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INVESTIGATION OF DIFFERENT GRAPHENE CONTENT BLENDED ON COMMERCIAL LUBE OIL

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Abstract

Graphene, a nanosheet of hexagonally arrayed sp^2-bonded carbon atoms, has outstanding properties such as mechanical, electrical, thermal, and optical properties. These unique distinguished graphene properties made it the first candidate used for many applications to be developed. So, it is important to investigate the properties of commercial lube oil blended with different content of graphene. In this study, the physical properties of the different weight present of graphene blended on the commercial lube oil were investigated. The graphene was obtained from graphite powder through modifying hammer method. The physical properties of blended lube oil are investigated such as density, viscosity@40 ^{0}C, and viscosity@100 ^{0}C. It is noticed that the density of blended oil is not changed. The other properties are improved. This study concludes that graphene could be used as an additive to commercial lab oil. Furthermore, the properties of blended lube oil could be tune using the graphene content of the blended oil.

Key Words: **Graphene oxide – Thermal reduction – Lube oil.**

1. Introduction

Recently, 2D materials such as graphene attracted the interdisciplinary research field due to their amazing propertiesGraphene is a nanosheet of sp^2-bonded carbon atoms constructed a monolayer of carbon atom-thick material Ithas many fascinating properties such as high electrical, thermal, mechanical, and optical properties (1). These properties have remarkable dependence on its morphology and atomic structure, e.g. its size and shape (2).These sensitive responses of a graphene sheet to structural and environmental cues enable us opportunities to engineer its physical and chemical properties at the nanoscale (3). Nowadays, there are many synthesized graphene methods such as micromechanical exfoliation (4), chemical vapor deposition thermal expansion, andreduction from (5). According to the experimental conditions and properties of the parent graphite, extracting graphene by reducing graphene oxide has the benefit of regulating the amount of oxygen (6).

Friction and wear are considered parasitic events in the machinery and leads to energy wastage, material loss, and accelerated

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emissions(7) .Supplement of lubricants having task-specific additives is the most effective way to reduce friction and wear (8). In passenger cars, almost one-sixth of the fuel energy is consumed to overcome the engine and transmission friction losses (9) .A reduction of 1% friction inside the car's engine by improving the lubrication technology would result in a worldwide saving of 6.3 million barrels of fuel (gasoline or diesel) annually(10). So, improving lubrication oil properties considered one of the most important and promising subjects.

In this study, high-quality graphene is prepared. The blending of different wt. % of graphene is blended with the commercial lube oil. The physical properties such as viscosity of lube oil improved after adding graphene nano-sheet. This study argues that graphene is considered a good additive material for commercial lube oil.

2. Experimental Procedure

2.1.Preparation of Graphene Oxide (GO) and graphene.

To obtain the graphene oxide from graphite powder, a modified Hummers method was used [7, 8]. All chemicals were used as received (11). In detail, 2.0 g graphite powder mixed with 1.0 g sodium nitrate in concentric sulfuric acid under constant stirring at temperature does not exceed 20 ^{0}C. Afterward, 6.0 g potassium permanganate was added slowly, and the stirring was continued for 2h. The mixture solution temperature was raised to room temperature and adding 50 ml deionized (DI) water was slowly. Finally, 140 ml of DI water was added, and 10 ml of H_2O_2 aqueous solution (30%) to finalize the reaction. The resultant solution keeps overnight, and we are washing our product with HCl and DI water consecutively till the PH of the solution approaches natural value (~7). The resulting mixture was washed with HCl and H_2O respectively followed by filtration and drying, then graphene oxide sheets were obtained. To reduce the GO to get graphene, 0.5 g of GO powder was inserted into an oven at 350 ^{0}C for 10 min, and an increase in the powder volume was observed. The obtained powder is called thermal reduced graphene oxide (TRGO) (12).

2.2 Graphene blended the lube oil.

In this study, the Mobil DELVAC 1350 (Monograde SAE 50) heavy-duty diesel oil was used as base oil. Furthermore, TRGO powder is blended with the lube oil with different concentrations. In detail, the TRGO powder with different wt.% is dispersed by sonication (300 W) for 1 h, attaining homogeneous base oil with concentrations 0.01, 0.02, 0.04, and 0.06 wt.%.

2.3 Material characterizations

To ensure the quality of the synthesized TRGO, it was analyzed using high-resolution transmission electron microscopy (TEM)(13). TEM images were taken by a microscopy model JEM 1230 (JEOL JAPAN). Densitometer (DST-2000 Density) with a hydrometer is used to measure the density of oil samples at 20 ^{0}C. Furthermore, the viscosity with different temperatures 40 ^{0}C, and 100 ^{0}C is one of the most important required to characterize the oil. RM 100 CP2000 PLUS is a device able to measure the viscosity at different temperatures(14-15).

3. Results and discussions

3.1 Graphene characterization

To confirm the quality of the prepared graphene, TEM imaging of thermal reduced graphene oxide is performed. Figure 1 showed a wide area exfoliated layer of the graphene sheet. Graphene sheet image has some features such as collapses, folds, and bends at the edges. Those features are constructed at the sheet surface due to the reduction process, where the thermal energy is the main reason for those features.

Figure1. TEM image of thermal reduced graphene oxide.

In Figure (2) presents the photographic pictures of lube oil blended with TRGO samples. By comparing the blended samples with the pristine lube oil, it is observed that the color is quite dark due to the blended amount of TRGO powder. But it is noticeable that TRGO is completely dispersed in lube oil without any aggregations. This confirms that different amount of TRGO is well blended with commercial lube oil.

Figure 2 Photographic for samples

It is well known that the density of the lube oil is considered as one of the most important properties. Where the density performs a vital function in how a lubricant features, in addition to how machines work efficiently. Lube oil must have a specific density value, where for instance the density of a lubricant increases; the fluid becomes thicker and could not be sufficient for its application. So, it is important to test the density of lube oil. Fig. 3 represents the behavior of pristine lube oil, and lube oil blended with different content of TRGO. It is noticed that the TRGO blended to lube oil did not have a remarkable change in its density.

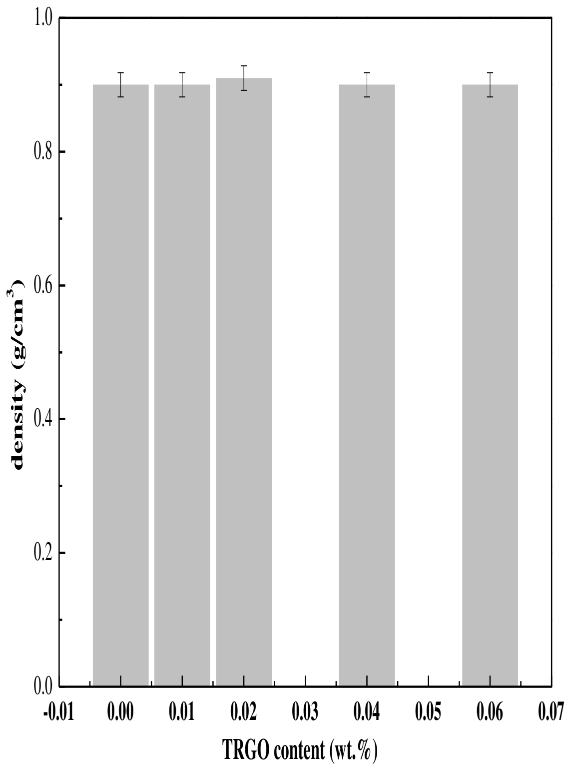

Figure 3 the density of TRGO/lube oil blend with different TRGOcontent.

Furthermore, it is important to check the other physical properties of lube oil blended with TRGO. It is well known that viscosity plays a crucial role in lube oil properties. Where the viscosity plays an impact on the quality, fatigue life of machinery, engines, and plays a major role in determining the oxidative stability of engine oils. Figure 4 depicts the variation of kinematic viscosity@ 40 °C of pristine lube oil and lube oil blended with different wt. % of TRGO. It is found that the viscosity is slightly increased after that, it is saturated at a higher value than a pristine sample. This behavior is quite a usual one because the viscosity will be increased due to the dispersion of TRGO in lube oil. The saturation behavior is due to the small amount of blended TRGO, which could not make too much effect.

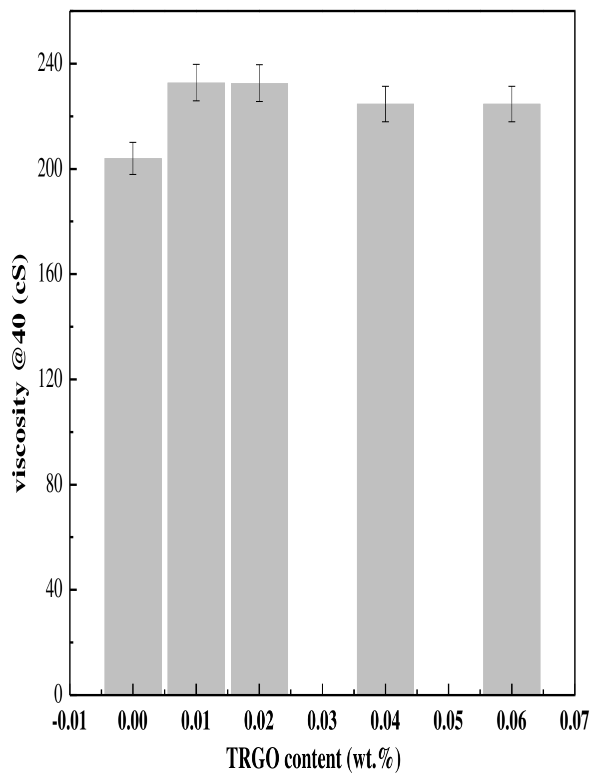

Figure 4. the viscosity @40 ^{0}C of TRGO/lube oil blend with different TRGO content.

Similarly, figure 5 depicts the variation of kinematic viscosity@ 100 °C of pristine lube oil and lube oil blended with different wt. % of TRGO. It is found the same behavior of viscosity@40 °C has happened @100 °C. This is also normal behavior. So, it is that the viscosity of lube oil is improved by blending it by TRGO, at the same time its density did not change.

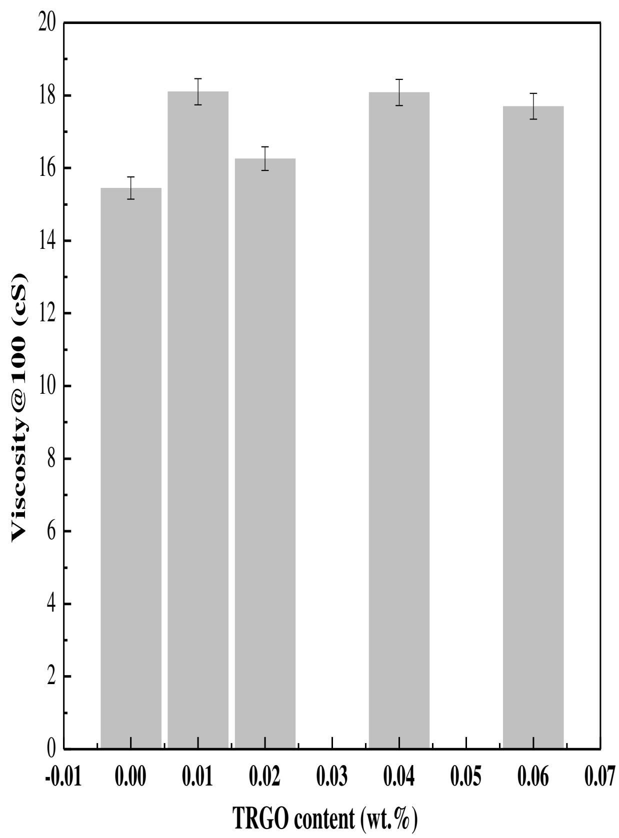

Figure 5 the viscosity @100 ^{0}C of TRGO/lube oil blend with different TRGO content

4. Conclusions

In this study, the thermal reduced graphene oxide is prepared with high quality. Furthermore, it is a well-dispersed with different wt. % of TRGO in commercial lube oil. The density of blended oil is not varied, at the same time the viscosity is improved. This study proposed that the TRGO is considered a good candidate as an additive of lube oil.

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