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ADVANCED HEAT TRANSFER ENHANCEMENT USING Tio_2 WATER BASED NANO FLUIDS

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Abstract- Nanofluids are quasi single phase medium containing stable colloidal dispersion of ultrafine or nanometric metallic or ceramic particles in a given fluid. Nanofluids possess immense potential of application to improve heat transfer and energy efficiency in several areas including vehicular cooling in transportation, power generation, defense, nuclear, space, microelectronics and biomedical devices. In the present contribution, a brief description about the Nano Tio_2 has been presented to provide an update on the historical evolution of this concept, possible synthesis routes, level of improvements are reported. According to this review, the future developments of these technologies are discussed.

***Key words**: NanoFluids, Nano Tio_2, Heat transfer enhancement, synthesis Routes.*

1. INTRODUCTION

Nanofluids are a new class of fluids engineered by dispersing nanometer-sized materials **(**nanoparticles, nanofibers, nanotubes, nanowires, nanorods, nanosheet, or droplets**)** in base fluids. Common base fluids include water, organic liquids (e.g. ethylene, tri-ethylene-glycols, refrigerants, etc.), oils and lubricants, bio-fluids, polymeric solutions and other common liquids. Materials commonly used as nanoparticles include chemically stable metals (e.g. gold, copper), metal oxides (e.g., alumina, silica, zirconia, titania), oxide ceramics (e.g. Al_2O_3, CuO), metal carbides (e.g. SiC), carbon in various forms (e.g., diamond, graphite, carbon nanotubes, fullerene) and functionalized nanoparticles. In view of the synthetic methods developed for the preparation of nanostructure TiO_2, a wide variety of approaches including flame synthesis, ultrasonic irradiation, chemical vapor deposition, sol–gel Method. Among them, Compared to other methods, sol-gel route is regarded as a good method to synthesis ultra-fine metallic oxide and has been widely employed for preparing titanium dioxide (TiO2) particles. In this paper, the recent trends on nanofluid heat transfer technologies are comprehensively reviewed. Thermal conductivities of various solids and liquids are listed in table 1. Through this review, the future technology development and research requirements have been identified.

Table:1 Thermal conductivities of various solids and liquids

	Material	**Thermal conductivity (W/mK)**
Carbon	Nanotubes	1800-6600
	Diamond	2300
	Graphite	110-190
	Fullerenes film	0.4
Metallic solids (pure)	Copper	401
	Aluminum	237
Nonmetallic solids	Silicon	148
	Alumina (Al_2O_3)	40
Metallic liquids	Sodium (644 K)	72.3
Nonmetallic liquids	Water	0.613
	Ethylene glycol (EG)	0.253
	Engine oil (EO)	0.145

2. EXPERIMENTAL STUDY

2.1 SYNTHESIS AND PREPARATION METHODS FOR NANOFLUIDS

The Preparation of nanofluids is the first key step in experimental studies with nanofluids. In the synthesis, there are mainly two techniques used to produce nanofluids: the single-step and the two-step techniques.

2.1.1 SINGLE STEP TECHNIQUE

The single step simultaneously makes and disperses the nanoparticles directly into a base fluid; best for metallic nanofluids. The problem of agglomeration can be reduced to a good extent by using a direct evaporation condensation method.

2.1.2 TWO STEP TECHNIQUE

Two-step method is the most widely used method for preparing nanofluids. Nanoparticles, nanofibers, nanotubes, and nanomaterials. In this method, first produced as dry powders by using chemical or physical methods. We used sol gel technique for preparation of nano Tio_2 powders. The obtained nanosized powder will be dispersed into a base fluid (Water) in the second processing step with the help of intensive magnetic force agitation.

2.2 NANO Tio_2 PREPARATION BY USING SOL GEL TECHNIQUE

TiO_2 nanopowders were prepared via sol–gel method using titanium (IV) isopropoxide (Sigma Aldrich 97%), distilled water, ethyl alcohol (EtOH, Merck) as the starting materials. Titanium tetra isopropoxide was dropped slowly into the solution of water and ethanol while magnetic agitating continuously to get white slurry solution. The obtained solutions were kept under slow-speed constant stirring on a magnetic stirrer for 5 h at room temperature.

3. RESULT AND DISCUSSION

The morphology of calcinated titania powders at 400ºC observed by SEM is shown. Significant differences are observed when comparing the microphotographs (Fig1.a–d). As shown in Figure 1, at mole ratio of TTIP(1): EtOH(15): H_2O(60), the size of titania particles was about 50nm and non hard-grained aggregates that are constituted of sharp faceted nanoscaled crystals were formed. However, when the mole ratio was changed to TTIP(1): EtOH(15): H2O(90)and TTIP(1): EtOH(15): H2O(120), the size increased to about 35- 40 nm(Fig. b and c) also, the morphology was changed to non hard-grained aggregates that are constituted of nearly spherical nanoscaled particles. SEM micrograph of titania prepared at the mole ratio of TTIP(1): EtOH(15): H2O(60) is shown in Fig.1d. The sizes of particles were larger to about 50 nm and the morphology is changed to hard-grained aggregates and nearly spherical nanoparticles.

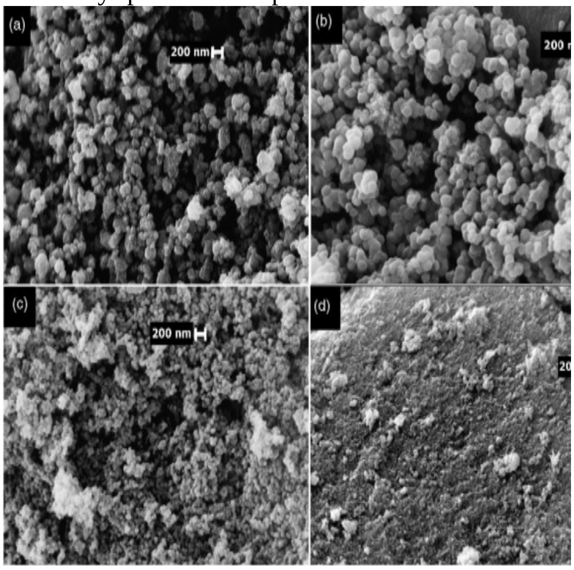

Fig.1 SEM images of surface morphology of calcinated titania powder at 400 ºC at different mole ratio of starting materials (TTIP:EtOH:H_2O): (a) 1:15:60, (b) 1:15:90(c) 1:15:120 and (d) 1:15:60

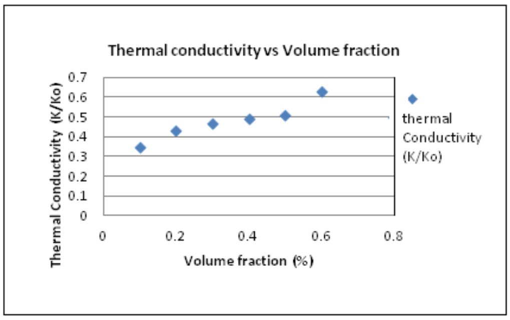

Fig 2. Thermal conductivity of TiO2 nanofluids for different concentrations of nanoparticles

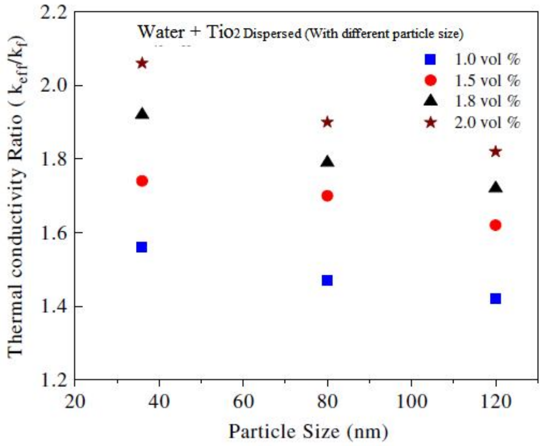

Fig 3. Variation of thermal conductivity as a function of nano particle size

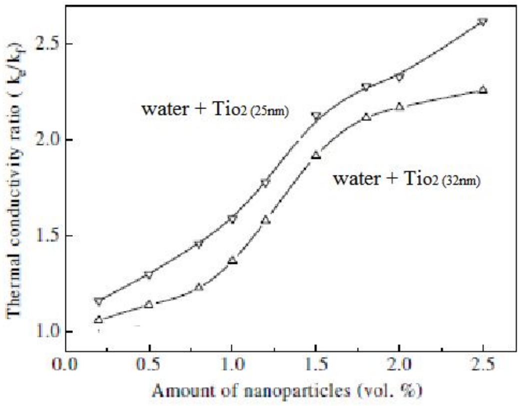

Fig 4. Variation of thermal conductivity as a function of volume percentage

We understand that the significant enhancement of TiO2 nanofluids is obtained due to the thorough dispersion of nanoparticles.The thermal conductivity increases nonlinearly as the volume fraction of nanoparticles increases. Thermal conductivity was measured when the best dispersion of nanoparticles was obtained with our ultrasonic disrupter. However, nanoparticles were still clustering in the fluid, even when sonicated, and clustering occurs more easily in nanofluids containing a higher fraction of nanoparticles. Therefore, we particularly mention the volume-fraction-of nanoparticles dependence of thermal conductivity in accordance with Figures 2, 3 and 4, because thermal conductivity would show more enhancement if the nanoparticles formed fewer clusters and this could be more profound in nanofluids containing higher fraction of nanoparticles. It was Observed that nanofluids containing metallic nanoparticles exhibit more enhancement of thermal conductivity than nanofluids containing ceramic nanoparticles. Therefore, it was expected that nanofluids containing more highly thermally conductive materials would be more effective in improving the effective thermal conductivity of nanofluids. From this work, we understand that the suspension of highly thermally conductive materials is not always effective to improve the thermal transport properties of nanofluids.

4. CONCLUSION

Nanofluids, i.e., well-dispersed metallic nanoparticles at low volume fractions in liquids, enhance the mixture's thermal conductivity over the base-fluid values. Thus, they are potentially useful for advanced cooling of micro-systems. This paper presents the recent developments in the study of nanofluids, including the preparation methods, the evaluation methods for their stability, the ways to enhance their stability and their potential applications in heat transfer intensification, mass transfer enhancement, energy fields, mechanical fields and so for. In summary, Nano-TiO2 powders have been prepared by sol-gel method and found to be 25nm. The future scope in the nanofluid research cycle are to concentrated on heat transfer enhancements and determine its physical mechanisms, taking into consideration such items as the optimum particle size and shape, particle volume concentration, fluid additive, particle coating, and base fluid. Finally, it is pertinent to suggest that nanofluid research warrants a genuinely multidisciplinary approach with complementary efforts from material scientists (regarding synthesis and characterization), thermal engineers (for measuring thermal conductivity and heat transfer coefficient under various regimes and conditions), chemists (to study the agglomeration behavior and stability of the dispersoid and liquid) and physicists (modeling the mechanism and interpretation of results).

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