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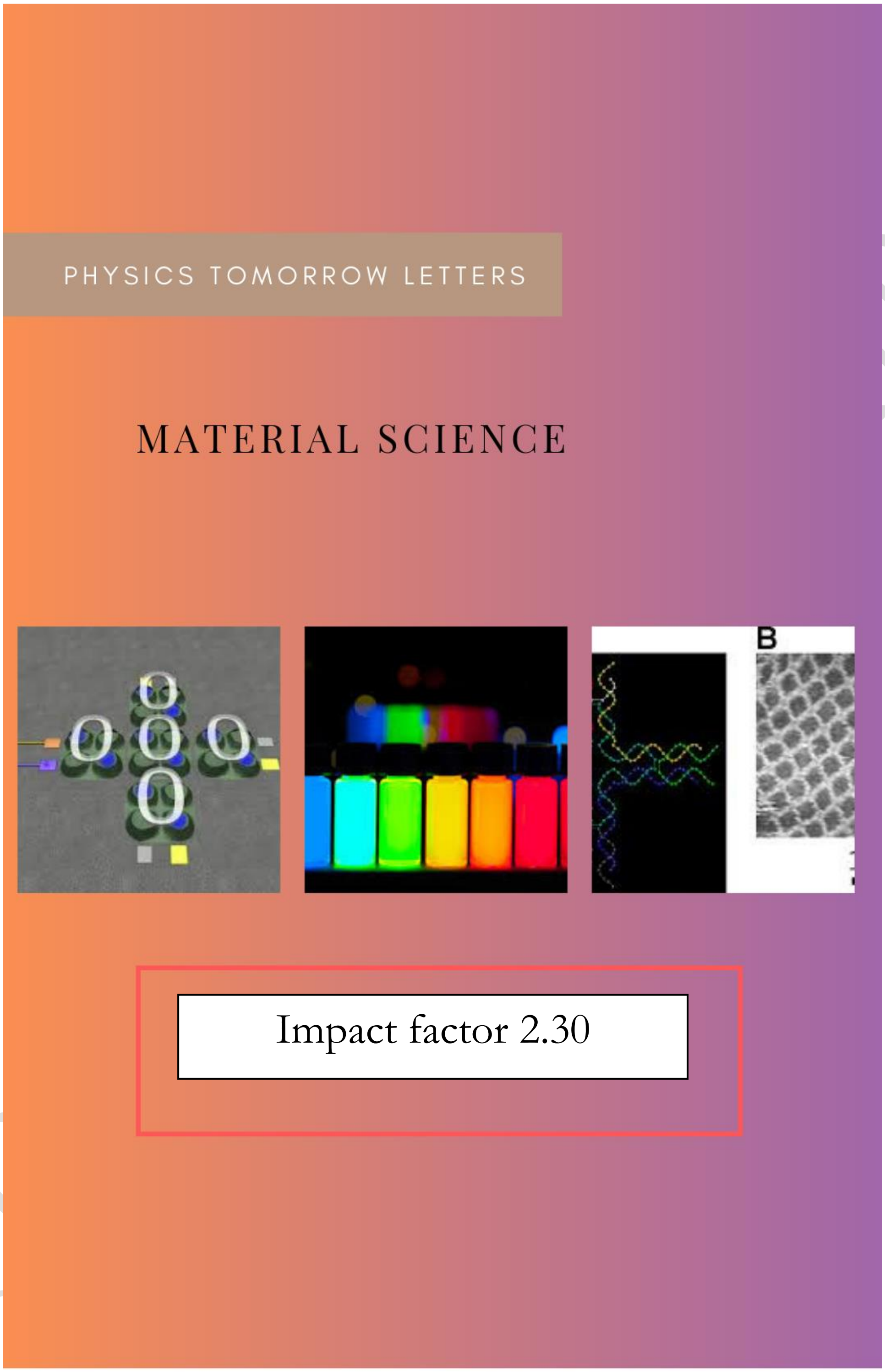

# A Review on Nanofluids, Definition, Classification, Preparation, Characterization Methods and Application



Nanofluids are suspensions of nanoparticles in fluids that show significant enhancement of their properties at modest nanoparticle concentrations. One of the most plausible applications of nanotechnology is to produce nanoparticles of high thermal conductivity and mixing with the base fluids that transfer energy forming what is called nanofluids. Adding of nanoparticles to the base fluid shows aremarkable enhancement of the thermal properties of the base properties. For this properties there is many research and review were reported to study nanofluids, in this review Definition, Classification, Preparation, Characterization Methods and Application of nanofluids were discussed briefly.

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REVIEW PAPER.

***Keys:*** *Nanofluids, Nanotechnology, preparation of nanofluids, Characterization of nanofluids, application of nanofluids, nanofluids stability.*

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# 1. Introduction

Modern nanotechnology provides new opportunities to process and produce materials with average crystallite sizes below 50 nm[1], fluids with nanoparticles suspended in them are called nanofluids, a term proposed in 1995 by Choi of the Argonne National Laboratory, U.S.A, [2]. Nanofluids are fluids with nanoparticles suspended in them are called nanofluids. In other words, nanofluids are nanoscale colloidal suspensions containing condensed nanomaterials. They are two-phase systems with one phase (solid phase) in another (liquid phase). [3]. Nanofluids have been shown to improve critical heat flux CHF under pool boiling conditions due to deposits of the nanoparticles on the heater surface [4]. As a bubble nucleates and evaporates, the local nanoparticle concentration increases, leading to their deposition in the vicinity of the nucleation cavities. Experiments with nanofluids of alumina particles under subcooled flow boiling in a large-diameter (8.7 mm) tube under vertical orientation have been investigated [5]. Pure water showed a CHF of 1.44 MW/m2 at an inlet subcooling of 20°C, while the nanofluids with 0.01% by volume alumina nanoparticles resulted in a CHF of 3.25 MW/m2 under a mass flux of 1500 kg/m2 s. The nature of the CHF failure was also noted to be quite different. The CHF with pure water resulted in a catastrophic failure of the tube at the cross-section, while the CHF with the alumina nanoparticles resulted in a localized pinhole type failure. The higher wettability caused by nanoparticle deposits is believed to improve wettability and prevent the growth of local burnout at the CHF location. Although these results are for a macroscale tube, they are included here to illustrate the basic mechanism that may be affecting nanofluid behavior in minicanals and microchannels as well. In a subsequent paper, heat transfer coefficients for the same tests were reported [6]. They observed no appreciable difference in the heat transfer coefficient between the nanofluids and pure water. an experiment was Conducted with copper–water nanofluids in 860-μm vertical channels under flow boiling conditions [7]. They noted that the heat transfer coefficient and pressure drop both increased with the addition of three concentrations, 5 mg/L, 10 mg/L, and 50 mg/L. The heat transfer coefficient increased over the entire range of quality. The heat transfer coefficient with pure water was well correlated [8] The increase in pressure drop observed with nanofluids is somewhat surprising, but it may be caused by the more prominent role played by the bubbles, which are faced with a more hydrophilic surface with nanofluids under subcooled flow boiling conditions [7]. Their two-phase friction pressure drop with pure water was well correlated [9]. Direct dispersion of SiO2 nanoparticles plays a critical role [10]. When the particles were not well dispersed, the heat transfer coefficient decreased by as much as 55% in comparison to pure R-134a in a 7.9-mm inner diameter tube. Well-dispersed nanofluids containing polyester oil with CuO nanoparticles resulted in a 100% increase. The pressure drop increase was insignificant. experiments with deionized water and alumina nanofluids in 510-μm-diameter microchannels under low mass flow rate conditions of 600–1650 kg/m2 s was investigated [11] . They found that CHF with nanofluids increased by 51% with 0.1% by volume of alumina nanoparticles. CHF increased with nanoparticle concentration from 0.001% to 0.1% by volume. They also noted that the pressure fluctuations were quite different with the nanofluids. The surface of a Zirlo tube used in nuclear applications was modified. It was treated with anodic oxidation and resulted in improved wettability [12]. This surface also exhibited up to 60% enhancement in CHF over a plain tube at a mass flux of 1500 kg/m2 s. This further confirms that the surface wettability modification is the underlying reason for CHF enhancement with nanofluids. Flow boiling with nanofluids results in the deposition of nanoparticles on the heater surface. This thin layer of nanoparticles changes the surface wettability of the channel walls. The higher wettability alters bubble behavior and enhances CHF. Since deposition of the nanoparticles depends on a number of factors, such as the size and dispersion of the nanoparticles, heat fluxes, nanoparticle–liquid interaction, concentration, duration of operation, and the base surface conditions, significant variations in the experimental results are expected from different sources [13]. Providing a thin nanostructured layer on the heater surface by microfabrication techniques may be an alternate way to realize the same benefits. Nanofluids offered marginal improvement in heat transfer, but the particles deposited in large clusters near the channel exit, causing catastrophic failure [14]. In light of their findings, the long-term benefits on boiling performance need to be validated, and the effect of nanoparticles on the other system components needs to be carefully evaluated before their practical implementation [13]. Recently, nanotechnology has played a major part in multifields of heat transfer processes and developed a remarkable progress in the energy applications. One of the most plausible applications of nanotechnology is to produce nanoparticles of high thermal conductivity and mixing with the base fluids that transfer energy forming what is called nanofluids. Adding of nanoparticles to the base fluid shows a remarkable enhancement of the thermal properties of the base properties. Nanotechnology has greatly improved the science of heat transfer by improving the properties of the energy-transmitting fluids. A high heat transfer could be obtained through the creation of innovative fluid (nanofluids). This also reduces the size of heat transfer equipment and saves energy [15].

## 2. Methods of preparing nanofluids

Nanofluids are produced by several techniques: first step, second step, and other techniques. To avoid the sedimentation of nanoparticles during its operation, surfactant may be added to them. Nanofluid preparation is the first step ahead of any implementations. Therefore, it entails more focus from researchers to obtain a good stage of stability. Colloidal theory states that sedimentation in suspensions ceases when the particle size is below a critical radius due to counterbalancing gravity forces by the Brownian forces. Nanoparticles of a smaller size may be a better size in the different applications. However, it has a high surface which leads to the formation of agglomerates among them [16, 17]. Therefore, to obtain a stable nanofluid with optimum particle diameter and concentration, it is considered a big chafor researchers. Two common methods are used to produce nanofluids, the two-step method and the one step method, and others have worked up some innovations.

### 2.1. *The two-step method*

The two-step method is the common method to produce nanofluids. Nanoparticles of different materials including nanofibers, nanotubes, or other nanomaterials are first produced as nanosized from 10 to 100 nm by chemical or physical methods. Then, the nanosized powder will be dispersed in base fluids with the help of intensive magnetic force agitation, ultrasonic agitation, high-shear mixing, homogenizing, and ball milling. As resulting from high surface area and surface activity, nanoparticles tend to aggregate reflecting adversely on the stability of nanofluid [17–21]. To avoid that effect, the surfactant is added to the nanofluids. The two-method preparation has been done by many researchers [22–27]. Figure 1 shows a block diagram of preparation of two-step method [28].

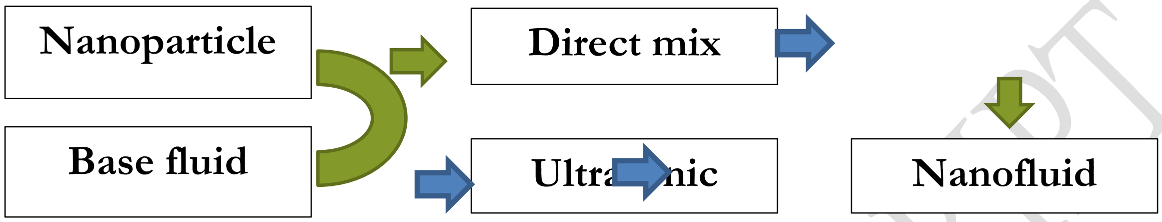


**Fig 1** | Figure.1. Two-step method of preparation of nanofluids [28] .

### 2.2. *One-step method*

The one-step process is simultaneously making and dispersing the particles in the base fluids which could be reduced to the agglomeration of nanoparticles. This method makes the nanofluid more stable with a limitation of the high cost of the process [29–38].

### 2.3. Other created methods

Some researchers create other methods to obtain new prepared methods for nanofluid with relatively high characteristics and more stability. Wei et al. [39] developed a method to synthesize copper nanofluids. This method can be synthesized through a novel precursor transformation with the help of ultrasonic and microwave irradiation [40]. Chen et al. [41] obtain monodisperse noble-metal colloids through using a phase-transfer method. Feng et al. [42] have used the aqueous-organic phase-transfer method for preparing gold, silver, and platinum nanoparticles with the solubility in water. Phase-transfer method is also used to prepare stable kerosene-based F3O4 nanofluids [43]. As stated above, the research proved that nanofluids synthesized by chemical solution method could be enhanced in conductivity with more stability [44].

## 3. Nanofluid Stability

Nanofluid stability is very important, and in spite of nanoparticles having extremely small sizes and relatively high kinetic energies resulting from Brownian motion, they do not remain in suspension. With time, nanoparticles settle out of solution under the influence of gravity. While in solution nanoparticle motions are the result of interactions involving van derWaals forces, electrical double layer action and steric action. Balancing the various competing interactions leads to nanoparticle dispersion and prevents clustering and sedimentation. From a practical point of view, clustering and sedimentation cause two problems. The first results from the loss of photo-thermal and thermal properties of the nanofluid. The second results from the build-up of sediments in the solar collector. The circulating sediments cause tube wall abrasion and the accumulating sediments reduce flow. Therefore, keeping nanoparticles dispersed is critical for the stability and performance of the nanofluid [45].

### 3.1. Methods to Enhance Nanofluid Stability

#### 3.1.1. Physical Methods

Physical methods used to promote nanofluid stability include mechanical agitation, stirring and ultrasonic vibration [46]. Mechanical stirring techniques have been used by several researchers, where the working fluid was distilled water and titanium oxide ($TiO_2$) and aluminum oxide ($Al_2O_3$) were the respective solid phases in the nanofluids [47,48]. While several articles have reported the use of ultrasonic vibration to disperse and suspend a variety of nanoparticles in different base fluids. For example, Duan et al. Have investigated the influence of sonication time on particle size and its influence on viscosity for $Al_2O_3$—water nanofluids [49]. While Eastman et al. [50], Lee et al. [51], and Wang et al. [48] have used two-step synthesis methods to produce Al2O3 nanofluids under the influence sonication and stirring to reduce particle clustering. A study by Hong et al. Found increasing sonication times lead to less particle clustering during the synthesis of iron (Fe)/ethylene glycol nanofluids [52]. Whereas, the influence of sonication time and power on long-term stability of TiO2—water nanofluids were studied by Lotfizadeh Dehkordi et al. Their study found increasing sonication time and power during synthesis reduced particle clustering [53]. Effect of Surfactants Physical dispersion methods are unsuitable for nanofluids used in direct solar absorption collectors. Instead, chemical methods are used. Steric stabilization is a chemical method that introduces small amounts of surfactant into the nanofluid to modify the surface properties of the nanoparticles. Surfactants are amphiphilic compounds that contain a hydrophobic tail and a hydrophilic polar head group [54]. The hydrophobic tails attach to the naturally occurring hydrophobic nanoparticles, while the hydrophilic polar heads radiate out to form a hydrophilic outer layer that interacts with the surrounding polar fluid (i.e., water). Thus, surfactants improve nanoparticle wettability by reducing surface tension and promoting greater fluid continuity. Therefore, selecting the correct surfactant is a very important factor that must be considered when producing a stable nanofluid. Surfactants come in four classes. The classes are based on head composition and include amphoteric, cationic, anionic, and non-ionic [55]. As a rule, nanofluids composed of a polar solvent should use a water-soluble surfactant. While nanofluids composed of non-polar fluids (i.e., oil) should use an oil-soluble surfactant. However, in spite of the wide range of commercially available surfactants, several problems have been reported in the literature [56]. For example, several studies have reported increasing surfactant concentrations can increase nanofluid viscosity [57,58]. Further problems include foam generation, contamination and lower heat transfer properties. In particular, irreversible surfactant deterioration has been reported for temperatures above 60 $^{o}C$. The resulting deterioration produces instability, particle aggregation and sedimentation [59].

3.1.2. pH Control of Nanofluid Stability

Controlling the surface charge on nanoparticles by regulating fluid pH is a technique that can increase nanofluid stability. Creating a high surface charge produces an electrical double-layer around the nanoparticle, which results in strong repulsive Coulombic forces that promote particle dispersion [46]. pH variation effects on dispersion stability and other properties of the resulting nanofluid have been studied by several researchers over the last decade.

# 4. Characterization of nanofluids

In this section, the characterization techniques that are commonly used by researchers to characterize nanofluids are dis- cussed. The nanofluids are characterized by the following techniques: SEM, TEM, XRD, FT-IR, DLS, TGA and zetapotential analysis [60]. SEM analysis is carried to study the micro structure and morphology of nanoparticles or nanostructured materials, TEM is like SEM but much higher resolution than SEM. XRD images are taken to identify and study the crystal structure of nanoparticles. FT-IR spectroscopy is done to study the surface chemistry of solid particles and solid or liquid particles, DLS analysis is performed to estimate the average disperse size of nanoparticles in the base liquid media and TGA is performed to study the influence of heating and melting on the thermal stabilities of nanoparticles. Zeta potential value is related to the stability of nanoparticle dispersion in base fluid. Review of characterization studies reveals that the important information like nanoparticle size, shape, chemical bonds, dis- attribution and stability are found from characterization techniques. But different researchers used different set of techniques and there are no recommended standard tests which would confirm the homogenous and stable nanofluid. There should be standard accelerated tests to confirm the long-term stability of dispersed nanoparticles in base fluid [60].

# 5. Thermophysical Properties of Nanoliquids

## 5.1. Thermal conductivity of nanofluids

Numerous research groups in the United States, Korea, the People's Republic of China, Japan, the United Kingdom, and other places are actively engaged in studying the properties of nanofluids, and the number of the publications devoted to the nanofluids, especially within the last decade, has been growing exponentially [61]. This is primarily due to the high thermal conductivity of nanoparticles. In Table 1, the values of the thermal conductivity at the ambient temperature for some materials used while producing the nanofluids are presented [62].

Table 1 : Thermal conductivity for some materials(at the ambient temperature)

| No. | Name of material | *k*, W/(m K) |
|---|---|---|
| 1 | Aluminum oxide ($Al_2O_3$) | 20 |
| 2 | CuO (copper oxide) | 40 |
| 3 | SiC (silicon carbide) | 120 |
| 4 | Au (gold) | 317 |
| 5 | Cu (copper) | 401 |
| 6 | Carbon nanotubes | ~3000 |
| 7 | Water | 0.55 |
| 8 | Machine oil | 0.145 |
| 9 | Ethylene glycol | 0.253 |



It is clear that the thermal conductivity of carbon nanotubes is significantly higher than in metals, exceeding the analogous value for the base liquid by more than four orders, which can lead to significant changes of the thermophysical properties of the nanofluids and intensification of the heat-exchange processes. In addition, many problems remain poorly studied, and the obtained results are often of contradictory character. This is because of the complexity of the process in the nanofluids, starting from their production, flowing of the destructive processes, peculiarity of the experimental technique, and reliability of the obtained results [62]. Difficulties of at least equal importance appear when creating the physical models describing the hydrodynamic and thermal phenomena in the nanofluids. A thorough analysis of the mechanisms of heat transfer in the nanofluids is required to determine the intensifying influence of the additions of the nanoparticles with forced and free convection of the heat transfer medium for the various modes of its flow along with determination of the possibility of using heat-transfer media with the additions of nanoparticles in real power plants. Conventional models of effective thermal conductivity of suspensions are reported for some researchers [63].

$$Keff/Km = 1+3(\alpha-1)v/(\alpha+2) - (\alpha-1)v \qquad (1)$$

$$Keff/Km = \alpha+(n-1)-(n-1)(1-\alpha)v/(\alpha+2)-(\alpha-1)v \qquad (2)$$

$$Keff/Km = 1+3\beta v+(3\beta 2+ 3\beta 2/4+[9\beta 2(\alpha+2)/16(2\alpha+3)]+....)v2 \qquad (3)$$

$$Keff/Km = [1+3(\alpha-1)/(\alpha+2)-(\alpha-1)v][v+f(\alpha)v2+0(\alpha 3)] \qquad (4)$$

where keff is the effective thermal conductivity of the suspension, n is a shape factor of nanoparticle, ν is nanoparticle volume fraction, and km and kc are the thermal conductivity of the suspending medium and solid particle, respectively. Also, α and β are empirical fitting parameters which are defined as (kc/km) and (α -1)/ (α +1).

### 5.2. Nanofluid convective heat transfer

Nanofluids have been proven a great potential for heat transfer enhancement alternative to base fluids to save energy, compact devices of low cost and design of multi-equipment used in a different application with nanofluids as working fluids. Experimental investigation on Cu- or water-based nanofluids has demonstrated [64], great enhancement of heat transfer was observed, and also, they reported that the friction factor has a very meager part in the application process. Other scholars [65] have concluded that a systematic and definite deterioration of the natural convective heat transfer occurs for the forced convection reliant on the solution concentration, the particle density, and the aspect ratio of the cylinder. Experimental investigation on Al2O3 nanofluids using water as base fluid has been studied by various research groups, and they concluded that the heat transfer coefficient in laminar flow [66–68] increases up to 12–15% and in the case of turbulent flow, it ranges up to 8% [69, 70]. CNT, CuO, SiO, and TiO2 nanofluids using water have been investigated [71–73]. Among these, CNT nanofluid produced similar results to that of Al2O3 nanofluid. Ding et al. [74] have concluded that the enhancement of heat transfer could be obtained by varying the flow condition and the fluid concentration. Alternatively, CuO has been investigated for several wall boundary conditions, and it has reached good results [75]. The increase in the concentration of the nanofluid on contrary gives very weak results on the heat transfer coefficient for volume fraction greater than 0.3% [76]. It is noted from the experiments that the heat transfer coefficient enhancement can be achieved in the range of 2–5%.

## 6. Nanofluid viscosity

Viscosity of nanofluid is measured by Viscometer. A particular measuring device called Brookfield programmable viscometer was used for measuring viscosity of CuO nanofluid. The viscometer drives a spindle immersed in test fluid[77].When the spindle is rotated ,the viscous drag of the fluid against the spindle is measured by the deflection of the calibrated spring. Viscosity is a measure of the tendency of a liquid to resist flow. It is the ratio of the shear stress to shear rate. When the viscosity is constant at different values of shear rate, the liquid is known as Newtonian while that varies as a function of shear rate then the liquid is known as non-Newtonian [78]. Einstein [79] was the first to calculate the effective viscosity of a suspension of spherical solids using the phenomenological hydrodynamic equations. Garg, Poudel, Chiesaetal. [80] conducted an experiment to test the viscosity of copper nanoparticles in ethyleneglycol and found that the increase in viscosity was about four times of that predicted by the Einstein law of viscosity given by

$$M/ \mu_{bf} = 1+2.5\varphi \qquad 5$$

Where μ the viscosity of the nanofluid, $\mu_{bf}$ the viscosity of the base fluid, and φ the nanoparticle volume fraction. It had been reported that the viscosity of nanofluid depends on many parameters such as base fluid properties, particle volume fraction, particle size, particle shape, temperature, pH value, surfactants, dispersion techniques, particle sized is attribution, particle aggregation and temperature [81]. The viscosity models discussed here are generally applied to measure the viscosity of nanofluids. However, the criterion for validating their results with experimental results and limitations till need more attention. Further work is required to determine newmodels for viscosity of nano- fluids with different materials and to understand the effect of viscosity variation on natural convection heat transfer. Chen *et. al.* [82] measured the volume fraction and temperature effects on viscosity for multi walled carbon nanotubes (MWCNT's) with distilled water for a temperature range of 5– 65 °C. They reported that viscosity increases accordingly with nanoparticle loadings when the volume fraction is higher than 0.4 vol%. Also, relative viscosity increases significantly with temperature after55 °C. Li et al. [83] measured the viscosity of water with CuO nanoparticles suspensions using a capillary viscometer. Results showed that the apparent viscosity of nanofluids Decreased with increasing temperature. However, as they pointed out, the capillary tube diameter may influence the apparent viscosity for higher nanoparticles mass fractions, especially at lower temperatures. Wangetal. [84] also measured the relative viscosity of Al2O3–water and Al2O3 ethyleneglycol nanofluids. Results showed similar trend of increase of relative viscosity with increased solid volume fraction for the two nanofluids. That means the desirable heat transfer increase may be offset by the undesired- able increase in pressure drop. In the experimental investigation of Sureshetal. [78], the Al2O3–Cu/water hybrid nanofluid is prepared by dispersing Al2O3– Cu nanoparticles in water. The concentration of particles varied from 0.001 to 0.02. It is well known that water is a Newtonian fluid because it continues to exemplify fluid properties no matter how fast it is stirred or mixed. Since the experimental results with the nanofluids also showed a linear relationship between the applied shear stress and the rate of shear, it is concluded that the addition of nanoparticles to water with volume concentration ranging from 0.001to 0.02do not change the Newtonian behavior of water. From the experimental results the viscosity of the hybrid nanofluid increases with volume concentrations. The increase in viscosity of the Al2O3–Cu/water hybrid nanofluids for volume concentrations 0.1%, 0.33%, 0.75%,1%, 2% are 8%, 22%, 54%,78%,115% respectively when compared to viscosity of water. It can also be understood that the difference between viscosity of the Al2O3–Cu/water hybrid nanofluids and that of Al2O3/water nanofluid at lower volume concentration sis very less while this differences very significant at higher volume concentrations.

## 7. Nanofluid specific heat

The specific heat of a substance c is the amount of heat required to change its temperature of unit mass (of one kilogram) of the substance by 1 kelvin [85]. The heat capacity of a mixture of substances is the sum of heat capacity of Individual heat capacities. i.e., Specific heat of nanofluid=Specific heat of base fluid + specific heat of nanoparticles, as the weight fraction of nanoparticles increases, the specific heat reduces [86]. The specific heat of material is quite an important property to define the thermal performance of any material [87]. Specific heats of nanofluids may differ according to the type of base fluids, nanomaterials, and concentration of nanoparticles found in base fluids [15]. Nowadays, the result of experimental data does not signal a discreet and clear-cut indication that there is the only reduction in the heat capacity with an increment of volume concentration, as has been reported by several academic figures. Experimental observations on various nanofluids show increase of specific heat capacity [88–96], whereas experimental observations exhibit decrease in specific heat capacity performed by many researchers [97, 98, 99–109].

The specific heat of nanofluid can be determined as function of the particle volume concentration using the following equation [108]:

$$(pCp)eff = (1- \varphi)\ (pCp)bf + \varphi(pCp)p \qquad (6)$$

$$Peff = (1- \varphi)\ pbf + \varphi pp \qquad (7)$$

## 8. Application Of Nanofluids

Nanofluids can be considered as the future of heat transfer fluids in various heat transfer applications. They are expected to give better thermal performance than conventional fluids due to the presence of suspended nanoparticle which have high thermal conductivity. Lately, there have been numerous investigations that have revealed the enhancement of thermal conductivity and higher heat transfer rate of nanofluids [110]. Significant enhancement in the heat transfer rate with the use of various nanofluids in various application compared to conventional fluids have been reported by several researchers. Understanding the properties of nanofluids, such as thermal conductivity, viscosity, and specific heat, is very important for the utilization of nanofluids in various applications. Further study of the fundamentals for heat transfer and friction factors in the case of nanofluids is considered to be very important in order to extend the applications of nanofluids [110]. For their unique properties nanofluids there is increased in using of it in many fields and there was many research have been carried in reviewing this use [3] and here is out line for this use:

a) Heat Transfer Intensification:

Electronic Applications, 2. Transportation, 3. Industrial Cooling Applications, 4. Heating Buildings and Reducing Pollution, 5. Nuclear Systems Cooling, 6. Space and Defense.

b) Mass Transfer Enhancement

c) Energy Applications:

  1. Energy Storage, 2. Solar Absorption

d) Mechanical Applications:

  1. Friction Reduction, 2. Magnetic Sealing

e) Biomedical Application:

  1. Antibacterial Activity, 2. Nanodrug Delivery

f) Other Applications:

1. Intensify Microreactors, 2. Nanofluids as Vehicular Brake Fluids, 3. Nanofluids-Based Microbial Fuel Cell, 4. Nanofluids with Unique Optical Properties.

Recently there is a new direction in the use of hybrid nanofluids, hybrid nanofluids are prepared by blending two different kinds of nanoparticles in the same base fluid to have greater thermophysical, optical, rheological, and morphological properties. Hybrid nanofluids are projected to replace simple nanofluids due to quite a number of reasons such as wide absorption range, lower extinction, high thermal conductivity, low pressure-drop, and low frictional losses and pumping power as compared to the mono nanofluids [111]. Hybrid nanofluids have been tested for various applications like solar collectors, photovoltaic thermal applications, electronic component thermal management, photovoltaic thermal management, machine cutting, engine applications, and automotive cooling.

# 9. Conclusion

Fluids with nanoparticles suspended in them are called nanofluids, there are mainly two methods of preparation and the other created methods is still under study, the only problem is the stability of the suspended nanoparticles which agglomerated with time, the characterization methods used to determine nanofluids depend on its application and the properties of the nanoparticles used in this fluid, in spite of this difficulty in the stability of this fluids which could be enhanced by several techniques nanofluids found many application in a wide field and still subject of interesting in the research field.

## Acknowledgement

Include if any.

## Author Deceleration

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