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Alternative Characterisation Techniques for Stability of Nanofluids

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Abstract: Nanofluids are colloidal engineered suspension of nanoparticles in a suitable base fluid. They have also been referred to as next generation heat transfer fluid. The success of nanofluid technology depends on stability of the nanofluid. Several researches have characterised the stability of nanofluid based on sedimentation test, zeta potential values, thermal conductivity, and viscosity. The nanoparticles were confirmed using powder XRD pattern and surface morphology were analysed by SEM study. An ideal nanofluid should have infinite stability and this refers to zero or negligible terminal velocity of the colloidal particle in the liquid medium. In the present work nanofluid stability has been characterised by alternative techniques like interfacial layer thickness and attenuation of transmitted laser intensity. The sedimentation time is compared with previous results in literature.
Key words: nanofluid, zeta potential, terminal velocity.

1. Introduction and Experimental:

Fluids with nanosized solid particles suspended in them have been given the name nanofluids. The term nanofluid was proposed by Choi in 1995 of the Argonne National Laboratory, U.S.A [1].They have also been proved as efficient heat transfer fluid [2]. The idea behind the development of nanofluid is to improve the heat transfer coefficient and to minimize the size of heat transfer equipment .Donzelli et al.[3] showed that a particular class of nanofluids can be used as a smart material working as a heat valve to control the flow of heat. The observed advantages of nanofluids over heat transfer fluids with micron sized particles include better stability, lower penalty on pressure drop along with reduced pipe wall abrasion and high thermal conductivity [4]. Stability has been reported as a challenging task due to strong vanderwaals interaction among nanoparticles [5]. Laura Fedele investigated the effect of different dispersion techniques and different surfactants on stability of nanofluids[6].Stability of nanofluids can depend on factors like nature of nanoparticles and base fluid and their combination. Minimum density difference and optimum nano size can lead to high stability. In addition, nanofluids stability is governed by nature of surfactant used, pH, viscocity, method of preparation of nanofluid, operating conditions such as pressure, temperature. Presently stability of nanofluids is measured by zeta potential. Measurement of zeta potential needs extreme dilutions and stringent sampling handling requirements. In the present work a alternative to zeta potential is explored to identify nanofluid stability. Nanofluid stability is characterised by two methods, interfacial thickness measurement and attenuation of transmitted intensity of laser light.

The two step method has been used for the preparation of TiO_2 nanofluids.TiO_2 nanoparticles were prepared as reported in [7,8]. 10 ml of Titanium tetraisopropoxide was slowly dropped into a solution of 100 ml water and ethanol during stirring with a magnetic stirrer to obtain a milky white slurry. The solution, which contains the white precipitate, was heated in the furnace for 400°C for two hours to obtain white nano particles of TiO_2. The prepared nanoparticle were dispersed in water by ultrasonicating at a frequency of 42 KHz for 10 minutes. Nanoparticles with volume fraction of 0.1 were prepared for investigation of stability. The nanofluids were stored in a measuring cylinder and the formation of interface between the nanofluid and base fluid was observed with time. Laser light from a semiconductor laser diode is passed through the TiO_2 nanofluid and the intensity of the laser is measured with a photo detector.

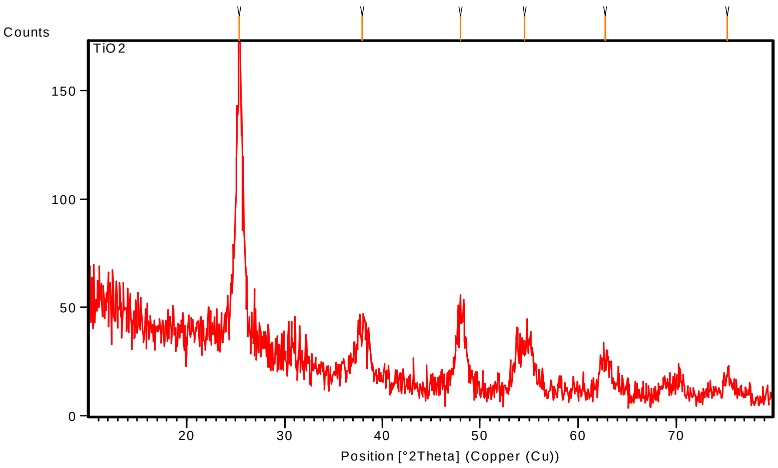

Fig 1: XRD Pattern of TiO_2

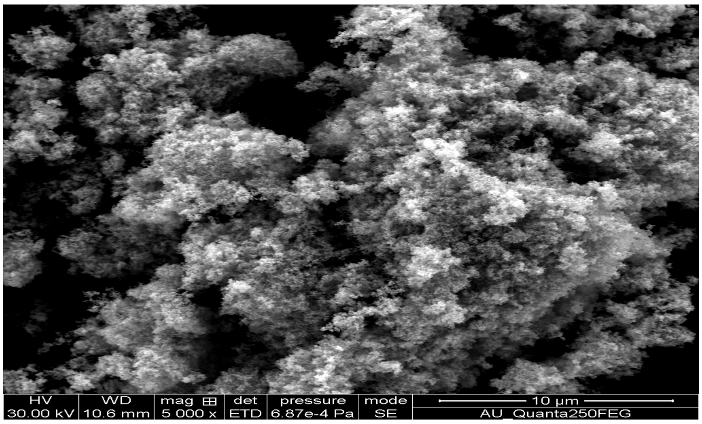

Fig 2: SEM image of TiO_2 nanoparticles.

2. Results and Discussion:

Figure 1 shows the X-ray diffraction peaks of prepared nanoparticles, which were confirmed with JCPDS-89.4203. The broad peaks were obtained at 2θ values of 25.36, 37.91, 48.04,55.05, shows formation of TiO_2 in anatase phase. The nanoparticle mean diameter was measured by scherrer formulae as 8.44 nm. The particle size by SEM(Fig2) is also in the same range. The morphology is uniform size particles with agglomeration. The sedimentation velocity was determined by the slope of time thickness plot (Fig 3) and the sedimentation velocity was found to be .04032 m/s. The intensity of the base fluid (40 Lux) is more than that of the prepared nanoparticles because nanoparticles can scatter or attenuate the incoming beam and reduce the intensity. Thus the time taken for the nanofluid to reach the intensity of base fluid can be defined as sedimentation time (Fig4). In the present case the sedimentation time is 4038 mins which corresponds to 67 hrs or 2.8 days.

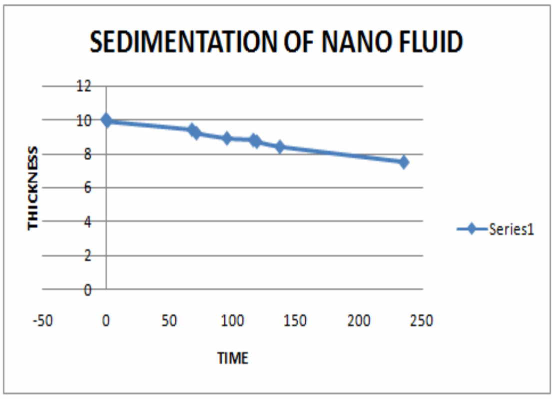

Fig 3: Sedimentation profile of TiO_2 nanofluid

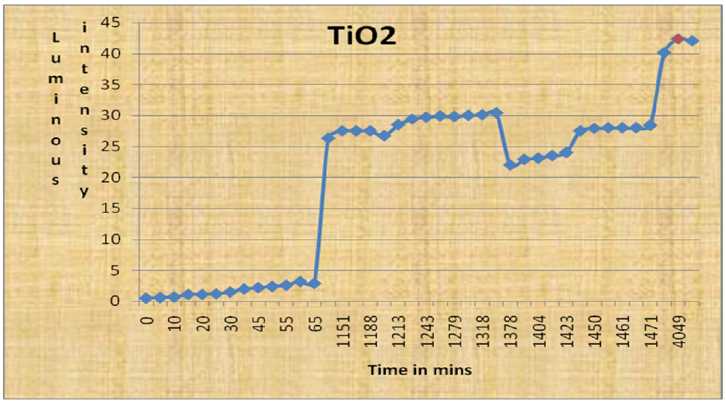

Fig. 4: Attenuation plot for nanofluid (blue) and base fluid (red)

Laura Fedele [6] investigated the sedimentation time of 0.01TiO_2 nanofluid with water as base fluid and acidification .Sedimentation time of 5 days is reported by zeta potential technique for a 21 nm size particles. In the present study the sedimentation time is found to be 2.8 days by laser attenuation technique for 0.1 TiO_2 nanofluid with particle size of 8.4nm.The variation in results can be due to particle size, acidification, temperature, area of sedimentation column, purity of sample. The present method of characterising stability is economical, reliable but time consuming in comparison to zeta potential technique.

References:

1. Choi S.U.S, Enhancing thermal conductivity of fluids with nanoparticles, Developments and Application of Non-Newtonian flows, FED-Vol231/MD-Vol.66 ,99-105.
2. Nandy Putra, Wilfried Roetzel, Sarit.K.Das, Natural Convention of nanofluids, Heat and mass transfer, 2003,39, 775-784.
3. Donzelli. G, Cerbino. R, and.Vailati. A, “Bistable heat transfer in a nanofluid,” Physical Review Letters, 2009 ,vol.102, no.10, Article ID 104503.
4. Thomas and Balakrishna Panicker Sobhan, A review of exprimental investigation on thermal properties of nanofluids ,Nanoscale Research Letters, 2011 vol 6, 377.
5. Ghadimi, R. Saidur, H.S.C. Metselaar, A review of nanofluid stability properties and characterization in stationary conditions, International Journal of Heat and Mass Transfer ,2011 ,54 , 4051–4068.
6. Laura Fedele, Laura Colla, Sergio Bobbo1, Simona Barison and Filippo Agresti, Experimental stability analysis of different water based nanofluids ,Nanoscale Research Letters ,2011, 6,300.
7. Kavitha T,Rajendran A,DuraiRajan A, Synthesis,characterization of TiO_2 nanopowder and water based nanofluids using two step method,European journal of applied Engineering and scientific research, 2012,1(4),235-240.
8. Subramaniyan A.L, Govardhan M.S, Lokesh,Rakappan M, Sundarakannan B,Kottaisamy M,Ilangovan R, Investigation on thermal performance of copper heat pipe, IEEE Conference proceedings, 2013, 6609732, 634-638.

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