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EXPERIMENTAL INVESTIGATION OF ABSORPTION AND THERMAL ANALYSIS OF DIFFERENT TYPES OF NANOPARTICLES WITH MOTOR OIL BASED NANOFLUIDS

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Highlights

- This study investigated the physical properties of two types of engine oil nanofluids.
- Different types of theoretical models were utilized and compared with the experimental results.
- This study focuses on finding the absorbance, specific heat capacity, thermal conductivity and viscosity experimentally.

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ABSTRACT: Nanofluids are fluid suspensions of nanoparticles that exhibit notable properties enhancement even at low nanoparticle concentrations. This work compares the measured and calculated thermophysical parameters of nanofluidic motor oil. Thermophysical parameters of motor oils include thermal conductivity, viscosity, and Absorbance. The nanofluidic engine oil was prepared by dispersing multi-walled carbon nanotube (MWCNTs) and copper oxide (CuO) at different particle concentrations (0.03-0.12) %. The oil characteristics were measured at wide range of temperature. The viscosity data were found to be comparable to the numbers reported in literature. We found that the thermal conductivity increased up to five times with minor variance in some cases. The variation in thermal conductivity can be related to several reasons such as oil specifications and nanofluid preparation conditions. The measured Absorbance of the nanofluid is comparable to literature and has direct proportion relation with the volume fraction of nanoparticles.

Keywords: Absorption, Nanofluid, Thermal Conductivity, Viscosity

1. INTRODUCTION

In 1995, Choi introduced the concept of nanofluid [1], which is created by adding a certain amount of nanoparticles to the conventional working fluids such as, ethylene glycol, water, oils (like transformer oil, engine oil, paraffin oil and SAE oil) etc. The unique thermophysical properties of nanofluids and prospective applications related to heat transfer and mass transfer have increasingly attracted researchers in the past decade. Therefore, many researchers focused on investigation of thermophysical properties of nanofluid, like viscosity, absorption, thermal conductivity, etc. Engine oils are employed in more fields because of they function well in high-temperature environments and can be integrated into heat transfer systems at low-pressure. Also, when these oils mixing with nanoparticles, the specific heat capacity of this fluids decreases while the thermal conductive, density and viscosity are increases. In previous studies, many researchers have focused on dynamic viscosity and thermal conductivity. There are some literatures searched about absorption of nanofluids too. An abundance of studies and investigations have been conducted about using the nanofluid in more application as shown as in this works. Hemmat is investigated the thermal properties of MWCNT/SiO_2-oil nanofluid [2]. The samples demonstrated non-Newtonian behaviour at volume fraction above 1%, while at lower concentrations (1%), the examined nanofluid behaved like a Newtonian fluid. The use of MWCNT-ZnO/oil as a nanofluid was studied by [3]. This investigation determined that the nanofluid behaves like a Newtonian fluid via a wide temperature and concentration ranges. [4] investigated the dynamic viscosity of oil with MWCNT/SiO_2. They performed tests at varying temperatures and in varying concentrations. In addition, they put up a novel relation for estimating the dynamic viscosity of nanofluid at temperatures between (25 - 60) ^{o}C and volume fraction range (0-1) %. [5] conducted experimental research into the thermal characteristics of MWCNT between (40 – 100) °C by used motor oil with MWCNT as a

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nanofluid and varying volume fractions (0.1, 0.2, and 0.4%). [6] studied on the thermal performance of nanofluid ZnO with engine oil (10W40). The range of experimental conditions included volume fraction range (0.25- 2) % and temperature range (5- 55) °C. [7] studied on the thermal characteristics of hybrid nanoparticles MWCNT-SiO_2 with engine oil (20W50) at temperatures range (40 - 100) °C and different volume fractions from (0.05- 1) % MWCNT-SiO_2. As a rule, absorbance of nanofluid enhancement with volume fraction of nanoparticles increase; however, this relationship is not linear. Added for that, increasing in the absorbance of nanofluid does not always coincide with the number of nanoparticles added. Nanofluid absorption coefficients made from composite nanoparticles (TiO_2, TiO_2/Ag, and Ag) were compared with [8]. They found that the TiO_2/Ag nanoparticle composite has exceptional optical characteristics, and they studied how changing the nanofluid volume percentage affected light absorption. An increase in volume fraction was shown to be related with an incremental improvement absorption of nanofluid. [9] studied the physical characteristics for CNT with water as a nanofluid at different volume fraction ratios. It was found that absorption is linear proportional to the nanoparticle volume fraction. The optical characteristics of MWCNTs were studied by [10], but they utilized a different base fluid. The base fluid comprised EG, water, therminol-VP-1, and propylene glycol. They mentioned that MWCNT-containing nanofluids are the most comprehensive absorbers of solar radiation across the spectrum. Small particle size and low concentrations did not prevent these nanofluids from absorbing nearly one hundred percent of the solar spectrum's energy. The optical characteristics of SWCNHs nanoparticle into water and glycol are studied by [11]. This research establishes the linear relationship between volume fraction or CNT particle size and light absorption. Researchers looked at how the size of SWCNHs [12] suspended in water affected their ability to soak up the light. In this research, it has been shown that the absorption coefficient is directly related with sizing of the nanoparticles; however, due to the enormous amount of scattering experienced by such massive particles, this relationship does not hold. The optical characteristics of the single-walled carbon nanotube (SWCNT) were examined by [13] using CuS as a base nanofluid. absorption was shown to be boosted for CuS nanofluids. Compared to Cu and SWCNT, SWCNT-CuS nanofluids performed better and absorbed more sunlight. Distilled water was employed as the nanofluid in an experiment by [14] to study carbon black's optical and photo-thermal characteristics. Carbon and water-based nanofluids exhibited a high absorption range and low transmission of solar radiation. [15] investigated on the physical characteristics of nanofluid at lower and higher temperature range. Light absorption was dramatically enhanced by including SWCNT. Karami used CuO with H2O-EG as a nanofluid at 0.01 vol.% improved the absorbed energy for nanofluid to 13.7% [16]. This study deals with two types of nanofluids, each having a specific ratio of volume fraction of nanoparticles, were used to test the effects of nanoparticles on thermal conductivity, viscosity, and Absorbance. This data was also compared to earlier findings and discussed. The aim of this study to clarify of the enhancement of Absorbance and thermal properties of nanofluids by added two types of nanoparticles separately to the engine oil (5W30).

2. MATERIAL AND METHODS

2.1. Material

Several distinct nanoparticle kinds were mixed with engine oil (5W30) at varying volume fractions (0.03, 0.06,0.09, and 0.12) to test the thermal and optical properties of nanofluids. CuO is used as a metallic nanoparticle and MWCNT as a non-metallic nanoparticle. Table 1 explains the physical specificities of nanofluid contains (nanoparticles and base fluid).

Table 1. Physical specificities of base fluid and nanoparticles.

		Nanoparticle types		Base fluid
Compounds		CuO	MWCNT	5W30
Main properties				
Manufacturing Company		Nanografi nanotechnology company		Motul
Purity		99.995%	> 99%	100% Synthetic
Morphology		Spherical	Cylindrical	Liquid
Particle Size (OD)	nm	15-45	18-28	
(ID)	nm		5-10	
Length	µm		15- 35	
Thermophysical properties				
Density	g/cm^3	6.5	2.2	0.851
Specific heat	J/Kg. k^o	531	711	1946.97
Thermal conductivity	W/m. K^o	33	3000	
Viscosity at 40°C	mm^2/s	0	0	70.1
Viscosity at 100°C	mm^2/s	0	0	12.1
Viscosity HTHS at 150°C	mPa.s	0	0	3.5
Refractive Index (n)		2.6	2.5	1.47
Color		Dark brown	Black	Dark yellow

2.2. Preparation and specifics of studied nanofluids

The preparation of samples conducted by used of the physical dispersion method through the ultrasonic solicitation. The preparation of nanofluid happened in the advanced technology research and application centre at Selcuk University. In this work used the measuring device is accuracy is up to 0.0001 and the model of ultrasonic device is a WUC-D10H Ultrasonic Cleaner. The operating condition of the ultrasonic frequency is a 60% from design power. The mixture time is two hours and temperature range of preparation process at (24-40) ^{o} C.

2.3. Measurements of thermophysical properties

In this study, focusing on three properties thermal conductivity, viscosity, and absorption.

2.3.1. Thermal conductivity

Nanofluid thermal conductivity was measured by using a Hot Disk TPS 500 model. These tests were carried out in the laboratories of the College of Science at the University of Anbar. The Hot Disk Thermal Constants Analyzer is the transient plane source (TPS) thermal characterization technique. The Hot Disk sensor factionalized as a heat source and as a dynamic temperature sensor. The measurement happened by running an electrical current lead to increase the temperature sensor up to several degrees and recording the increasing of resistance (temperature)with time. That represents a temperature function with time. During measurements processes used TPS sensor, was 5501 (radius 6.4 mm). The tests were performed at a room temperature of 21 ˚C.

2.3.2. Viscosity

The viscosity of these types of nanofluids is measured by using a Rotational Viscometer NDJ-4. It is a device used to find the dynamic viscosity of fluid at different temperature ranges also, for fluids whose viscosity value does not vary according to different flow conditions. These tests were carried out in the thermodynamics laboratory at Konya Technical University. This device is used to find the dynamic viscosity in many applications such as painting, engine oil, plastic grease..., etc. The tests calculate dynamic viscosity of the nanofluid in the temperature range (9 – 80) °C and the volume fraction range (0.03–0.12) %.

2.3.3. Absorption of nanofluids

To study nanofluid absorption, researchers varied path depth, base fluid types, and volume fraction. Researchers have found that higher metal oxide particle concentrations result in more excellent nanofluid absorption. All absorption experiments were performed in the SPL laboratory in the advanced technology research and application center at Selcuk University by used Biochrom Libra S22 Visible Spectrophotometer and these tests happened at room temperature approximately 22 ^{o}C.

3. RESULTS AND DISCUSSION

3.1. Thermal conductivity

The transient hotwire approach represents the most popular method for measuring thermal conductivity [17] as it characterized by fast calculation and high precision in repetitive observations. Nanoparticle material, size, shape, and volume fraction ratio has significant effect on thermal conductivity. Past research has developed many models that allow the thermal conductivity values to be computed for various concentrations and environmental circumstances. Many scholars, however, have doubts about these numbers' accuracy [19-20]. Measurements of conductivity for engine oils have been reported in the literature, showing maximum values between 0.12 and 0.16 (W/ m.^{o}k) that shift with temperature. The values obtained from experiments are 0.141 (W/ m.^{o}k) and 0.142 (W/ m.^{o}k), respectively. So, the value found in experiments is reasonable for this oil. The figure below compares the results of various tests performed on thermal conductivity.

As mentioned earlier, there are a lot of previous studies in verifying thermal conductivity, but most studies show that there are still contradictions, so the systematic experimental study of thermophysical properties of nanofluids is required to develop previous models and find other parameters to improve the thermal properties of industrial oils. Below are some of basic models used to estimate the thermal conductivity, which can be compared with our experimental results.

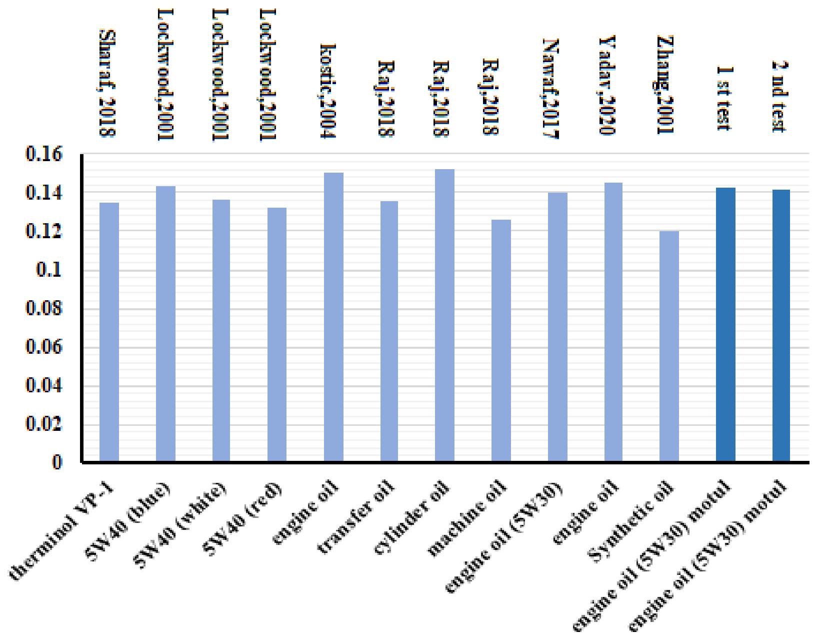

Figure 1. Comparison of the test results of previous studies on thermal conductivity

For the calculation of thermal conductivity there are two methods, the first method used a static model, which assume a stationary of nanoparticles in the base fluid such as Maxwell, Hamilton Crosser, and other researchers such as Jang and Prasher models [21], depend on random motion of the nanoparticles in fluid (Brownian motion) by using dynamic models. The maxwell model [20] was considered for the suspension, with low concentration of solid spherical particles homogeneously dispersed with no interaction between particles. The following equation gives Maxwell model:

$$K_{nf} = K_{bf}\left(\frac{K_{np}+2K_{nf}+2\varphi(K_{np}-K_{nf})}{K_{np}+2K_{nf}-\varphi(K_{np}-K_{nf}}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where K_{nf}, K_{bf} and K_{np} are the thermal conductivity of nanofluid, base fluid and nanoparticle respectively. Also, φ represent the volume fraction of mixture.

Hamilton and Crosser [20] suggested a similar thermal conductivity model for liquids with a little higher concentration by Wasp [19]. The model gives the same result as the Maxwell and Hamilton and Crosser models under spherical particles, with $\psi = 1$

$$K_{nf} = K_{bf}\left(\frac{K_{np}+2K_{nf}+2\varphi(K_{np}-K_{nf})}{K_{np}+2K_{nf}-\varphi(K_{np}-K_{nf}}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Hamilton–Crosser proposed a model for a nanofluid mixture of spherical and non-spherical particles by considering particle shape in calculation procedures. The empirical shape factor (n) can vary from 0.5 to 6.0, as shown in nanoparticle shape.

$$n=3/\psi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where K_{nf}, K_{bf} and K_{np} are the thermal conductivity of nanofluid, base fluid and nanoparticle respectively. Also, φ represent the volume fraction of mixture and ψ represents sphericity which is the ratio of the surface area of a sphere to the volume of a sphere. If the nanoparticle is spherical, the empirical shape factor (ψ) = one and equals 0.6, where the nanoparticle shape is the rod. The Hamilton–Crosser (H-C) model is given by:

$$K_{nf} = K_{bf}\left(\frac{K_{np}+(n-1)K_{bf}-(n-1)\,\varphi\,(K_{bf}-K_{np})}{K_{np}+(n-1)K_{bf}+\varphi\,(K_{bf}-K_{np})}\right) \ldots\ldots\ldots\ldots (4)$$

[22] recommended a different model for the thermal conductivity of nanofluid with homogeneous spherical particles as following:

$\varphi(\frac{K_{np}-K_{nf}}{K_{np}+2K_{nf}})$+ (1-φ) $(\frac{K_{bf}-K_{nf}}{K_{bf}+2K_{nf}})$ = 0 …………………...(5)

But Murshed and researchers offered a simple solution for Bruggeman model as:

Knf =$\frac{1}{4}$ [(3φ -1) *Knp +(2-3φ)Kbf]+$K_{bf}\,\frac{\sqrt{\Delta}}{4}$ …………….. (6)

Δ = $(3\varphi-1)^2\,(\frac{K_{np}}{K_{bf}})^2+(2-3\varphi)^2+2+9\varphi+9\varphi^2)\,(\frac{K_{np}}{K_{bf}})$ ……………. (7)

[23] recommended a model for the thermal conductivity of nanofluids by using CNT as a nanoparticle as;

K nf = Kbf $\left(\frac{1-\varphi+2\varphi\frac{K_{np}}{(K_{np}-K_{bf})}\ln\frac{(K_{np}+K_{bf})}{2K_{bf}}}{1-\varphi+2\varphi\frac{K_{bf}}{(K_{np}-K_{bf})}\ln\frac{(K_{np}+K_{bf})}{2K_{bf}}}\right)$ ……………. (8)

Although various models have been tried to predict the experimental results, a general method has not been established to calculate the thermal conductivity of fluids containing a different type of nanoparticle [24], or to predict the influence of the increase of nanoparticle volume fraction. Generally, nanoparticles are used to enhancement of thermal conductivity of fluids by adding them to base fluids. In this study we used enhancement of thermal conductivity ratio (ER) to clarification of effect of adding the nanoparticle. This ratio can be calculated by the following equation:

ER % = (K_{np} -K_{bf})/K_{bf} .... (9)

Figures 2 and 3 showed the experimental results compared with some theoretical models of thermal conductivity for both nanoparticle types (MWCNT and CuO) with engine oil (5W30).

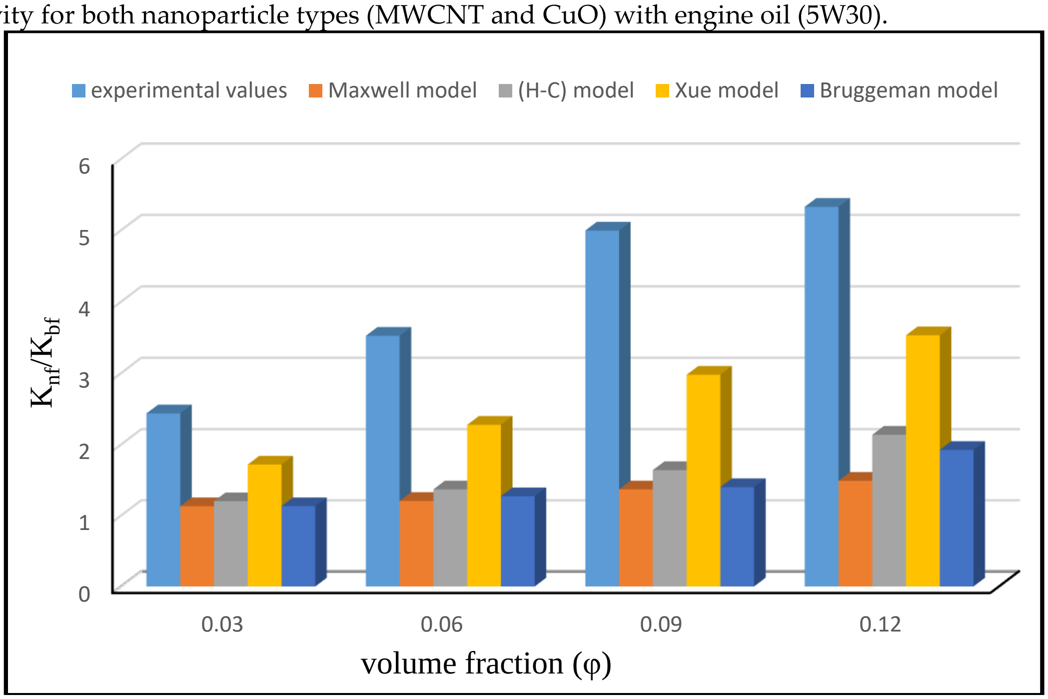

Figure 2. Comparison between MWCNT with 5W30 as a nanofluid and theoretical models of thermal conductivity.

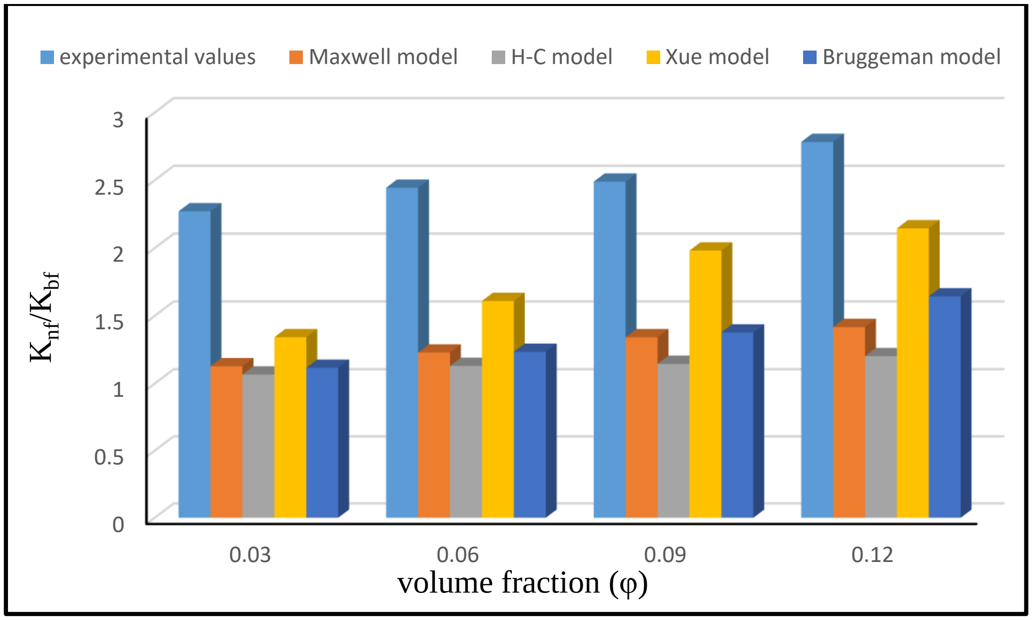

Figure 3. Comparison between CuO with 5W30 as a nanofluid and theoretical models of thermal conductivity.

Figures 2 and 3 showed the enhancement of thermal conductivity when added both nanoparticle types with 5W30. The enhancement rate increased with volume fraction increase. And the enhancement of thermal conductivity for experimental results higher than theoretical models. In previous works, Moghaddam used MWCNT-CuO/Oil (SAE40) as a nanofluid at a temperature limit (25–50) °C for a volume fraction between 0.0625–1%. The enhancement ratio rises to 29.53% [25]. Karami used CuO with H2O-EG as a nanofluid at 0.01 vol.% improved to 4 times [16]. And it was observed that thermal conductivity was enhanced by 44 % at only 0.052 % volume concentration of copper nanoparticles in oil [26]. Zhang dispersed 1 % of multi-walled carbon nanotubes into the oil. The enhancement in thermal conductivity reached to 160 %. In another study reported an enhancement exceeding 250% at 1.0 vol% of MWNTs in oil nanofluid [27]. The measurement of thermal conductivity of MWCNT with 5W30 as a nanofluid indicates some variation in the results between the theoretical models and the experimental results as shown as in figure 2. A similar trend with less deviation between theoretical models and experimental results was observed in CuO nanofluidic oil as shown in figure 3. As we mentioned earlier there are many studies that confirmed the inaccuracy of the conventional equations in calculation of thermal conductivity of nanofluids [18-19]. Munish confirmed that this is due to many reasons that must be studied carefully (effect of nanoparticle size, effect of nanoparticle shape and effect of nanoparticle type). The Xue model of thermal conductivity values are very close to the measured values for these nanofluids. Figure 4 showed the enhancement ratio of thermal conductivity for nanofluids types MWCNT and CuO with 5W30 respectively.

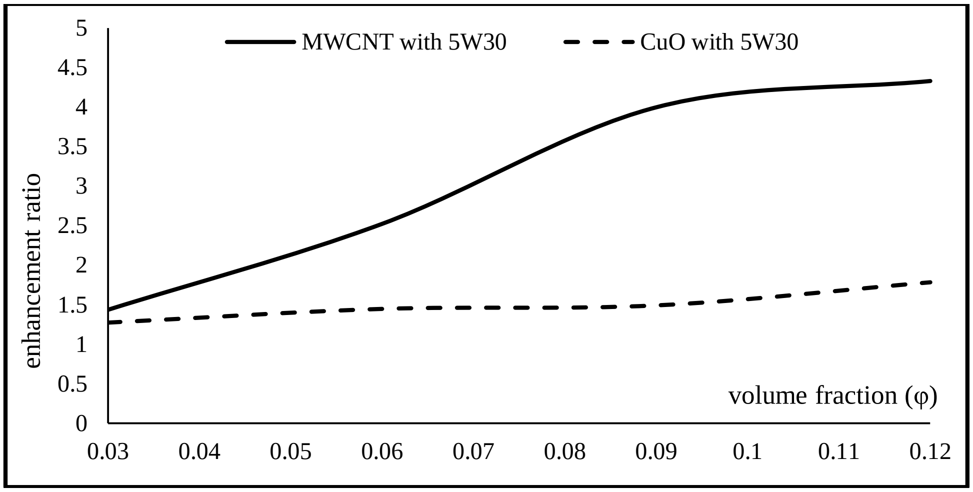

Figure 4. Comparison of experimental results between MWCNT and CuO with 5W30

Figure 4 included the improvement of thermal conductivity by using two types of MWCNT and CuO with type of engine oil (5W30) at different volume fractions. From the figure above, the enhancement of thermal conductivity is affected by increased concentration of nanofluids. And the thermal conductivity values for MWCNT-based nanofluids display a higher value than CuO. Therefore, MWCNT become attractive to many researchers in recent years due to its excellent thermal conductivity.

3.1. Viscosity

As mentioned earlier we used the Rotational Viscometer NDJ-4 to find the viscosity values of fluids. Experiments were conducted with used a temperature sensor had a control precision of 0.1 °C (-80 - +80) °C. In the experimental work the viscosity of fluids measured in the temperature range (10.2-74.5) °C. At first, we measured the viscosity value of base fluid (5W30) and compared with manufacturing values of MOTUL company to confirm assure the viscosity within the recommended range. The difference between experimental results and theoretical models values had been investigated by a deviation analysis using Eq. (6) [28].

$$DEV=\frac{\mu_{exp}-\mu_{thero}}{\mu_{exp}}*100\% \text{ .... } (10)$$

The figure 5 showed the deviation ratio of measured viscosity at temperature range between (0-100) °C. This ratio must be less than 4% [28].

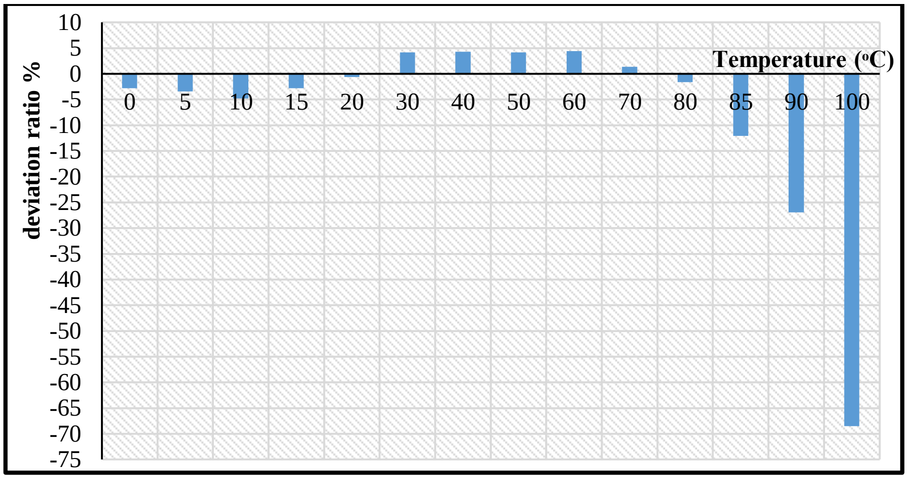

Figure 5. Deviation ratio of measured viscosity from the oil datasheet.

In the figure above, the viscosity values between (80-85) ^oC can be considered acceptable, but beyond 85^oC are not acceptable because the deviation ratio is very high.

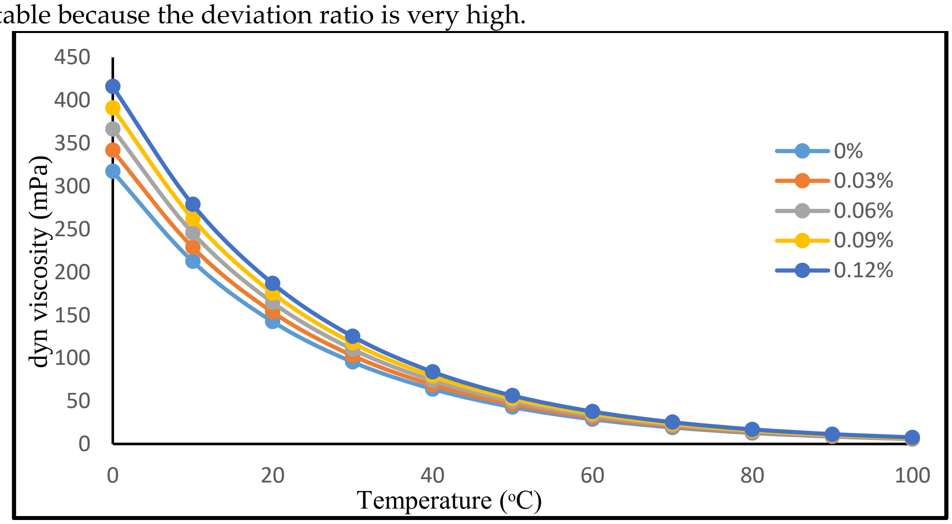

Figure 6. The dynamic viscosity as function of temperature and MWCT concentration for 5W30 oil.

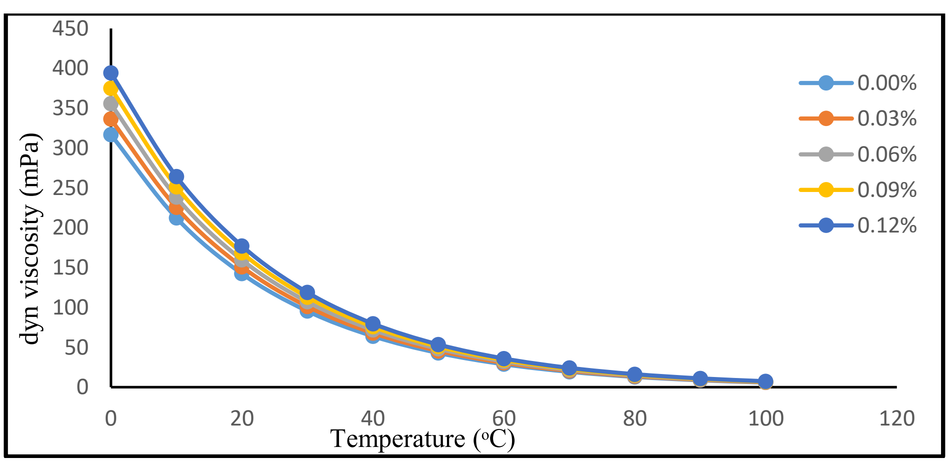

Figure 7. The viscosity as function of temperature and CuO particles concentration.

Figures 6 and 7 showed the relation between viscosity measured with temperature at different volume fraction. Both types of nanofluids have a convergent Newtonian behaviour and non-linear relation between dynamic viscosity with temperature which is consistent with all previous studies.

For example, non-linear decrease of the viscosity of nanofluid (MWCNT with engine oil) by increasing the temperature has been reported. This test happened by using a volume fraction ratio of 0 to 1 wt. % in the temperature limit of 25 to 90 °C [29]. Some previous studies neglected a few effects on the nanofluid viscosity (particle weight, size, temperature, particle shape and effect of nanoparticle types [30]. This work discussed the effect of nanoparticle type, and it was found that there is a slight difference between the use of both types as shown as in figure 8. This figure showed the relationship between the difference between the viscosity values of two types of nanoparticles with different of volume fraction.

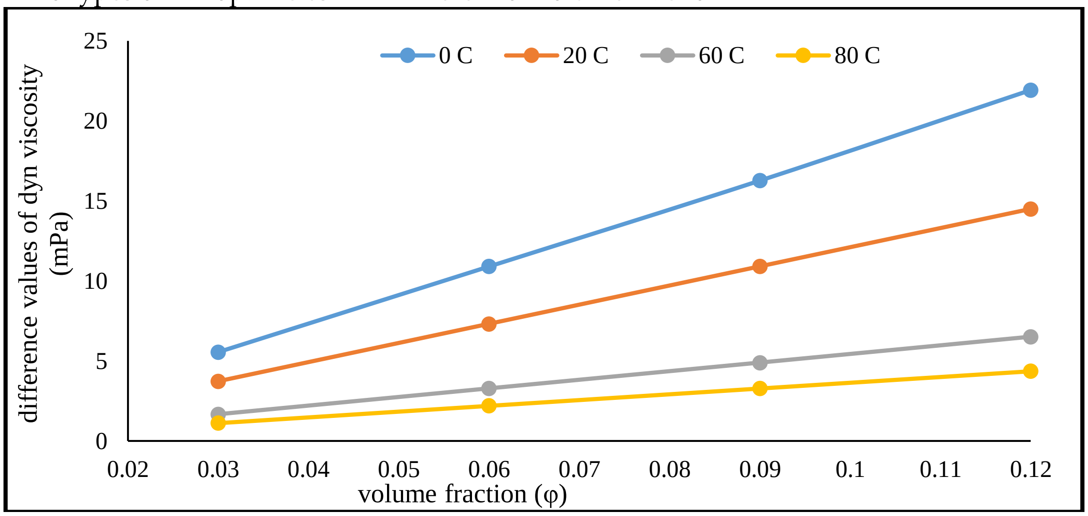

Figure 8. Measured viscosity at different volume fraction and temperature

To further investigate in the viscosity of nanofluid, a comparison was made between the experimental results and theoretical models. In this study, these theoretical equations have been used.

- Einstein model $\mu_{nf} = (1 + 2.5\varphi)\,\mu_{bf}$

Where μ_{nf}, μ_{bf} and φ represent the dynamic viscosity of nanofluid, dynamic viscosity of base fluid and volume fraction of nanoparticle respectively. This function was appropriate at lower particle volume fraction $\varphi < 2\%$ [18].

- Brinkman model $\mu_{nf} = \mu_{bf}\left(\frac{1}{(1-\varphi)^{2.5}}\right)$

Extended Einstein equation for average particle volume fraction and μ_{nf}, μ_{bf} and φ represent the dynamic viscosity of nanofluid, dynamic viscosity of base fluid and volume fraction of nanoparticle respectively [18].

- Batchelor model $\mu_{nf}, = \mu_{bf}\,(1 + 2.5\,\varphi + 6.5\,\varphi^2)$

Considered the effect of Brownian motion of particles for suspension of rigid and spherical particles and μ_{nf}, μ_{bf} and φ represent the dynamic viscosity of nanofluid, dynamic viscosity of base fluid and volume fraction of nanoparticle respectively [18].

- Sunder 1 $\mu_{nf} = \mu_{bf}\,(1+\varphi)^{0.68}$
- Sunder 2 $\mu_{nf} = \mu_{bf}\,(1+\varphi)^{1.205}$

Sunder models used Fe3O4 with EG/water at different volume fraction (0-1) % [30].

The figure 9 include the comparison between experimental result and theoretical results for MWCNT with engine oil.

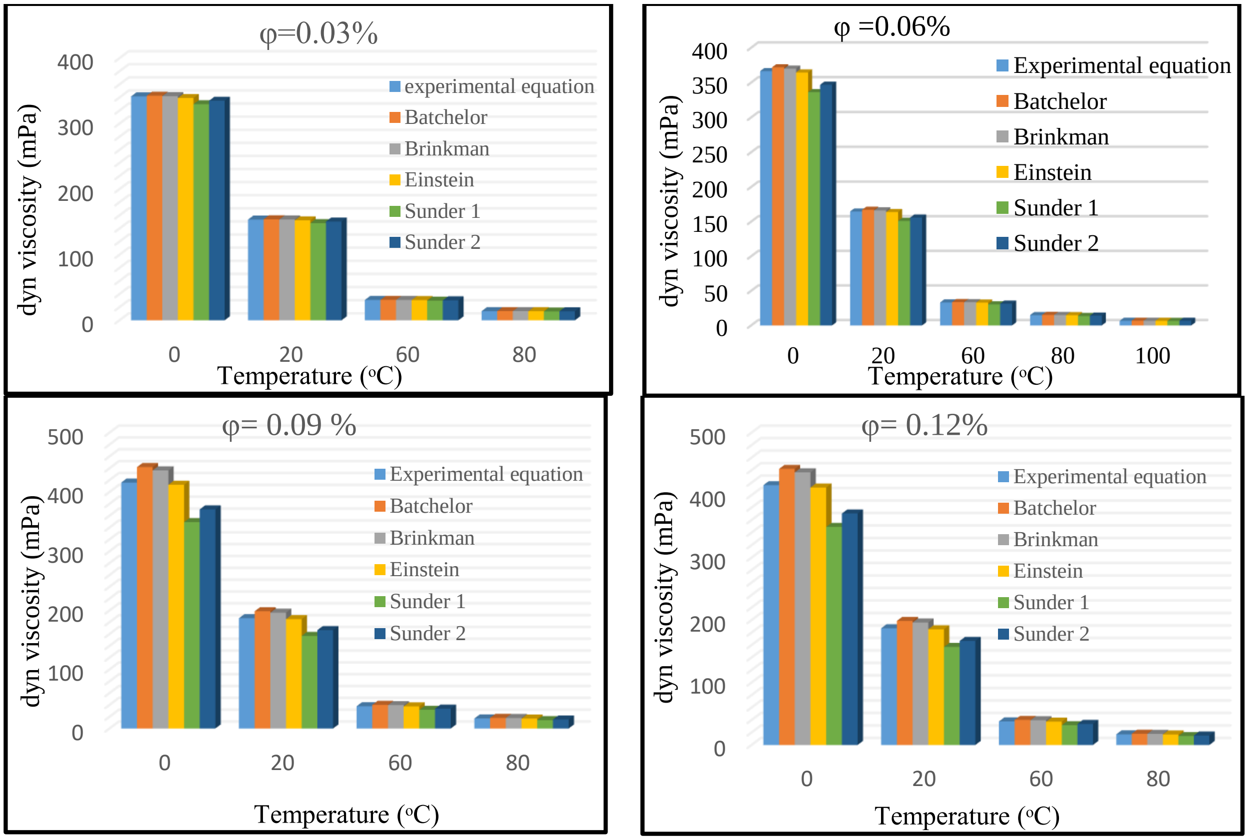

Figure 9 Viscosity results compared with other thermo-optical models for MWCNT nanofluid oil.

From the figures above, we notice that the difference between the experimental results and the results of theoretical models is little, and it is increase with volume fraction increase.

3.2. Absorbance

The intensity of absorption in nanofluids is affected by some factors, type of nanoparticle, size of the nanoparticle, volume fraction, type of base fluid and thickness of nanofluid. In this study focusing on the effect of nanoparticle type, nanoparticle sizing and volume fraction by used the MWCNT and CuO with engine oil. The figures 11 and 12 showed the intensity of absorption for nanofluid types at different volume fraction.

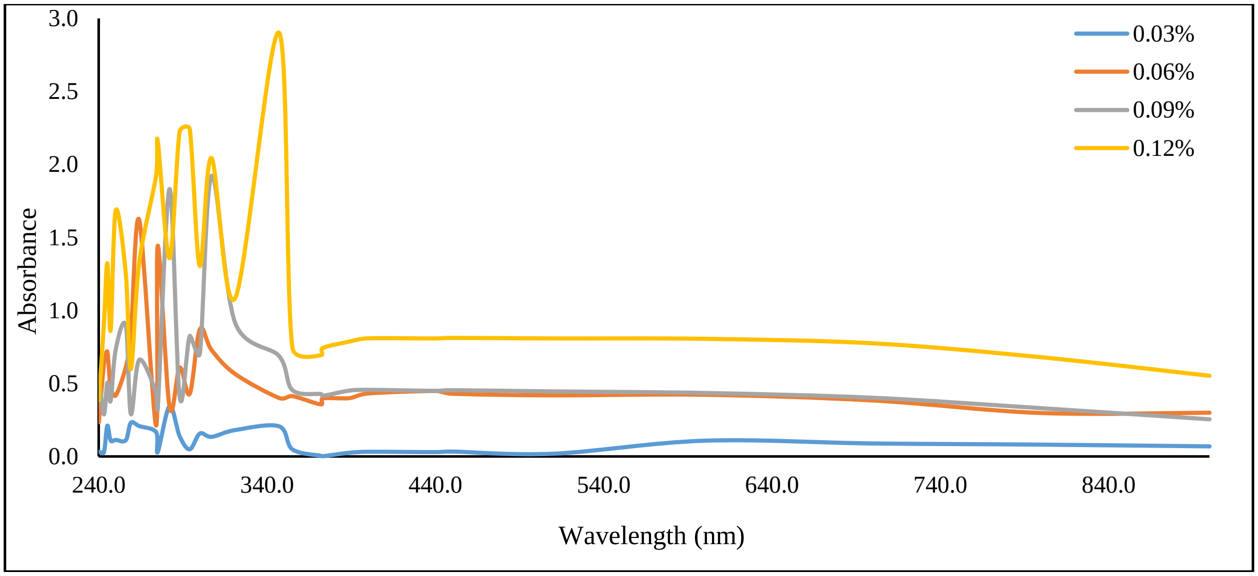

Figure 10. The absorption values for CuO with 5W30 as a nanofluid at different volume fraction ratio and wavelength.

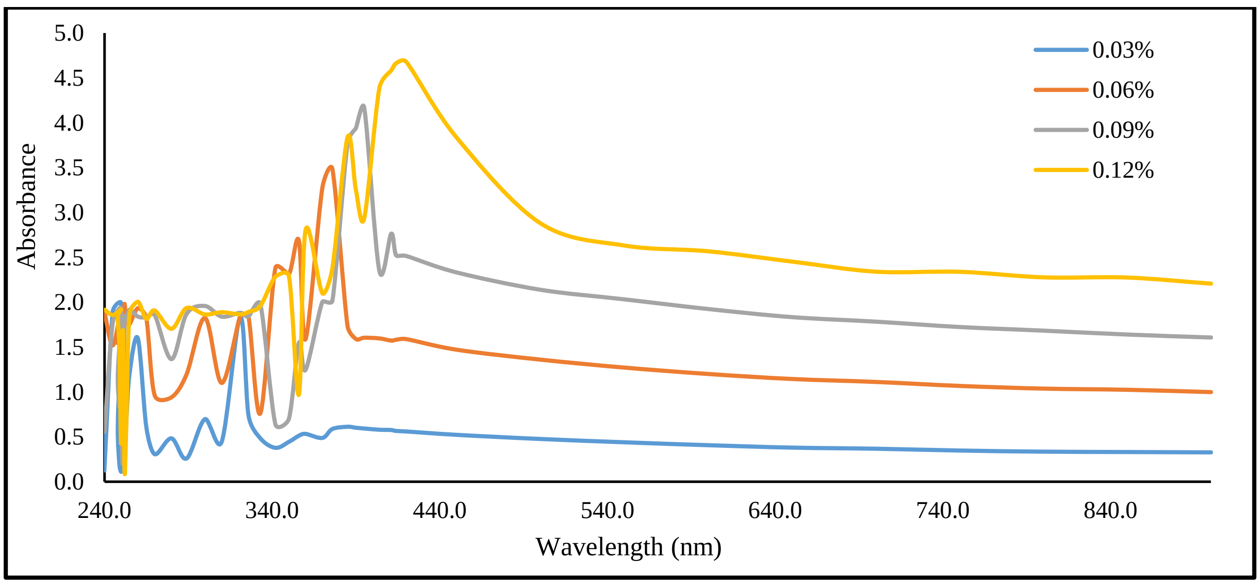

Figure 11. The absorption values for MWCNT with 5W30 as a nanofluid at different volume fraction ratio and wavelength.

From figures above, the effect of nanoparticle types seems obvious, as the absorption intensity of MWCNT particles are better than CuO particles and absorption intensity for both types of nanofluid affected by volume fraction of nanoparticle. The volume fraction of nanoparticle has a positive effect on the absorptivity, and we noted a little change in the wavelength at maximum intensity. The range of this change for MWCNT is (260-400) and for CuO is (260-330) nm. The reason for this change is due to the effect of nanoparticle size and volume fraction ratio, both of which have a direct effect on the wavelength and absorbance. The absorption coefficient can be calculated using equation (11).

$$Ka = \frac{1}{L}\ln\frac{I_o}{I} = \frac{\ln 10}{L}\log_{10}\frac{I_o}{I} = 2.303\,\frac{A_{abs}}{L} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(11)}$$

Where the L represents the path length through the sample, L is 10 mm for the quartz cuvette used in

Biochrom Libra S22 Visible Spectrophotometer and A_{abs} represent the intensity of absorption. Table 2 explains the absorption coefficient (m^{-1}) values for experimental tests and previous studies for the same nanofluid contents.

Table 2. The absorption coefficient (m^{-1}) for experimental values and previous studies

Nanofluid contents		φ %	0.025	0.05	0.055	0.06	0.075	0.09	0.1	0.12
Resulting test	Base fluid	nanoparticle								
	5W30 (motul)	MWCNT	45.81			802		958.7		1077.6
	5W30 (motul)	CuO (15-45) nm	53.2			373		443		668.6
Chen, 2016	WD 350	CuO		75.94		150	214.38		345.49	
Xu, 2015	synthetic oil.	CuO (200nm)			103					

As mentioned earlier, there are many factors that affect absorbance values so, there is no way to validity of experimental results except by re-examination. However, some previous studies show some absorbance results. Therefore, if these results are compared with similar nanofluids in previous studies, they can be considered acceptable.

4. CONCLUSION

In conclusion, this study investigated the physical properties of two types of engine oil nanofluids. Different types of theoretical models were utilized and compared with the experimental results. A sweep for particle volume fraction was investigated. The main findings of this work are summarized in the following list.

1. MWCNT and CuO with 5W30 as nanofluids enhances the absorption and thermal properties of the 5W30 oil. The thermal properties of the nanofluid for MWCNT with 5W30 have the same trend as CuO fluid but with a higher magnitude of all measured properties.
2. The theoretical models for thermal conductivity showed inconsistent results between all the utilized models. However, the viscosity models proved to have a great agreement with the experimental results and predicted the viscosity more accurately in the range between (0-80) ^{o}C.
3. The MWCNTs nanofluids has thermal conductivity and absorbance of 2-folds of that for the nanofluid CuO oil.
4. The measured absorption of the nanofluid is affected by different factors such as nanoparticle type, base fluid type, and the volume fraction of nanoparticle. However, our results are still comparable to the reported number in literature.

Nomenclature

φ	Volume fraction.
Ψ	Sphericity
ΔT	Difference of temperature.
CuO	Copper oxide.
*MWCNT*s	Multi-walled carbon nanotube.
k	Thermal conductivity.
μ	Dynamic viscosity of nanofluid.

Ka	Absorption coefficient.
DEV	Deviation analysis values
EG	Ethylene glycol
ER	Enhancement ratio.
ID	Inlet diameter
OD	Outlet diameter

Declaration of Ethical Standards

The authors paid attention to the ethical rules while writing the manuscript and the authors have full consent to the publication of the manuscript.

Credit Authorship Contribution Statement

All authors worked on this article. For example, Jasim Mohammad Abid ALENEZY and Dr, Amar Hasan HAMEED worked on thermal conductivity. Also, Jasim Mohammad Abid ALENEZY and Prof, Rafet YAPICI worked on other properties.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships.

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Data Availability

There is no available data.

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