Journal of Physics: Conference Series

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# Evaluation of Stability and Enhancement of Nano Fluid Methods

To cite this article: Z.A. Shaalan *et al* 2024 *J. Phys.: Conf. Ser.* **2688** 012016

# EVALUATION OF STABILITY AND ENHANCEMENT OF NANO FLUID METHODS

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## ABSTRACT

Over the last ten years, there has been a substantial increase in research on nanofluids, and the findings indicate that these fluids are superior heat transfer fluids for application in engineering. The improved heat transfer is exclusively dependent on the thermal conductivity of the nanoparticles at constant particle volume concentrations and flow rates. By creating hybrid nanoparticles, one can change or vary the thermal conductivity of nanoparticles. Nanoscale particles with two or more separate components come together to form hybrid nanoparticles. Fluids made from hybrid nanoparticles are known as hybrid nanofluids. By utilizing more sophisticated materials, hybrid Nano fluids aim to significantly boost heat transmission. Results shows that the nanofluid stability is sensitive to environmental conditions including temperature, pH, and shear rate. It should be using surfactants, additives such as polymers and colloids, ultra-sonication, high shear mixing, applying magnetic field.

***Keywords*:** nanofluid, heat transfer, hybrid nano, thermal conductivity, stability.

## INTRODUCTION

Nanotechnology was introduced for the first time by physicist Richard Feynman in 1959 to explain the special properties of nanoparticles. The discovery of the first atomic cluster using scanning tunnelling microscopy in 1981 marked the start of the nanotechnology era. Carbon nanotubes (CNTs) were first discovered by IIJIMA in 1991, and since then, one of the hottest topics and fastest-growing fields has been the study of the materials' mechanical properties. Nanotechnology, which makes use of nanoscale-sized particles, ensures continuous advancement. Many nanomaterials, including nanoparticles and nanotubes, have successfully proven their skill in specific domains and have been produced utilizing a number of techniques, including physical, chemical, and biological ones [1].

Nanomaterials are compounds with at least one percentage that behave differently on a nanoscale than more conventional man-made substances that have garnered a lot of attention, according to the fundamental knowledge of nanotechnology. They are broken down into four groups, which includes fine particles. The dimensions of the fiber, sheet, and mass were shown in Fig. 1. The primary goals of nanotechnology research are the synthesis, characterization, and behavior representation of nanomaterials for use in microelectronics, IT, healthcare, spaceflight, energy, ecological environments, as well as biotechnology and agricultural applications [2]. Hybrid nanofluids, which include two different kinds of nanoparticles, have been created recently. Numerous research has shown that nanofluids offer superior characteristics than regular fluids [3-5].

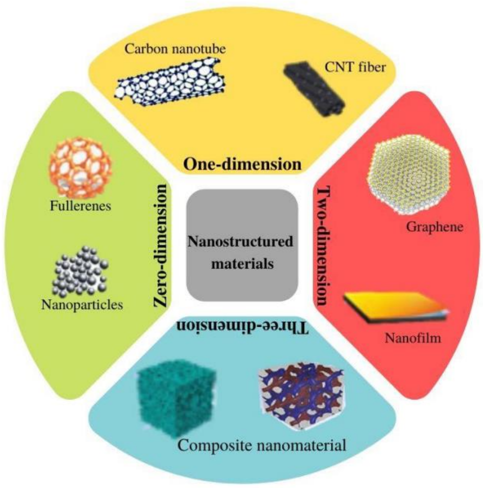


Fig. 1. Schematic representation of nanostructured.

Nanofluids run the risk of losing their stability due to a wide variety of processes, such as aggregation, surface deposition, morphological changes, cluster formation, oxidation, and particle disbanding. Nanofluids must be stored for a certain amount of time in order to retain their long-term stability under ambient conditions and to keep their promising thermal and optical properties. [6]. The development of clusters and the deposition of nanoparticles may negatively affect the thermal, optical, and rheological properties of nanofluids [7]. After analyzing the ways in which nanomaterials excel above conventional solids, a wide range of potential uses for these nanoparticles and their benefits to our environment emerge. energy, space, military, automotive, electronic cooling are only few of the promising fields for using nanostructured materials [8]. Heating and cooling systems, as well as heat exchangers, porous media, and energy systems [9], nanofluids are often used [10–11]. the using of numerous of nanofluids is illustrated in Fig. 2.

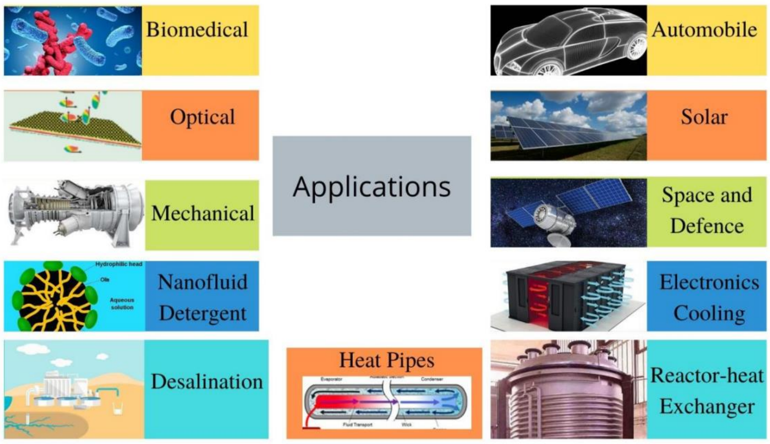


Fig. 2. Applications of Nanofluids.

There are many litreture survey of nanofluid stability but in this article, it is focusing on the hybrid nanofluid stability. The bond forces among the particles of different materials are too strong which will keep their properties. It will be attendance with recent methods of hybrid nanofluid preparation to reach a significant stability.

## NANOFLUID PREPARATION

Hybrid nanofluids are a type of tailored fluid made by suspending nanoparticles made of different materials in a base fluid. In turn, hybrid nanofluid is produced. These nanoparticles can be created utilizing a variety of materials and techniques, including chemical synthesis, physical vapor deposition, and electrode positioning. These materials and processes include metals, ceramics, and polymers. Additionally, a variety of materials can be used to create these nanoparticles [12]. One typical technique for creating hybrid nanofluids is to first create the nanoparticles using an appropriate technique, then distribute them in a base fluid using a sonication or high shear mixing procedure. This can be done with a variety of base fluids, including water, ethanol, and ethylene glycol [13]. Another method for preparing hybrid nanofluids is to synthesize the nanoparticles directly in the base fluid using a suitable chemical reaction. For example, copper oxide nanoparticles can be synthesized in a water-based solution using a chemical reduction method [14].

The term "single-step method preparation of hybrid nanofluids" refers to processes that may simultaneously produce nanoparticles and disperse them across a base fluid in a single step. This kind of approach is used to make hybrid nanofluids. These methods are attractive because they simplify the preparation process and can potentially improve the stability of the nanofluid [15]. One example of a single-step method for preparing hybrid nanofluids is the laser ablation method. In this method, a laser is used to ablate a target material (such as a metal or a ceramic) in a liquid medium, which results in the formation of nanoparticles that are dispersed in the liquid. The laser ablation method has been used to prepare hybrid nanofluids that contain metallic nanoparticles such as gold, silver, and copper, as well as ceramic nanoparticles such as alumina and titania [16].

Another example of a single-step method for preparing hybrid nanofluids is the electrochemical method. In this method, an electrode is immersed in a liquid medium and a current is passed through the liquid, which results in the formation of nanoparticles on the electrode. The nanoparticles can then be dispersed in the liquid by stirring or sonication. The electrochemical method has been used to prepare hybrid nanofluids that contain metallic nanoparticles such as silver, copper, and iron, as well as ceramic nanoparticles such as titanium dioxide and silicon dioxide [17].

The two-step process is frequently used to make hybrid nanofluids. The two main steps in the procedure are the production of nanoparticles and their subsequent distribution in the supporting fluid. Synthesis of nanoparticles: Various synthesis methods, such as electrochemical synthesis, chemical synthesis, and physical vapor deposition, are used to produce nanoparticles during this stage of the procedure. The desired attributes of the base fluid and nanoparticles should direct the selection of the best technique. Dispersion of nanoparticles in base fluid: Once the nanoparticles are synthesized, they are dispersed in the base fluid using various methods such as ultra-sonication, high-pressure homogenization, or ball milling [18]. The choice of method depends on the desired dispersion stability and the viscosity of the base fluid as in Table 1.

Journal of Physics: Conference Series **2688** (2024) 012016 doi:10.1088/1742-6596/2688/1/012016

Table 1. Stability of nanofluid depending on synthesis.

| Ref. | Nano fluids | Preparation method | Shape of nanoparticles |
|---|---|---|---|
| [19] | Cu-Al/water | 1-step | Spherical |
| [20] | Au/water | 1-step | Plate shaped |
| [21] | $Al_2O_3$/water | 1-step | Semi spherical |
| [22] | Ag/water | 1-step | Spherical |
| [23] | $TiO_2$/EG-water | 1-step | Rounded |
| [24] | Cu-Zn-Al/water | 1-step | Spherical |
| [25] | Cu/diethylene glycol | 1-step | Spherical |
| [26] | Au/thermal oil | 1-step | Spherical |
| [27] | CuO/water | 2-step | Hollow rod |
| [28] | ZnO/propylene glycol | 2-step | Spherical |
| [29] | CuO/heat transfer oil | 2-step | Spherical |
| [30] | CuO/engine oil | 2-step | Spherical |
| [31] | CuO/EG | 2-step | Spherical |
| [32] | ZnO/propylene glycol | 2-step | Spherical |


Fig. 3. Preparation by using the two-step method.

## RESULTS AND DISCUSSION

Nanofluids are fluids that have had nanoparticles scattered throughout them, and the stability of nanofluids is a crucial factor to take into consideration when using them in a variety of contexts. The stability of nanofluids may be influenced by a variety of variables, such as the kind of nanoparticles present, their size, the concentration of nanoparticles in the fluid, and the characteristics of the fluid itself. There are a variety of methods available for determining the stability of nanofluids. Two of these methods include monitoring the pace at which particles settle and determining the zeta potential of the particles.

Visual inspection, laser diffraction, and dynamic light scattering are some of the ways that the stability of nanofluids may be measured. Other approaches include dynamic light scattering. The measurement of the zeta potential, which is a measurement of the electrical potential at the surface of the nanoparticles, is a typical approach. This potential is a measure of the electrical potential. If the zeta potential is high, the suspension is stable; on the other hand, a low zeta potential implies that the suspension is unstable. Research has demonstrated that the stability of nanofluids may be enhanced by using surfactants or other stabilizing agents, as well as by using smaller nanoparticles or lower concentrations of the nanoparticles [30-31].

Other ways to increase the stability of nanofluids include using smaller concentrations of the nanoparticles. The dimensions and shapes of the nanoparticles have a significant role on the stability of nanofluids, making them one of the most critical aspects to consider. Nanoparticles that are bigger and more irregularly shaped have a tendency to be less stable than those that are smaller and more spherical [32].

Particles that have a surface energy that is lower are more stable than particles that have a surface energy that is greater. Additionally, the surface chemistry of the nanoparticles may also have a role in the stability of the nanoparticles. The stability of nanofluids may also be affected by the parameters of the base fluid. For instance, a liquid that has a higher viscosity would often have a greater tendency towards stability in comparison to a liquid that has a lower viscosity. In a similar vein, a liquid that has a higher surface tension would often have a greater degree of stability compared to a liquid that has a lower surface tension [33]. In conclusion, the stability of nanofluids is governed by a number of different aspects, some of which include the size and shape of the nanoparticles, the concentration of the nanoparticles in the suspension, and the characteristics of the base fluid [34-35]. Figure 4 provides an indication of the hybrid nanofluid's inherent stability.

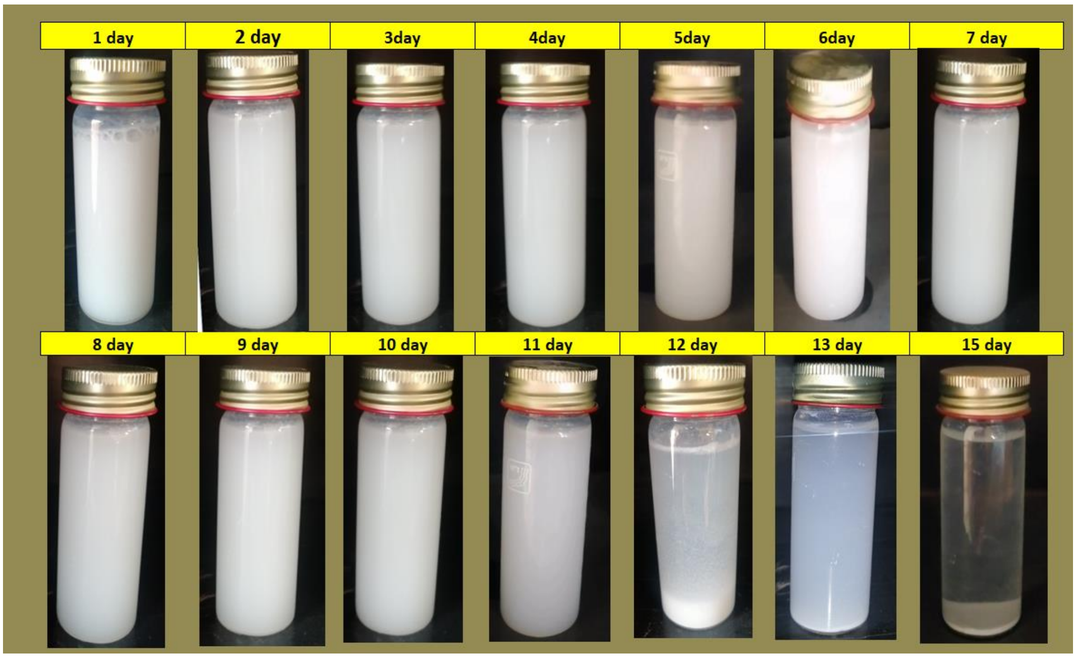


Fig. 4. Stability of hybrid nanofluid.

To keep the stability of the nanofluid during the working time, the stirrer part has been added and attached to the system as shown in Fig. 5.


Fig. 5. The stirrer part has been attached to the nanofluid tank.

When dealing with nanofluids, stability is a key factor to take into account since it influences how well the nanofluids function in a variety of applications, including lubrication and heat transmission, among others. The capacity of nanoparticles to stay afloat in the fluid medium without settling to the bottom of the container or aggregating is a critical factor in determining the stability of nanofluids. Because nanoparticles in nanofluids have a high ratio of surface area to volume, they are extremely reactive and prone to aggregation. This is because of their high surface-to-volume ratio. Because of this, the thermal conductivity and viscosity of the nanofluids might drop, which can result in poor performance in applications such as heat transfer and lubrication [3].

Surfactants and stabilizing agents like polymers are two examples of strategies suggested to increase nanofluid stability. The nature of the nanoparticle and the medium it is floating in will determine which stabilizing agent is most suited to the situation. Nanofluid stability is also sensitive to environmental conditions including temperature, pH, and shear rate. Because of this, it is crucial to maintain tight control over these factors throughout nanofluid synthesis and storage [36].

It has been suggested that increasing the stability of nanofluids, which are suspensions of nanoparticles in a fluid, may be accomplished via the use of a variety of different approaches. These include the items listed below: [37-38]:

- Using surfactants: To lower the surface tension of the nanofluid, surfactants may be added between the particles and the fluid, which helps to prevent particle aggregation and sedimentation.
- Using additives: Additives such as polymers and colloids can also be added to the nanofluid to help stabilize the suspension.
- Using ultrasonication: Ultrasonication is a technique that uses high-frequency sound waves to create small bubbles that can help to keep the particles in suspension.
- Using high shear mixing: High-shear mixing is another technique that can be used to prevent particle aggregation and sedimentation by applying a strong force to the nanofluid.
- Using magnetic field: Applying magnetic field to the nanofluid may provide an additional mechanism for stabilization of the nanoparticles.

## CONCLUSIONS

One of the main issues with nanofluids that this article emphasizes is the stability problem, which hinders them from becoming viable applications. Numerous stability evaluation and enhancement methodologies have been looked into in this study. It describes how to create nanofluids in one step and two steps. The 2-step method is often used to prepare nanofluids due to decreased production costs and the flexibility to produce a wide variety of nanofluids. The importance of nanofluid stability for the efficient operation of thermal systems is also covered. Nanofluid instability impairs thermophysical properties and reduces the efficiency of systems for transmitting heat.

Researchers are looking into a variety of stability improvement approaches to increase the stability of nanofluids. Surfactant addition, surface modification of nanoparticles, and ultra-sonication. In search of the best solution, stability interval for nanofluids, the optimal ultra-sonication time period should be needed to explore for each type of nanofluid. The new class of nanofluids, hybrid ones, very recently came into being. More research on this new category of nanofluids is required to reap the rewards of the best thermo-physical qualities. The bulk of researchers in this sector are also concerned about the high expense of nanofluids. For nanofluids to be used in the real world, problems related to them need to be solved.

## NOMENCLATURE

| | | | |
|---|---|---|---|
| $A_r$ | reciver area (m²) | $T_{f,o}$ | out let fluid temperature(ºC) |
| $D_{r,ext}$ | external diameter of reciver (m) | $T_{f,i}$ | inlet fluid temperature( ºC) |
| $D_{r,int}$ | internal diameter of reciver (m) | $T_a$ | ambient temperature(ºC) |
| $\dot{m}$ | mass flow rate (kg/s) | $Qu_{th}$ | theoritical useful enrrgy(W) |
| Cp | specific heat of fluid(J/kg. ºC) | $\phi$ | concentration ratio (%) |
| L | length (m) | W | width of collector(m) |

## DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## ACKNOWLEDGMENTS

The laboratory support by School of Mechanical Engineering, Engineering Campus, University Sains Malaysia; Technical College of Engineering, Northern Technical University and Faculty of Mechanical and Automotive Engineering Technology and the financial support by Research Management Office (RMC) Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA) through research grant RDU223302 is gratefully acknowledged.

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