing heat transfer rate of nanofluids. Specific heat is the amount of heat required to raise the temperature of one gram of nanofluids by one degree centigrade. Specific heat is varies to change the heat transfer with different temperature's .For a given volume concentration of nanoparticles in the base liquid. Heat transfer rate can be defined as equation

$$Q=\dot{m}Cp\Delta T$$

Where Q is the heat transfer rate, $\dot{m}$ is the mass flow rate and ΔT is the temperature difference of the cooling liquid.

The specific heat is calculated from Xuan and Roetzel as following:
Equation,

$$(\rho Cp)_{nf}=(1-\emptyset)(\rho Cp)_{f}+\emptyset(\rho Cp)_{p}$$

Where
Cpnf is the heat capacity of the nanofluid, *Cpf* is the heat capacity of the base fluid and *Cpp* is the heat capacity of the nanoparticles.

If the specific heat capacity is effect on heat transfer. It is used as several types and some of the applications are given below.
The advanced concepts of nanofluids offer fascinating heat transfer characteristics compared to conventional heat transfer fluids. There are considerable researches on the superior heat transfer properties of nanofluids especially on thermal conductivity and convective heat transfer. Applications of nanofluids in industries such as heat exchanging devices appear promising with these characteristics. Kostic reported that nanofluids can be used in following specific areas heat transfer nanofluids. Surfactant and

coating nanofluids. Chemical nanofluids. Process/extraction nanofluids. Environmental (pollution cleaning) nanofluids. Bio- and pharmaceutical nanofluids. Medical nanofluids (drug delivery and functional tissue–cell interaction).

V. RESULTS AND DISCUSSIONS

Volume concentration:

Given below table give the results for 3 different nanofluids. They are:

SI. NO	Volume concentration	Weight of CuO Grams {for 100 ml}	Weight of Al2O3 Grams {for 100 ml}	Weight of ZnO Grams {for 100 ml}
1	1%	6.087	10.195	8.1408
2	2%	12.174	20.390	16.281
3	3%	18.261	30.585	24.422
4	4%	24.348	40.780	32.563

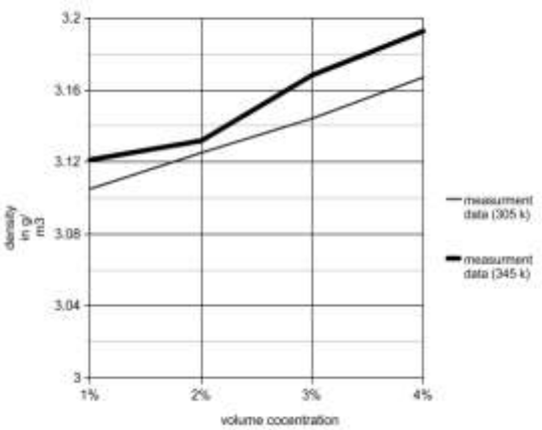
Lee et al (1998), Das[7] et al. (2000), Xuan[1] and Roetzel (2003), and Choi[2] et al. (2003) base fluid is calculated by using the following relation.

$$\%\ \text{volume concentration} = \frac{\left[\dfrac{W_{CuO}}{\rho_{CuO}}\right]}{\left[\dfrac{W_{CuO}}{\rho_{CuO}} + \dfrac{W_{bf}}{\rho_{bf}}\right]}$$

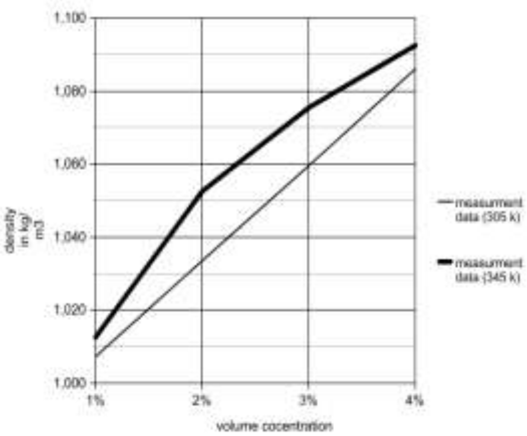
The volume concentration was measured by several methods but here using follow chemists. But in this, The Das[9] et al. (2000), Xuan[1] and Roetzel (2003), and Choi[8] et al. (2003) realation is used for calculations.

Density of Nano fluids:

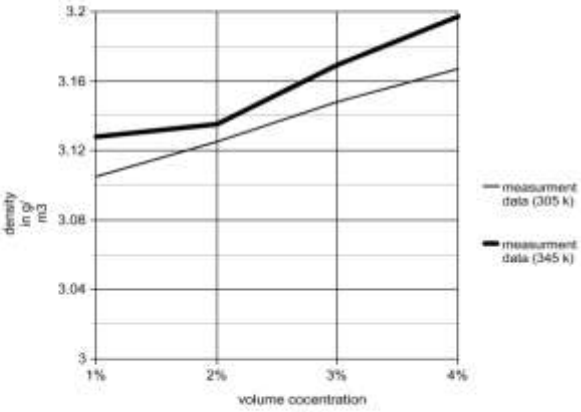
Density of Nanofluids was measured by several methods. But in this, by using mixture modal density was calculated. It shows the effect of temperature and nanoparticles concentration on the density of base fluid. If measurement of the impact of the both concentration of and temperature on thermo physical properties is fascinating for designing applications. For these reasons, the variety of nanofluid density with focus and temperature has been researched in this study. Weight drop and pumping power fundamentally rely on upon the thickness and consistency of any liquid. Along these lines, the impact of these parameters ought to be researched. . Hence, density of various nanofluids can determined by graphically and table given below.



a.CuO



b.Al2O3

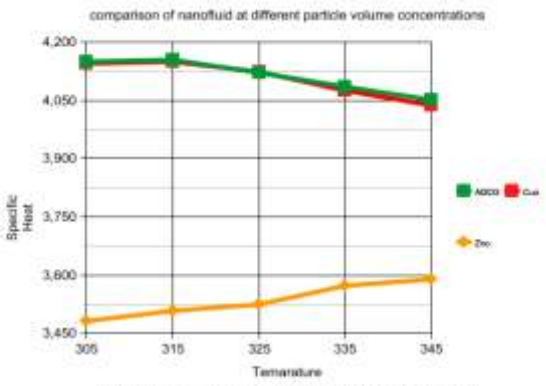


c.ZnO

The density is effect on the specific heat. If the density is increses with incresing volume concentraion. Effect of temperature and nanoparticles concentration on the density of base fluid. Here a. CuO; b. Al2O3; c. ZnO. And which is effect on specific heat capacity and heat transfer.

VI. SPECIFIC HEAT OF NANOFLUIDS

The specific heat is one of the important properties and plays an important role in influencing heat transfer rate of nanofluids. Specific heat is the amount of heat required to raise the temperature of one gram of nanofluids by one degree centigrade. For a given volume concentration of nanoparticles in the base fluid. The experiment results were led for nanoparticles suspended in two diverse base liquids. The aluminum oxide Al2O3 and zinc oxide ZnO nanoparticles were suspended in a base liquid of , and the CuO no particles were suspended in water. Not very many trial studies are accessible in the writing on the estimations of particular heat of nanofluids. Zhou and Ni 4[5] exhibited the estimations of the particular heat of water-based Al2O3 nanofluid as a component of focus at one temperature, 33°C. In any case, their analyses are restricted to one and only nanofluid in one sort of base liquid, and no relationship has been determined. Namburu et al. 5 introduced particular heat estimations of cuo in the base liquid. Their information is likewise restricted to one nanofluid, demonstrating a plot of particular warmth as a capacity of volumetric concentration at a different temperature. Subsequently, so as to dissect the particular heat information of nanofluids all the more widely, extensive estimations of three distinctive nanofluids were completed. Das [7] presented a complete set of polynomials and the resulting correlation for the nanofluid in the form *Cpnf ,T*. The specimens of Al2O3, ZnO, and CuO nanofluids tried had normal molecule sizes of100nm. In making nanofluids, producers use the surfactants to settle the scattering of nanoparticles, which will influence the particular heat of the nanofluid. The trials of Hong and Marquis 7 demonstrate that a surfactant of 1% by weight yielded a decent scattering quality, the impact on the particular heat may not be significant. Be that as it may, this is a critical range to explore by leading estimations with various surfactants with different weight rates. For specific heat capacity of nano fluids are given below in graphically.



Variation in the specific heat of nanofluids of different volumetric concentrations with temperature

Al2O3 Nanofluid:

Al2O3 Nanofluid Subsequent to checking the precision of the estimation system by looking at the deliberate particular heat estimations of the base liquid, far reaching estimations of particular heat were directed for the Al2O3 nanofluid, with molecule volumetric groupings of1% 2%,3%, 4% . It is watched that the particular heat of this nanofluid diminishes with an expansion in the volume concentration. for this measurment we find that if the temparature incresess specific heatcapacity is decresess.

CuO Nanofluid:

CuO Nanofluid displays the measured specific heat values of the SiO2 nanofluid varying in particle volume concentration from 1% to 4%. In order to include the effect of a different base fluid on the specific heat of a nanofluid, this experiment was conducted with water as the base fluid. The results in show that the specific heat of this nanofluid decreases graphically with increase in temperature. However, the specific heat decreases with an increase in particle volume concentration.

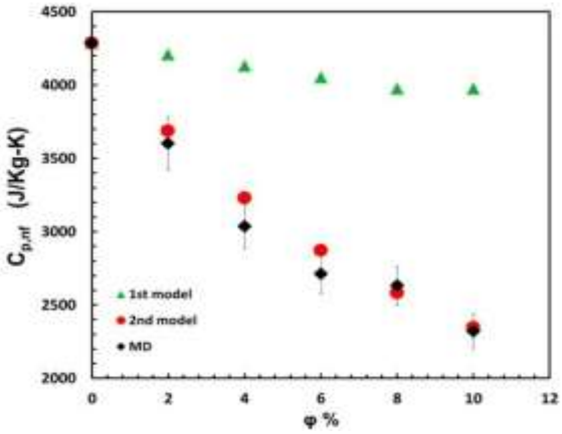
ZnO Nanofluid:

ZnO Nanofluid presents the experimental valuesof the specific heat of the ZnO nanofluid. The specific heat results shows for ZnO an increasein the specific heat with an increase in temperature and decrease in the specific heat with an increase in particle volume concentration.

For CuO and Al2O3 of Nanofluids Specific heat capacity decreases with icreases in Temparature.Where as in ZnO nanofluids Specific heat capacity is increases.Which is effect on Heat transfer. Probably the distinctive technique in the type of nanoparticles and size and generation procedure of the nanoparticle itself would represent these varying results got.

VII. IMPLICATIONS FOR FURTHER RESEARCH

Furthers research into other materials such as plastics and various metal alloys that were not included in this testing will be needed to narrow the temperature range specific to those materials but according to our findings the temperature curve will follow the thermal conductivity profiles of common materials. A more focused study into identifying a precise amount of relative humidity may result in increased sensitivity but our statistics show that a range of 46% to 72% relative humidity is safe and conducive to cyanoacrylate polymerization on latent fingerprints. Specific heat capacity for water-Cu nanofluid .After validating our method, the MD simulation results of the specific heat of nanofluid are presented here. Moreover, the obtained results by MD are compared with the mentioned theoretical models. The nanofluids with 2%, 4%, 6%, 8%, and 10% volume fractions are considered in the MD simulations. In all cases, the diameters of Cu nanoparticles are set to 2 nm. It should be noted that the Cu nanoparticles have not tethered to its initial position and can freely have its Brownian motions in our simulation. In this paper, the particular heat limits of the Cu-water nanofluids with various volume divisions were resolved utilizing modal recreation. the results were accepted with test information for the particular heat of unadulterated water and immaculate copper. The particular heat of nano fluid was found to diminish with the expansion in the volume division of copper nanoparticles. It was additionally watched that the modal results are in great concurrence with the heat balance model for foreseeing the particular heat of nanofluids, and the other model in light of the blending hypothesis for perfect gas blends neglected to anticipate the particular heat of nanofluids.



CONCLUSION

All through this study, it could be estimate that volume concentration,temperature,and added substances.which effecton specific heat of thermal impacts of nanofluids. The outcomes demonstrate that specific heat of nanofluids increases with the expansion of nanoparticle focus. No current model or relationship is fit for exact estimate thespecific heat upgrade or derogation with deference to volume parts. As far as temperature impact, analysts concur that surface strain of nanofluids reductions with the expansion of temperature.By using the PbO also we get the specific heat capacity.

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