# GRAPHENE OXIDE AS NANO ADDITIVES IN BIODIESEL: CHARACTERIZATION AND DISPERSION STABILITY

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*Biodiesel can be a promising alternative to petroleum diesel, except its poorer performance and NOx production. Graphene oxide has become a popular additive for improving combustion efficiency and minimizing emissions. This study explored the stability characteristics of GO into waste cooking oil biodiesel, using a UV-Vis spectrophotometer. The GO suspension with 3 hours of sonication period found more stable. Highest absorbance value was found 0.620 for 100 ppm concentration with 3 hours of sonication period. The percentage drop in absorption after four days of 25 and 100 ppm concentration with 3 hours of sonication period was 21% and 4%, respectively.*

**Keywords**: Nano Additives, Graphene oxide, Biodiesel, Waste cooking oil.

## 1. Introduction

Energy consumption has grown in synch with population expansion. Fossil fuels are the most widely used energy resources in industry; resulting in rising greenhouse gas emissions. Emissions from diesel fuel combustion are harmful to the ecosystem [1-3]. Diesel engines have a wonderful reputation for low specific fuel consumption and reliability, because of their high compression ratio [4]. The scientific community is exploring for alternative resources such as biodiesel as an alternative fuel [5-8]. Biodiesel has poorer performance and produces more NOx than petroleum diesel [9]. Fuel additives to improve biodiesel qualities are becoming more popular as a way to overcome these constraints, and they have the potential to improve combustion performance while lowering emissions without modifying the engine [10-11]. In the reviewed study, carbon allotropes such as carbon nano tube and graphene oxide were used as additives in diesel and biodiesel fuel mixes [12-14].

Very few of the previous research have documented the use of nano-additives in waste cooking oil biodiesel blends to overcome their limitations [15]. As a result, the usage of viscous biodiesel containing nano-additives, such as waste cooking oil biodiesel, has a gap. Hence, inclusion and dispersion stability of

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Graphene oxide as nano additives to waste cooking oil biodiesel at three different dosage levels of 25, 50, and 100 ppm is explored in this study.

## 2. Materials

The Graphene oxide (GO) with 99% purity was purchased from the Shilpa Enterprises and the waste cooking oil biodiesel (BWCO) was made by transesterification of waste cooking oil.

## 3. Characterization

The graphene oxide was powdered and black in appearance. Fig. 1 shows the scanning electron microscopy (SEM) and transmission electron microscopy (TEM) images of graphene oxide.

The thickness of graphene oxide was 3 to 8 nm, with an average surface area of 180 $m^2/g$. The length of GO was in the range of 5 to 10 microns and the thermal conductivity was 5000 W/m-K. The specifications of graphene oxide is given in Table 1.

*Table 1*

**The specifications of graphene oxide**

| Specification | Explanations |
|---|---|
| Product Name | Graphene oxide |
| Average Length | 5 to 10 microns |
| Average Thickness | 3 to 8 nm |
| Number of layers | 3 to 6 layers |
| Surface Area | 180 $m^2/g$ |
| Purity | 99% |
| Thermal Conductivity | 5000 W/m-K |

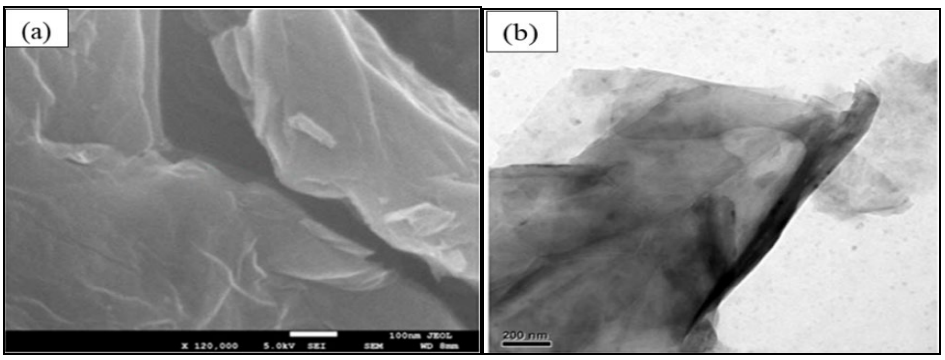


Fig. 1. (a) SEM and (b) TEM image of Graphene oxide

## 4. Preparation of dispersion

To create a homogeneous dispersion of 25, 50, and 100 ppm, the graphene oxide with weight of 1.25, 2.5 and 5 mg were mixed with 50 ml of BWCO. The dispersion were then homogenized for 1 hr, 2 hr, and 3 hr using a probe-based ultrasonicator (make LABMAN) device set to 24 kHz.

Fig. 2 and Fig. 3 show the setup of nanofluid preparation and the dispersed sample of GO in BWCO, respectively.

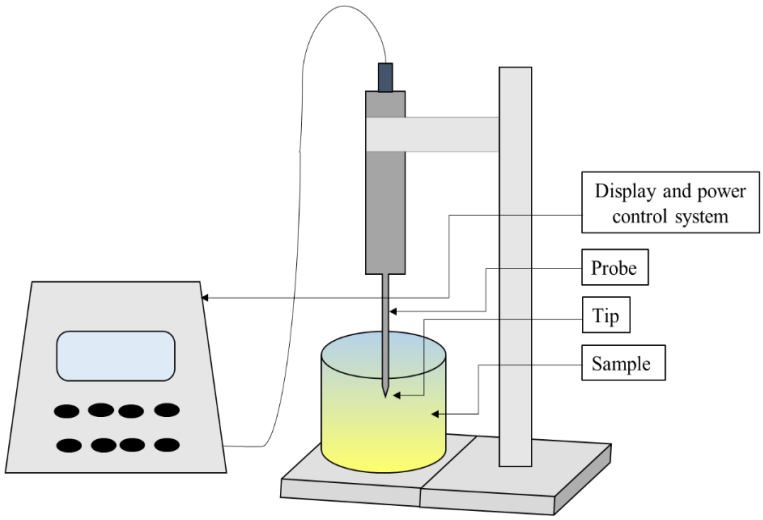


Fig. 2. Nanofluid preparation setup

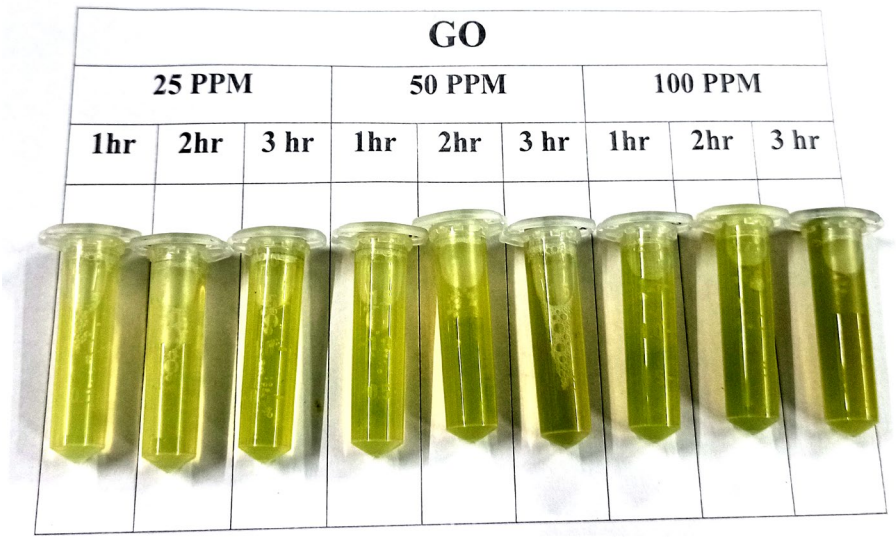


Fig. 3. Nanofluid sample of GO and BWCO


Fig. 4. V-730 UV-Vis spectrophotometer

## 5. Stability of the dispersion

Using a V-730 UV-Vis spectrophotometer (make JASCO), the dispersion characteristics of graphene oxide at varied concentrations and sonication times were investigated for four days. The V-730 UV-Vis spectrophotometer is shown in Fig.4.

BWCO was used as the reference sample, while the prepared dispersion as specimen sample. The reading was taken for the wavelength range of 200 to 1000 nm, scan speed of 400 nm/minute and a slit width of 5 nm.

## 6. Results and discussion

This section shows the effect of sonication time and GO concentration on nanofuels stability as a function of time.

Fig. 5, Fig. 6, and Fig. 7 show the effect of sonication duration on the stability of different GO concentrations. The absorbance decreased at the end of each day, because the graphene oxide started to agglomerate and settle with time. Furthermore, the absorbance drop of 25 ppm concentration with each day was more than that of 50 ppm and 100 ppm concentrations. This may be due to even sedimentation and agglomeration there was enough GO present to reflect more absorbance than that of a 25 ppm concentration. The GO suspension with 3 hours of sonication was more stable, regardless of concentration. These results are in close agreement with those of *Soudagar et al.* [13].

Fig. 8 and Fig. 9 show the absorbance values of GO nanofuels for all concentration. The highest absorbance value was 0.620 for GO concentration of 100 ppm with 3 hours of sonication period, while the lowest absorbance value was 0.095 for 50 ppm GO concentration with 2 hour of sonication period.

The percentage drop in absorption after four days of sample preparation of 25 ppm and 100 ppm concentration for 3 hours of sonication period was 21% and

4%, respectively, it indicates that even after four days, the sample with 100 ppm concentration was more stable than the sample with 25 ppm concentration.

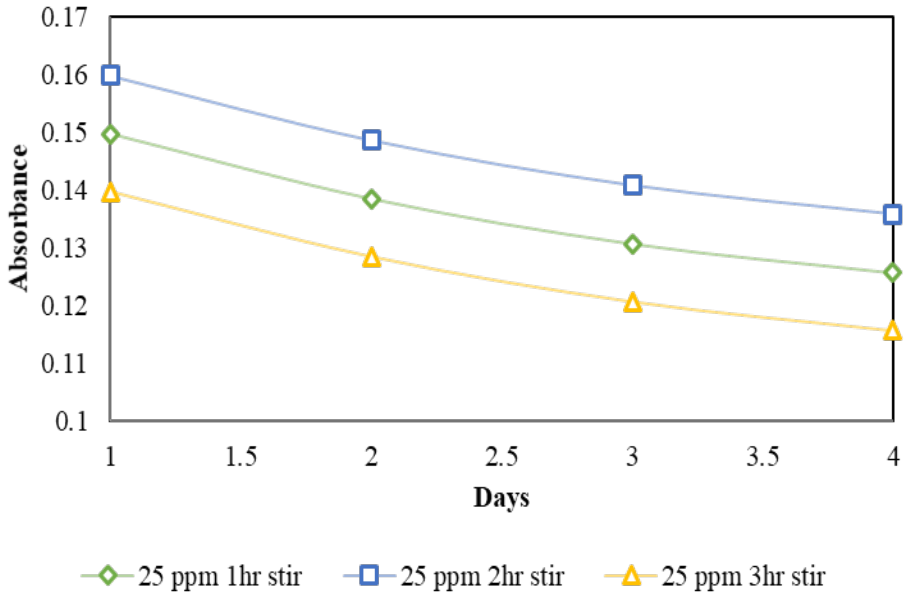


Fig. 5. Stability characteristic of 25 ppm BWCO

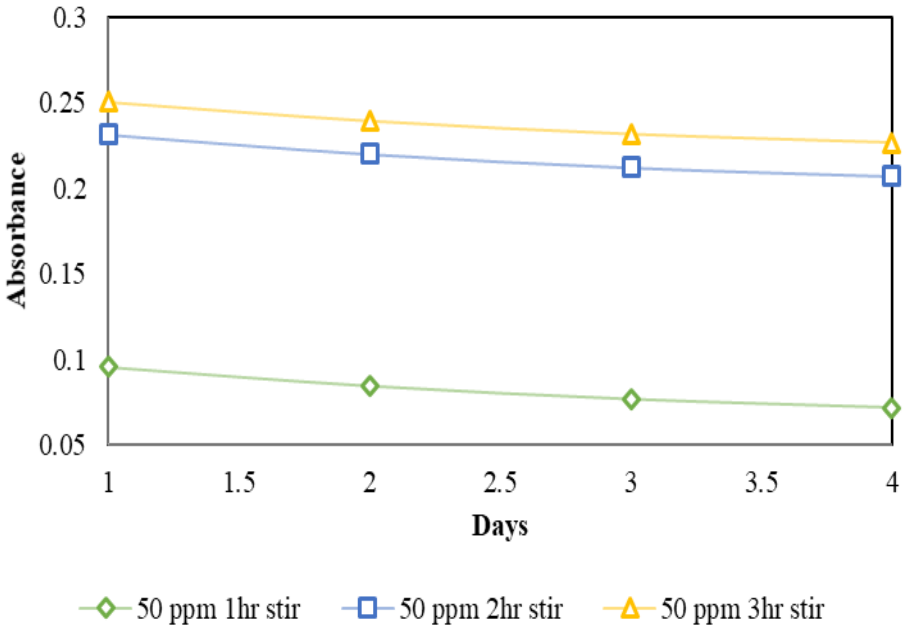


Fig. 6. Stability characteristic of 50 ppm BWCO

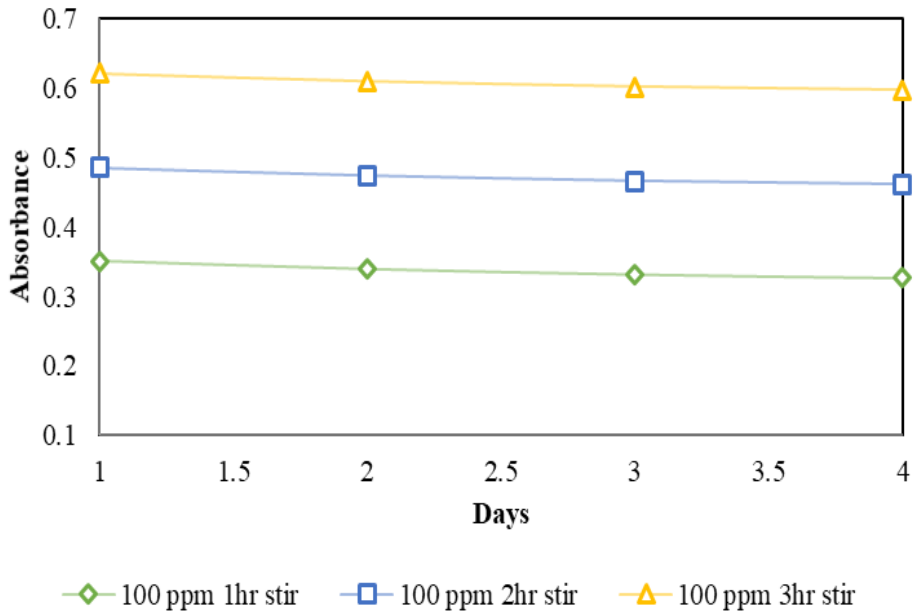


Fig. 7. Stability characteristic of 100 ppm BWCO

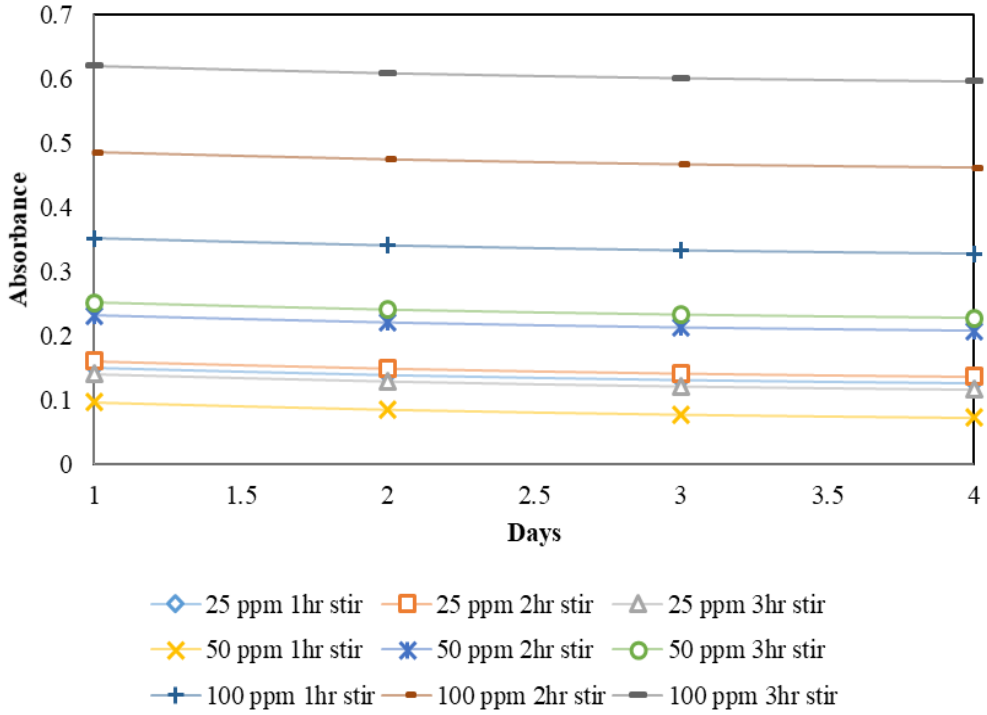


Fig. 8. Stability characteristic GO BWCO for all concentration

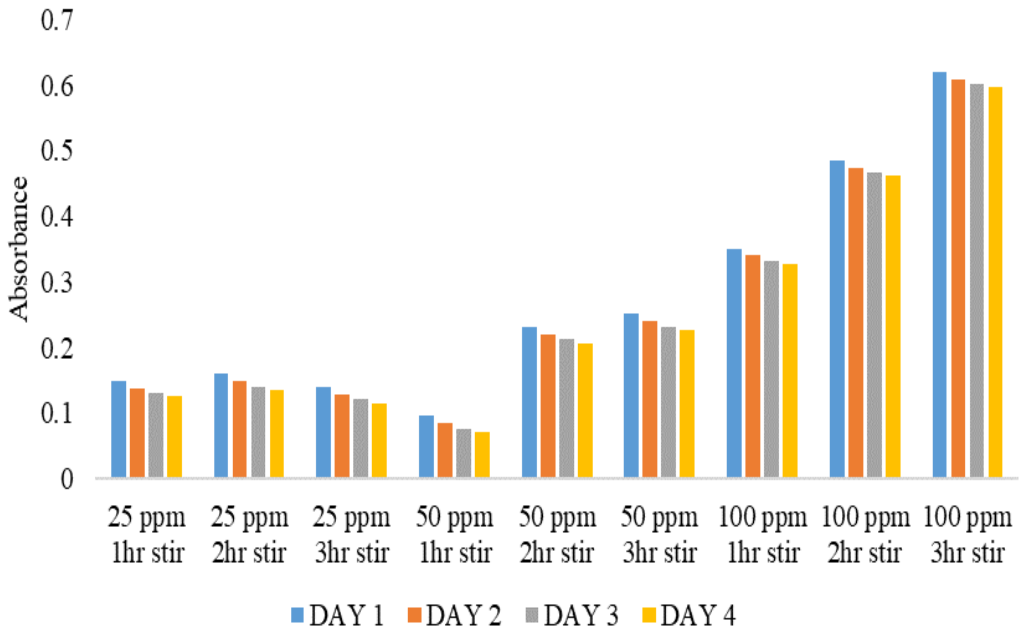


Fig. 9. Stability characteristic GO BWCO for all concentration

## 7. Conclusions

The impacts of GO nano-additives stability in biodiesel fuel for different concentrations and sonication durations were investigated in this paper. The sedimentation of GO nanofuels was studied using a UV-Vis spectrophotometer. The findings of the present investigation are listed below:

(1) Regardless of concentration, GO started to cluster and settled by each day.

(2) The GO suspension with 3 hours of sonication period found more stable for the concentration 25 ppm, 50 ppm and 100 ppm.

(3) Highest absorbance value was 0.620 for 100 ppm concentration with 3 hours of sonication duration.

(4) The percentage drop in absorbance after four days of 25 ppm and 100 ppm concentration with 3 hours of sonication duration was 21% and 4%, respectively, it shows that the sample with 100 ppm concentration was more stable.

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