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Improve Diesel Properties by using Al_2O_3 Nanoparticles

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Abstract: In this research, were studied the thermophysical property of Al_2O_3 NPs with a particle size of 30 nm in diesel fuel nanofluid which was brought from Al-Rashid Oil company in Iraq for attention because of emissions of pollutant from traditional fuels, fossil fuel reserves dropping, petroleum costs increment and further severe release protocols. The weight fractions used were 0.1, 0.5, 1 and 1.5% and at diverse compositions for the range temperatures from 303-353 K on the thermal conductivity, pH, viscosity, flash point and fire point values of nano fluid were characterized. Experimental results showed that the thermal conductivity of Al_2O_3 NP_{sis} enhanced as much as 77 at 1% under 80°C. Flash point enhancement about 8%.

Key words: Nanofluids, thermal conductivity, viscosity, diesel, Al_2O_3 nanoparticals, company

INTRODUCTION

Diesel fuel is a liquid used in engines of diesel whose ignition of fuel occur without any spark as a outcome of the entrance air mixture compression and then fuel insertion. Engines of diesel have found wide procedure as a outcome of higher efficiency of thermodynamic and fuel. This is renowned anywhere engines of diesel are run at part-load as their air source is not throttled as in engine of petrol, their efficiency still stays very high. As a result of population growth and increased fuel use leads to the depletion of fuel reserves, so, we need to look for alternative energy.

Diesel engine contest vital role in applications of vehicular. Because of negative effects of diesel engine such as little ignition efficiency, high freezing point and high content of impurity, so that, are used nanoparticles that have surface area to enhance the characteristics of physicochemical of fuel and lower the release of harmful pollutants by Raja and Sathinathan (2015).

Venkatesan (2015) studied the effect of nano-aluminum oxide mixed with diesel, to conclude combustion, performance and also emissions diesel engine properties at different volume concentrations with different load conditions, the results shown the brake thermal efficiency enhancement. And also, they observed reducing the NOX and Unburnt Hydrocarbon (UBHC) content at all the loads because of nano Al_2O_3's.

Abdel-Rahim and Akl (2016) investigated the efficiency of an engine and properties of emission by the addendum of Al_2O_3 nanoparticles to the base fluid. They used two volume concentration in a single cylinder, direct injection four stroke diesel engine. The results showed enhancement the diesel performance engines and decrease the discharge of pollutants with concentration of nanoparticle of 0.5% offers improved performance properties in proportion with that of 0.1%.

Kaviyarasu *et al*. (2018) studied creation of biodiesel from recycled cooking oil by using alumina nanoparticles. An experimental set-up involving of a single-cylinder four stroke and showed improvement in the efficiency of brake thermal and reducing emissions from diesel fuel.

In the present study, the thermophysical properties of Al_2O_3 nanoparticles in base fluids of diesel in the temperature ranges of 30-80°C at different volume concentrations of nanoparticles (0.1, 0.5, 1 and 1.5%) was investigated.

MATERIALS AND METHODS

Preparation of nanofluids: Al_2O_3/diesel nanofluids have been prepared by two step method by dispersing desired volume fractions of Al_2O_3 (0.1, 0.5, 1 and 1.5%) the average size of 30 nm in diesel. Diesel was used as the base fluid for preparation Al_2O_3 nanofluids. It was supplied from the Ministry of Oil-Mid land Refineries

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Table 1: Some properties of diesel

Variables	Values
Density	830 (kg/m^3)
Sp. gravity @ 40C	0.849
Diesel index	62.200
Cetane No.	58.500

Table 2: Properties of Al_2O_3 nanoparticles

Variables	Values
Average particle diameter (nm)	30
Purity (%)	99.99
Density (kg/m^3)	3700

company in Iraq. Table 1 shows some common properties of the diesel. The suspension of nanoparticales with the base fluid was stirred thoroughly for 30 min in an ultrasonic homogenizer for making uniform suspension Al_2O_3 nanoparticles in diesel. Table 2 shows the properties of the Al_2O_3 nanoparticles, (ordered from USA nanomaterials co., www.us-nano.com).

Determination properties of nanofluids: The thermal conductivity, viscosity, pH, density, flash and fire point were measured using standard test methods. Thermal conductivity was studied using a thermal conductivity meter (KD2 Pro, Decagon device, USA). A viscometer (Fungilab) was used for viscosity measurement (dynamic viscosity). pH parameter was deliberate by employing a pocket-sized pH meter with replaceable electrode (Inolab pH 7110). Testing of the fire point is done by open cup apparatus.

RESULTS AND DISCUSSION

Figure 1 shows thermal conductivity increasing with increasing particle volume fraction. The extreme enhancement in thermal conductivity practical for 1% volume concentration in 80°C was 67% due to the role of Brownian motion of particles in nanofluids play needful factor to enhance the conductivity where high relations between the base fluid and nanoparticle. This has been illustrate in expressions of the formation interfacial nanolayers round the nanoparticles and clustering of nanoparticle. The layer of interface created about the nanoparticle doing as a bridge of thermal between the base fluid and the nanoparticle investigated by Yu and Choi (2003).

The thermal conductivity value decreased from 0.72 for 1% volume concentration in 80°C-0.566 for 1.5% volume concentration. This is attributed to the impacts of nanoparticles which are known to presence clusters this clustering can make to fast heat transfer over comparatively large ranges by Babu *et al.* (2013).

When thermal conductivity is reducing, the temperatures of peak fire deck is increasing which creates higher fatigue stress levels.

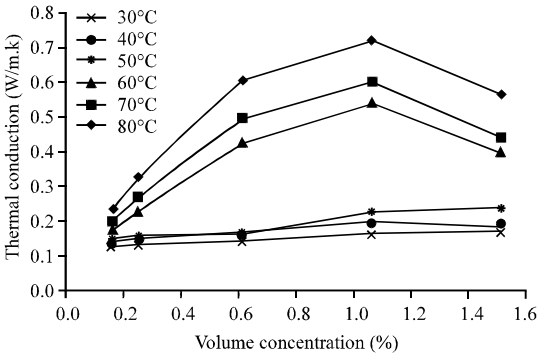

Fig. 1: Thermal conductivity of Al_2O_3/diesel nanofluids versus Al_2O_3 nanoparticle volume concentration at different temperatures

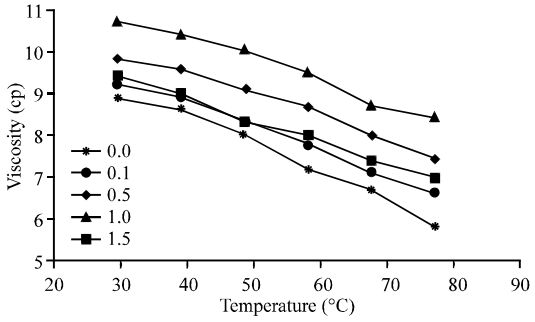

Fig. 2: The Al_2O_3/diesel nanofluids viscosity as a function of Al_2O_3 nanoparticles volume concentration at different temperatures

Figure 2 shows the viscosity of base fluids is increased when the concentration is increased. The nanofluid viscosity with 1% volume concentration declined near 23% with temperature different from 30-70°C. These results are in agreement with (Schaschke, 2013). When the temperature and the concentration are increasing, we get the results of inverse due to the clusters formation show that at 1.5% volume concentration. When the value of viscosity (either too high or too low) can lead to damage of fuel system.

The pH is known as the most significant factors which influences the aggregation of particle and the suspension stability. The fuel stabilizers slow the degradation to keep its quality of combustion as long as possible. The possibility of corrosion in material components increases when the value of PH decreases. Figure 3 shows that the pH value of Al_2O_3 NPs/DDW nanofluid increased with increasing particle volume fraction.

Flash points and fire points were measured at the Midl and Refineries Company laboratories. Table 3 shows the outcomes of flash point and fire point of Al_2O_3/diesel nanofluids.

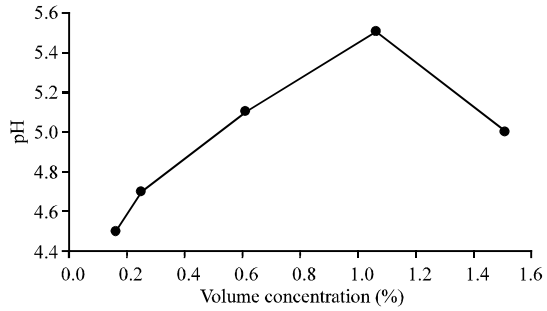

Fig. 3: pH of Al_2O_3/diesel nanofluids as a function of Al_2O_3 NPs

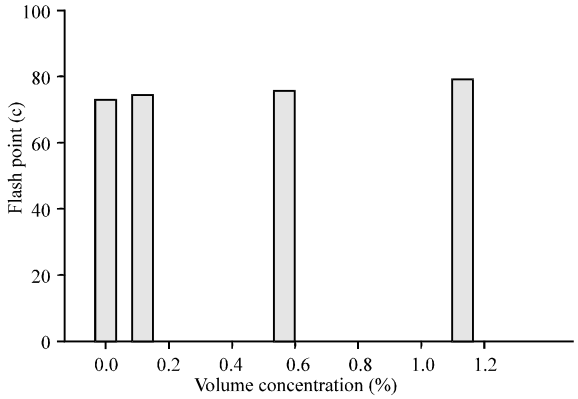

Fig. 4: Flash point of Al_2O_3/diesel under different volume concentration

Table 3: Fire point and flash point of Al_2O_3/diesel nanofluids

Variables	Fire point (°C)	Flash point (°C)
0 (diesel)	76	73
0.1% (diesel+Al_2O_3)	80	74
0.5% (diesel+Al_2O_3)	81	76
1% (diesel+Al_2O_3)	83	79

Flash point and fire point were calculated at three different concentrations of the original diesel. Flash point was important to account for any contamination with gasoline that occurred during movement of product from the refinery to the consumer. And flash point is lowest temperature that oil vapor when is contact with air and since, exposed to a catching fire takes fire an immediate as well as possible fastly extinguish (Ahmadi *et al*., 2013).

Figure 4 and 5 and Table 3 show a raise in the original diesel at flash point with the added of Al_2O_3 nanoparticles to the original diesel. Reducing the ignition of diesel through nanoparticles used. The improvement in value of flash point is about 8% of Al_2O_3NPs volume concentration values of 1%. Whenever diesel fuel has a high flash point, becomes more safety because he became less prone to burning.

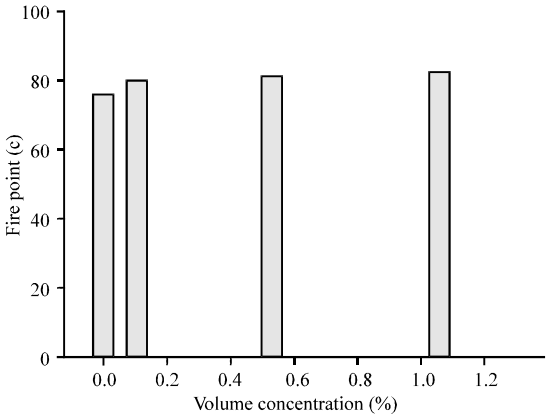

Fig. 5: Fire point of Al_2O_3/diesel under different volume concentration

The fire point of a fuel is the temperature at which the vapor continues to burn after it ignited. The improvement in fire point value is about 9% of Al_2O_3NPs volume concentration values of 1%.

CONCLUSION

In this research, Al_2O_3 NPs/Diesel nanofluids, enhance the mixture's thermal conductivity over the base-fluid values The results showed that the thermal conductivity improved with both volume fractions and temperature. The enhancement is 67% at 80°C from the base fluid by 1%. On the other hand, the viscosity of Al_2O_3 NPs suspension decreased about 33% when the temperature value improved from 30-80°C by 1% and increased with particle volume fraction.

By adding Al_2O_3 nanoparticles to the diesel fuel, flash point and fire point had been improved by 8 and 9% at 1% volume concentration, respectively, as matched to the diesel fuel with no Al_2O_3 NPs.

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