Experimental Investigation of the effect of Tribological Performance of Reduced Graphene Oxide Additive Added into Engine Oil on Gasoline Engine Wear

E. Hakan Kaleli[1)*] and Selman Demirtas [1)]
[1)] Yildiz Technical University, Faculty of Mechanical Engineering, Automotive Division 34349
E1 Block, No.28, Beşiktaş-Yıldız-İstanbul / TURKEY
*Corresponding author: kaleli@yildiz.edu.tr

As the tribological behavior of a commercialized, fully synthetic engine oil upon the incorporation of reduced graphene oxide in sample (0.02 wt.%) called rGO6 presented superior tribological properties by exhibiting the lowest COF value in our previous work [1], the same sample was evaluated through a reciprocating tribometer, using steel ball (100 CR6) on a real polished gasoline engine cylinder liner with 5W-40 engine oil to investigate their wear and friction behavior in boundary lubrication regime. Metallurgical analysis of the samples was carried out using a 3D digital optical, SEM-EDX and AFM. It was found that a RGO nano-additive plays an active role in lowering the coefficient of friction (%3.29) and increasing surface protection and lubrication by forming a protective layer on the rubbing surfaces.

Keywords: reduced graphene oxide, engine oil, friction coefficient, wear; tribotest

1. Introduction

It was found that lubricant 5W-40 containing 0.02 wt % rGO nano-additive called rGO6 played an active role in lowering the coefficient of friction and increasing surface protection and lubrication by forming a protective layer on the rubbing surfaces [1].

2. Methods

rGO was incorporated in mass ratio (0.02%) and the mixture was homogenized for 30 min, utilizing an ultrasonic probe assisted process. Sample was centrifuged (Sigma 2-16P) at 4500 rpm (1856× g) for 30 min, in order to remove any aggregate/sediment and to increase its long-term stability.

2.1. Results

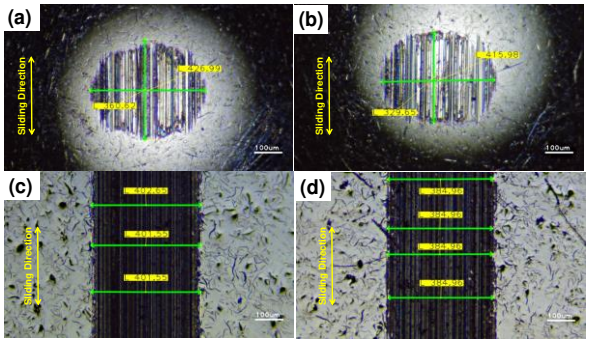

Figure 1: Microscopic examination of the ball (a and b) and liner (c and d) surfaces with reference oil and rGO6 after tribotest.

Figure 1 presents the microscopic examination of the ball and liner surfaces with reference oil (a, c) and rGO6 (b, d) after tribotest. Coefficient of Friction (COF) results were presented in "Figure 2". rGO containing engine oil showed lower wear scar distance horizontally and vertically and less COF protecting well the surfaces of sliding pairs. Tests were repeated three times.

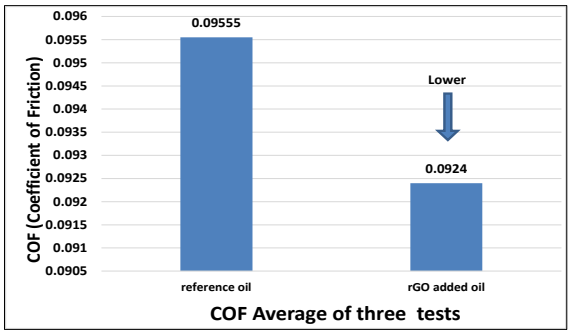

Figure 2: Average COF of three repeated tribotests.

The surfaces as well as all additives were analyzed through optical microscopy, SEM-EDX and AFM. The accumulation of carbon (C) derived from the derivatives of graphene was heavily detected on the rubbed surface of ball/liner.

3. Discussion

It is well known that Graphene, a lamellar structured material, easily shears at the contact interfaces and exhibits excellent mechanical strength and conductivity, which promises its potential for tribological applications [2].

4. References

[1] Kaleli, H. et al., "Tribological Performance Investigation of a Commercial Engine Oil Incorporating Reduced Graphene Oxide as Additive, Nanomaterials 2021, 11, 386, 1-14.

[2] Mungse, H. P.. and Khatri, O. P., "Chemically Functionalized Reduced Graphene Oxide as a Novel Material for Reduction of Friction and Wear", J. *Phys. Chem. C* -2014, 118, 26, 14394–14402.

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