Synthesis of MWCNT nanofluid by using two step method

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SYNTHESIS OF MULTI WALL CARBON NANOTUBES NANOFLUID BY USING TWO STEP METHOD

by

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The nanofluids, the fluid interruptions of nanomaterial, have presented lots of exciting properties and characteristic structures offer unique potential to the various applications. The article recaps the latest development of revision of nanofluids, for example the method of evaluation of strength of nanofluids, method of preparation and methods of enhance the stability of nanofluids. Finally, this paper finds the chances for future development of research work.

Key words: *multi wall carbon nanotubes, two-step method, ethylene glycol, nanoparticles*

Introduction

The nanofluids are an innovative class of fluid caused by dissolving in the base fluid of water by nanometre size materials are namely as nanotubes, nanoparticles, nanowires, nanosheet, nanorods, nanofibers, *etc.* The nanofluids are wide range of nanoscale colloidal suspensions having condensed nanomaterial. Generally, two phase system is having solid phase as well as liquid phase. The nanofluids are widely used to increase the various properties like as thermal conductivity, viscosity, thermal diffusivity, heat transfer coefficient, and specific heat which compare to water (base fluid) [1-4].

During the preparation of nanofluids we have challenging issue in nanofluids stability. In this work, the technique for preparing stable nanofluids is will summarize. The nanofluids have involved more attention in the current scenario due to wide various application can be used and increase in performance than existing one. Even though research papers containing the progress of nanofluids to investigate by experiment or theoretically on convective heat transfer coefficient of nanofluids and various thermophysical properties [5-9]. The main drive of this paper to concentrate on preparation method and steadiness of nanofluids. It has confirmed great usage possibility in various applications.

Nanofluid preparation

The stable nanofluids are prepared by the following two methods: one-step and two-step.

The one-step method

In this method the nanoparticles agglomeration is reduced. During this case, consecutively creating and dissolving the nanoparticles in the base fluid. During this processes the

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followings are avoided namely storage, drying, transportation, and nanoparticles dispersion. Therefore, the collection of nanoparticles is reduced, and fluid steadiness stays improved. The one-step method can make consistently distributed the nanoparticles, particles be able to firmly suspend in water. The main drawback of this method is couldn't synthesize the nanofluids in huge quantity, and preparation cost is more.

One-step technique combines the production of nanoparticles and dispersion of nanoparticles in the base fluid into a single step. There are some variations of this technique. In one of the common methods, named direct evaporation one-step method, the nanofluid is produced by the solidification of the nanoparticles, which are initially gas phase, inside the base fluid. The main drawback of one-step techniques is that they are not proper for mass production, which limits their commercialization.

The two-step method

This method is the greatest financial to create nanofluids. In this method the nanofluids preparations are widely used. Here the nanoparticles are used as dry powder by either physical or chemical methods. The nanosized powder willpower is ball milling and spread into water in the next processing stage by ultra-sonication, which will provide serious magnetic force agitation. Because of high surface area, surface activity, the nanoparticle ensures the trend to cumulative. Generally, the surfactant is playing major role to improve stability of nanoparticle in fluid. However, if utilize surfactants under high temperature applications are challenging one. In two-step method, the nanoparticles are made and then using any one of the manufacturing technique disperses them in the base fluids.

Procedure adopted for the nanofluid preparation

– The volume fraction of multi wall carbon nanotubes (MWCNT) is calculated by:

$$x = \frac{V_n}{V_n + V_b} \tag{1}$$

where x is the volume fraction, V_n – the volume of nanofluid, and V_b – the volume of base fluid

– The required quantity of based fluid is taken and then it is added with various surfactants such as cetyl pyridinum chloride, cetyl dimethyl benzyl-ammonia chloride, benzyl trimethyl ammonia chloride and spectral database system (SDBS). The SDBS as a surfactant to disperse the MWCNT uniformly in the base fluid.
– Among these the SDBS is found to be most suitable for the preparation of stable nanofluids by carried out the stability test for more than 24 hours and it is presented in tab. 1.
– The calculated quantity of MWCNT is added to the mixture of base fluid and the surfactant and then the mixture is stirred for 30 minutes using magnetic stirrer.
– The mixture is ultrasonicated in the ultrasonicator for one hour continuously to prepare the nanofluid with greater stability of MWCNT in the base fluid.

Nanofluids stability

Table 1 shows the stability test for 0.15 vol.% of MWCNT and various surfactants. The prepared solutions are keep upon monitored for period of time and reported whether CNT is settling or not and shown in above table briefly. Due to agglomeration of nanoparticles, the nanofluid thermal conductivity is decreasing. Therefore, is essential to study and investigate what are the influencing factors to the concentration stability of nanofluids [10].

Table 1. Stability test

Illustrate	Description	Time [hours]	Remarks
	0.15 vol.% of MWCNT	1	MWCNT is settled
	0.20% Cetyl pyridinum chloride + 0.15 vol.% of MWCNT	2.15	MWCNT is settled
	0.20% Cetyl dimethyl benzyl-ammonia chloride + 0.15 vol.% of MWCNT	2.30	MWCNT is settled
	0.20% benzyl trimethyl ammonia chlo-ride + 0.15 vol.% of MWCNT	6	MWCNT is settled
	0.20% SDBS+ 0.15 vol.% of MWCNT	20 days	MWCNT is not settled

There are several methods are established to estimate the nanofluids stability. In that the method of sedimentation is simplest one. The sediment volume or nanoparticles weight in nanofluids below an outside power is signal of characterized nanofluids [11-13]. The concen-tration variation of supernatant element with sediment time able to attain by the apparatus set up. The nanofluids are stable to consider when particle size or supernatant concentration of particles kept constant. The sedimentation of nanofluids is shown in below figure and which is helped for observe the nanofluids stability. The centrifugation process is formed to assess the nanofluids stability. It is found that obtain stable nanofluids are for more than 20 days in the ideal state and 9 hours in centrifugation at 2900 revolutions per minute without any sedi-mentation. Finally, outstanding nanofluids stability is attained.

The SEM is a powerful tool used for taking SEM images. The SEM analysis helps to analyze the size of the suspended MWCNT for various concentrations [14-17]. The SEM cre-ates the magnified images by using electrons instant of light waves. Figures 1 and 2 show the

SEM image of 0.15 vol.% and 0.3 vol.% dispersed MWCNT in base fluid with 0.20% SDBS with different magnification rates. The average size of the suspended carbon nanotubes is found to be 12 nm, 22 nm.

The SEM image of 0.15 vol.% and 0.3 vol.% dispersed MWCNT in base fluid with 0.20% SDBS with different magnification rates

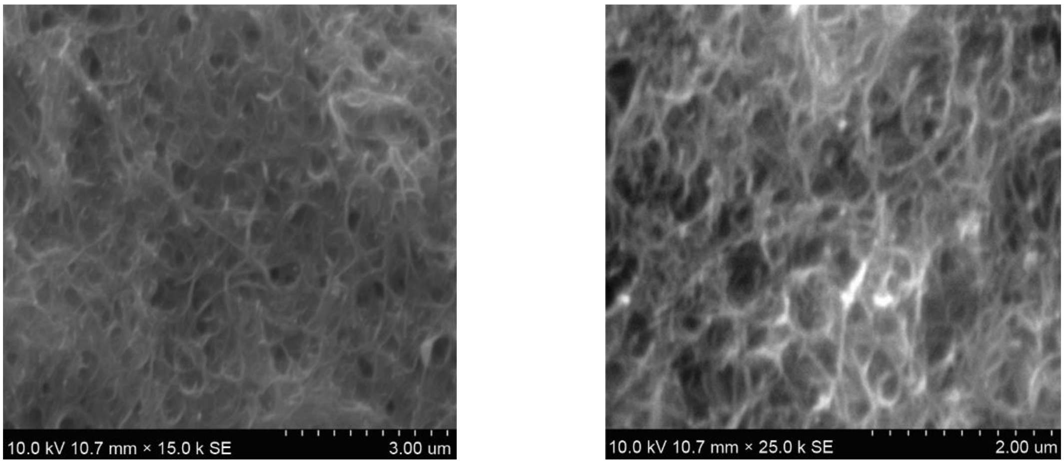

Figure 1. The SEM image of 0.15 vol.% dispersed MWCNT in base fluid with 0.20% SDBS with different magnification rates

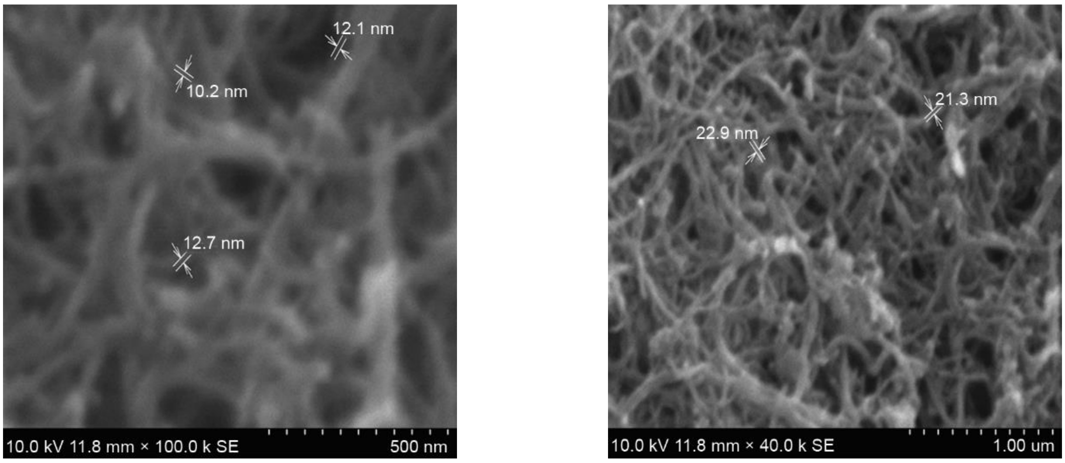

Figure 2. The SEM image of 0.3 vol.% dispersed MWCNT in base fluid with 0.20% SDBS with different magnification rate

Surfactants

Surfactants are used to lower the surface tension among two liquids whereas liquid and gas, or solid and liquid. The surfactant is play as wetting agent, detergents, foaming agent, dispersants, and emulsifiers. The Surfactants use in nanofluids is known as dispersants.

The addition of dispersants in the two-step method is simple and cost-effective one to develop the nanofluid stability. As per the composition, the surfactants are separated to four types as nonionic surfactants, cationic surfactants, amphoteric surfactants, and anionic surfactants. Even though surfactant adding is an efficient method to improve nanoparticles dispersibility, the surfactants may reason quite a few problems. The adding of surfactants might contaminate the heat transfer medium. The surfactant might create foam during cooling/heating is regular process in the heat exchanger. In addition, surfactant molecule attach on nanoparticle surfaces might increase thermal resistance among the nanoparticles and water (base fluid), which can bound the improvement of effective thermal conductivity.

Nanofluids application

Cooling

In industrial cooling applications the nanofluids will involve great energy saving. It remained noticed the nanofluid specific heat was recorded 52% more for nanofluid, and increase by temperature. The thermal diffusivity was established 5 times more for nanofluid and convective heat transfer improved 12% by nanofluids.

Heating

A nanofluid is suitable in building heating applications. In cold region, it is a general tradition to use water along with ethylene glycol (EG) mixed at various proportion as heat transfer fluid. Hence 70:30 water and EG (by weight) was choosing as base fluid. The result shows nanofluid used in heat exchanger may decrease the mass flow rates, minimize the pumping. This will also diminish environmental pollutions, due to lesser heating unit and use a smaller amount of power.

Transfer of heat

While beginning of nanofluid idea concerning a decade ago, nanofluid potential in various applications of heat transfer need involved extra consideration. There are a number of journal papers which current overview of different features of nanofluid as well as preparation, characterization technique used for thermal conductivity, thermophysical properties and convective heat transfer coefficient. This article studied about thermal conductivity of ethylene glycol based nanofluid contains better character with lowest viscosity and good in thermal conductivity.

Energy storage

To increase the superior thermal conductivity of nanofluids, more heat transfer rate, the nanofluids are widely used in various energy storage applications. The nanofluids overcome extraordinarily more thermal conductivity when compare to the base fluid.

Conclusions

The present work concerns the preparation of MWCNT by using two-step method is more effective than the one-step method and by using surfactants the stability of nanofluid is increased. From the observations strictly conclude that the MWCNT playing vital role in heat transfer applications like heating, cooling, *etc.* The further work is going to carried as measurement of the thermophysical properties of water-ethylene glycol mixture based MWCNT nanofluids and do enhancement of nanofluids by various concentrations and various flow rate conditions. Then comaparison is going to do for the effective for MWCNT nanofluids to determine the heat transfer rate.

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