Chitosan and Carbon NanoDot (CNDs) as Filter For Contact Oil as Additives in Oil for Enhancing the Wear Resistance

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Abstract

The purpose of this work was to investigate a wear resintance, the friction and wear characteristic of Chitosan and NanoDot (CNDs) as filter for contact oil as additives for enchanging the wear resistance were been evaluated test conditions to simulated before and after. The stability of oil (ferrolubricant) with the addition of Chitosan and Carbon NanoDot 2.5 ml and 7.5 ml is homogenous, and at 100 °C viscosities, the lubricant and Ferro lubricant (Oil) are 8.65 mm^2/s and 8.96 mm^2/s, respectively. The elements absorbed in lubricant and Ferro lubricant (Oil) are Cr and Mg elements at 115 and 125, respectively, with a total base number of 0.55. It is seen from the oxidation, soot, and nitration attributes that Mg is high in sulfate. In conclusion, particle quantification is high and Fe is Low, with the majority of the wear larger than 10 µm. Chitosan and Carbon NanoDots has the ability to produce good ferro-lubricant (oil).

Keywords: ***Chitosan, NanoDot, Filter, Contact Oil, Additives, Enhanging, Wear Resistance***

1. Introduction

In engine, the friction between two moving parts (e.g gears) cannot be eliminated as part of their main function and can only be reduced to a certain level. Besides that the friction can cause the heat and can damage the components. This friction between two moving parts cause very high maintenance cost and the replacement of the components as a result of the malfunction. The friction also contributes to the overall energy losses: 40-60% [1-2].

An effective lubrication system plays an important role in mechanical equipment, due to about eighty percent of mechanical failure caused by friction and wear [3,4]. Conventional lubricants are mainly composed of mineral base oils containing saturated hydrocarbon polymers and compounds with sulfur and phosphorus. With complexity of service condition growing, the original additives hardly meet the requirements of equipment lubrication. However, some nanoparticles (NPs) additives, which has the characteristics of small size, large specific surface area and strong surface activity, can significantly improve the lubrication performance. Researches [3,5] suggest the optimal concentration in base oils is between 0.2% and 2% for most nanoadditives, and tribological enhancement generally are classified into three types including physical deposition mechanism [6,7], chemical reaction mechanism [8,9] and self-repair mechanism [10,11].

The friction occurred on the moving part can be reduced using lubricants that create additional layers between the moving components. In order to enhance the capability of the lubricant to reduce the friction and to eliminate the heat, a modification in the lubricant was applied by several researchers using material additives. The utilization of additives in lubricants presents many advantages, as they are relatively insensitive to temperature, and tribochemical reactions are limited, compared to traditional additives [12]. Another advantage by using material additives, such as metal oxide and hydrate particles is its ability to change their solubility under the effect of surface modification[13].

Recently, studies on lubricants with additives such as nanoparticles have attracted the interest of many researches. Nanolubricants have raised great interest in tribology management; the idea was by mixing the various kinds of nanoparticles made of polymer, metal, organic and inorganic materials into the lubricating oil. From the combination, many studies report that nano lubricants are effective in decreasing wear and friction caused by high pressures and temperatures [14], [15], [16], [17], [18]. However, the reduction of friction and antiwear performance depends on various factors, including compatibility with a base lubricant/oil, their sizes and morphologies, as well as volume friction.

Bajing ren, et al (2019) in research Tribological properties and anti-wear mechanism of ZnO@graphene core-shell nanoparticles as lubricant additives. During the preparation of nano additives, all chemical reagents used are of analytical grade. A synthetic ester lubricant (SparkM40) for common engines is employed as the modified base oil, The expected ZnO NPs with different morphologies are prepared by the concentration variation of the alkaline solution based on the hydrothermal synthesis method [21].

Xiyangyuan ye, et.al (2019) with the research about Evaluating tribological properties of the stearic acid-based organic nanomaterials as additives for aqueous lubricants. The SSA solutions show promising results in reducing friction and wear for various friction pairs under a range of loads and shearing velocities, and can be used as potential lubricants in various processes [22].

Summarizing the research of the rheology and the wear of the particle additives in lubricant, the authors have found that some problems, such as the dispersibility, the stability, the uniformity, and the medium compatibility need an improvement and then study Chitosan and NanoDot (CNDs) as filter for contact oil as additives for enchanging the wear resistance were been evaluated test conditions to simulated before and after [35].

2. Materials and Methods

Dissolve 5 grams of chitosan with 15 mL of distilled water and stir with a stirrer at 80oC on a hot plate then add 5 mL of 3% acetic acid with a stirring time of 15 minutes. After being homogeneous, 10 mg of carbon nanodots (CNDs) synthesized from burning cellulose nanocrystals were added in a microwave and stirred for 1 hour. A total of 10 mL of chitosan/CNDs which had dissolved was put into a beaker glass to be used as an electrolyte solution in the coating process [30]. The coating process was carried out using the electroplating method. Cu electrodes were strung together in parallel and dipped into the chitosan/CNDs solution then a voltage of 0.5 Volts was applied for 30 seconds. Then the sensitive material which has been attached to the surface of the electrode is dried at 37 oC after that it is tested for its chemosensory properties [35].

3. Results and Discussions

1. Viscosity

Fig.1.a)TEMimageofuncoated chitosan and NanoDot;b)Histogramofuncoated chitosan and NanoDotsize;c)TEMimageof coated chitosan and NanoDot;d)Histogramof coated chitosan and Nano Dot

Fig. 1. The results suggested that the particleshavealargeraveragediameter of150nmthanthebefore-after withanaveragesize of 120 nm. Thus, silica layers have been successfullycoated on the surface of the magnetite particles. The coat-inglayerofchitosan and NanoDot,whichhasanoleophiliccharacteristic,is essential for the particles to be easily dispersed in thelubricant and improve stability [27–29].

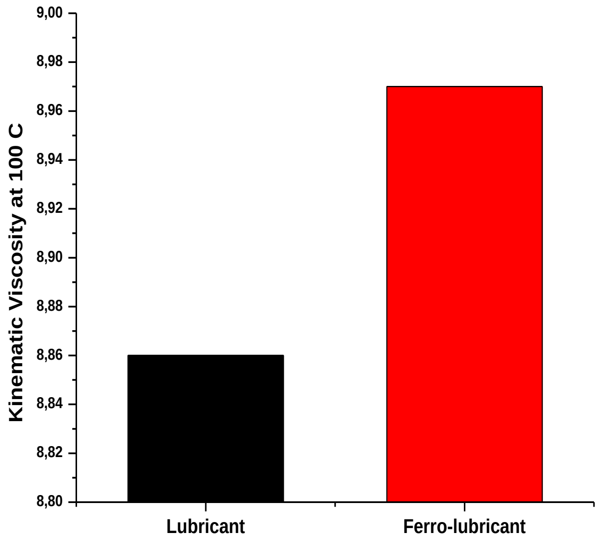

Fig 2. Viscosity index of Lubricant and Ferro lubricant

To compare the effects of different concentrations and types of nano additives in liquid base lubricants, kinematic viscosity tests were performed as per ASTM standards. Kinematic test results disclose the viscosity of lubricant and ferro lubricants (oil) at 100 °C. The resistance of lubricants to changes in temperature (viscosity index) is important to improve hydrodynamic lubrication regimes at large temperature ranges. As per the base oil data sheet provided by Petro Canada, viscosities at 100 °C of lubricant and fero lubricant is 8.65 mm^2/s and 8.96 mm^2/s, respectively. The calculated viscosity index for base oil is 98. Surface analyses suggest that the predominant properties at −10 and 20 °C were ascribed to the tribofilms composed of chitosan and NanoDot [9].The result indicate that the viscosity of the lubricant (oil) system increase remarkably with augment of the additive[10].

2. The element is absorbed

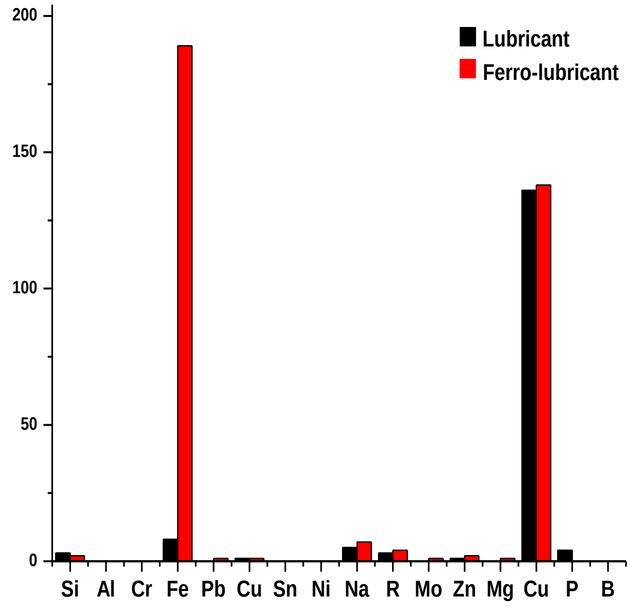

Fig 3. The element is absorbed

Fig. 3 shows the elements Fe and Cu which show a significant difference. In the element Fe for lubricant 10 and for ferrolubricant 180 while for the element Cu shows Lubricant 115 andFerrolubricant 125.this is because the additional elements in ferrolubricant are more dominant elements of Fe and Cu.This has resulted in a range of the new and different characteristic [11]. Additionally, the Cu matrix has deformed significantly [17].

3. Total base number

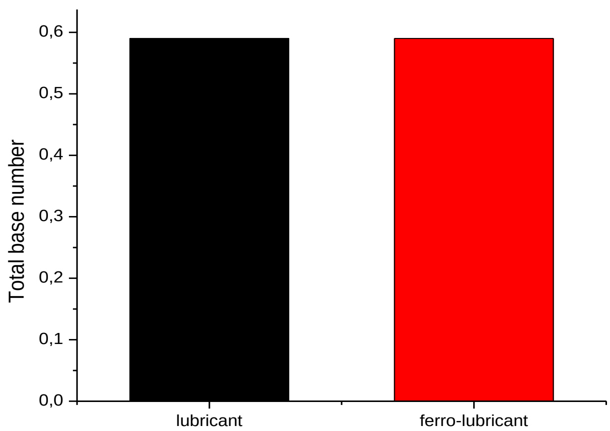

Fig.4.Total base number (size of the amount of alkaline or alkaline content in lubricant and ferro lubricant)

The total base number (size of the amount of base or alkali in lubricant and ferro lubricant) shows the same number, namely 0.55.For lubricant and ferrolubricant (oil) there is no difference in the total base[18,37].

4. The element of feasibility on lubricant

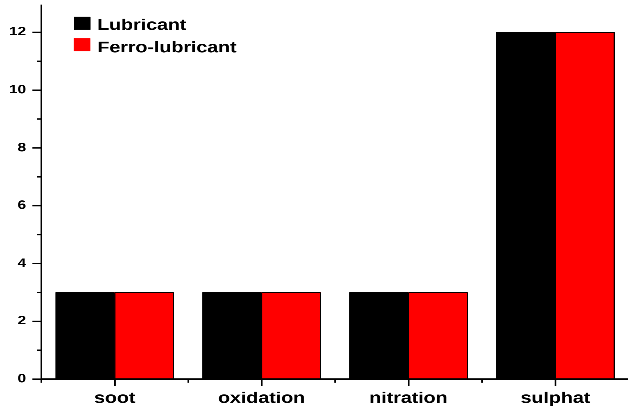

Fig 5. The element of feasibility on lubricant and ferrolubricant

It can be seen from the image of elements that are high in sulfate, for the other three elements, namely soot, oxidation and nitration.For lubricant and ferrolubricant there is no difference in the element of feasibility on lubricant and ferrolubricant (oil) [20].

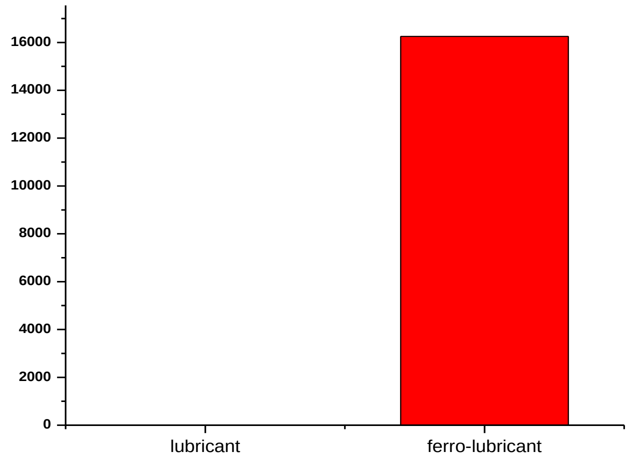

Fig 6. Particle Quantification (PQ) Lubricant compare ferrolubricant

5. Particle quantification

When Particle Quantificationis High and Fe is Low, then this can become a concern because the majority of the wear is larger than 10 µm and will cause accelerated damage. The High readings of theParticle Quantification can be caused by many factors and will need further diagnoses or testing. Rapid High Particle Quantificationreadings on a trend scale can indicate a failure or potential failure. Never ignore High Particle Quantification readings and if unsure what it means, ask the laboratory to do a Ferrogram or Microscopic analysis on the sample. This can provide you with information on particle sizes, type of wear and particle identification all of which can be useful in helping diagnose the issue further. At higher contents, the precipitation conversey is less with increase of settling time [12].

6. FTIR

Fig.7 shows the FTIR analysis for both before-after with chitosan and NanoDot 2.5 ml and fero-particles with chitosan and NanoDot 7.5 ml. The results suggested that the bonding and the stretching phenomena occurs and can be confirmed from the peaks as suggested by the graph. The results confirmed that the FTIR for both before-after (with the addition of 2.5ml and 7.5 ml of chitosan and NanoDot) magnetite nano-particles have a spectrum range of 1500-2500 cm^{-1}. In the FTIR analysis of the coated particle,spectrum shows at a wave number of 2117 cm^{-1}which indicates that a bending vibration of C-O vibrationwith happen hexyl chain in heat transfer [13]. Just with limited C-OH/C-O-C and HO-C bond [19].

Fig. 6. FTIR spectra with the addition of 2.5ml of Chitosan and Carbon NanoDot and 7.5 ml of Chitosan and Carbon NanoDot

4. Conclusion

The purpose of this work was to investigate a wear resintance, the friction and wear characteristic of Chitosan and NanoDot (CNDs) as filter for contact oil as additives for enchanging the wear resistance were been evaluated test conditions to simulated before and after.The stability of oil (ferrolubricant) with the addition of Chitosan and Carbon NanoDot 2.5 ml and 7.5 ml is homogenous, and at 100 °C viscosities, the lubricant and Ferro lubricant (Oil) are 8.65 mm^2/s and 8.96 mm^2/s, respectively. The elements absorbed in lubricant and Ferro lubricant (Oil) are Cr and Mg elements at 115 and 125, respectively, with a total base number of 0.55. It is seen from the oxidation, soot, and nitration attributes that Mg is high in sulfate. In conclusion, particle quantification is high and Fe is Low, with the majority of the wear larger than 10 µm. Chitosan and Carbon NanoDotshas the ability to produce good ferro-lubricant (oil).

5. Credit authorship contribution statement

Indri Dayana: Conceptualization,Methodology, Writing–original draft. **Habib Satria:** Software, Writing – original draft. **Moranain Mungkin:** Data curation. **Muhammad Fadlan Siregar:** Writing – review &editing. **Fuadaturrahmah** :Writing – review &editing.

6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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