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Behavior Of Lubricating Oils Dispersed By Calcium Carbonates As A Solid Additive

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1. Introduction

Wear is the main cause of around 80% exhaustion of the operational potential of machines and vehicles[1]. Lubrications are widely utilized in the industry, especially in machine industry and so reputed as "the blood of machines". The proper use of the lubrications can improve the efficiency of the engine, economize on energy as well as prolong the machine life. It is well accepted that lubricants gain their good wear prevention ability and friction-reducing properties mainly from the doped boundary lubrication additives, function by forming different sorts of protective films on rubbed surfaces. Most of the additives are organic substances with the advantage of their comparability with the base oil. Lately, some inorganic materials have received more and more attention for their good performance in wear and friction reduction. Small amount of yttrium in a vegetable-base oil lubricant or in a polyester grease is beneficial to protect the materials from corrosive wear. Hexagonal boron nitride with a graphite-like lamellar structure is a potential lubricating oil additive for certain applications. Recently, the use of the organic-inorganic composite as lubrication additive arouses much interests. The preparation and application of organic- inorganic composite is of great importance in modern material science and industry[2].

Generally[2], $CaCO_3$ has excellent cleaning and dispersion properties, which can guarantee the effects of cleaning of combustor parts of diesel, such as piston, piston ring and cylinder, for a long time and reduce the deposition of carbon and lacquer. At the same time, it also enables the lubricating oils to maintain necessary Total Base Number (TBN) so as to neutralize the vitriol resulted from using the high-sulfur fuel. The CeO_2 nanoparticles has excellent properties of wear resistance, chemistry erode resistance and good polishing. several new solid lubricant and modern lubrication concepts have been developed to achieve better lubricity and longer wear life in demanding tribological applications. Most of the traditional solid lubricants were prepared in the form of metal, ceramic and polymer-matrix composites. They have been used successfully in various engineering applications. Recent progress in thin-film deposition technologies has led to the synthesis of new generations of adaptative, self-lubricating coatings with composite or multilayered architectures, by using duplex/multiplex surface treatments. These modern self-lubricating coatings progressively make their way into the commercial marketplace and meet the ever-increasing performance demands of more severe applications. Tribological properties of the spherical CaCO3 composite as additive to machine oil were evaluated with a three-ball tester. The composite with the

average diameter of about 4 μmwas synthesized by taking an amphiphilic copolymer asmedium. Scanning electron microscope was used to investigate

the surfaces of the lubricated steel balls in the test. The results show that the CaCO3 composite exhibit good performance in wear and friction reduction.

The anti-wear improvement capability of the machine oil turn up to be the most efficient when 5 wt.% CaCO3 composite was added[6].

The present paper reviews our recent understanding of the lubrication mechanisms of both traditional and new solid lubricants, with particular emphasis on solid lubricant methods and practices[4]. In these experiments, the growth of tribo-films is investigated for the commonly used solid lubricant additive "calcium carbonates particles". The influences of additive structure and sliding conditions on tribofilm growth are determined in a cross-pin wear tester. The understanding of the contributing factors for the formation of tribo-films can promote the development of tribological predictions for rolling bearings.

2. Materials and Methods

Experiments were carried out using pin-on-disc wear tester, as shown in Fig. 1. It consists of a rotary horizontal steel disc driven by variable speed motor. The test specimen is held in the specimen holder that fastened to the loading lever. Through two thin spring steel sheets, where strain gauges are adhered, friction force can be measured. Friction coefficient was determined through the friction force measured by the deflection of the spring steel sheets by strain gauges. The load is applied by weights. Test specimens were in the form of a cylindrical pin of 6 mm diameter and 30 mm length. The commercially supplied calcium carbonates "$Caco_3$" particles (99.98% purity with average particle size lower than 50 μm) were suspended in acetone and sonicated using ultrasonic dispersing technology for more than 6 h until the particles was obtained. After sonication, the $Caco_3$ particles were dispersed in two different types of lubricating oils (POA and paraffin oils) using ultrasonic homogenizer, with concentration of 0,5,10,15,20 wt.%. The test rig is fitted by a load cell, to measure the frictional force generated in the contact zone between the rotating disc and stationary pins. Rotational speed was 170 r.p.m. and 10 N normal load was applied by means of weights attached to a loading lever. The rotating specimens were lubricated before and every 30 secs. during the test. Every test time was 5, 10, 15 min. The test specimens are prepared from carbon steel (St. 60), (0.6 wt. % C, 0.25 wt. % Si, 0.65 wt. % Mn, 0.045 wt. % P and 0.045 wt. % S). The material loss of the test specimens during sliding was measured by weighing the specimen before and after test, using electronic balance of ±1 mg accuracy. The test specimens were loaded against counter face of grey cast iron disc (3.60 % C, 2.30 % Si, 0.50 % Mn, 0.12 % S, 0.75 % P), of 150 mm outer diameter, fastened to the rotating disc. Before the test, the friction surfaces of the test specimens and the cast iron discs were ground by 320 grid sand paper. Experiments were carried out at 25 °C. The tribological test of as-prepared under ambient condition (temperature of (20±5) °C and relative humidity of 60%±5%).

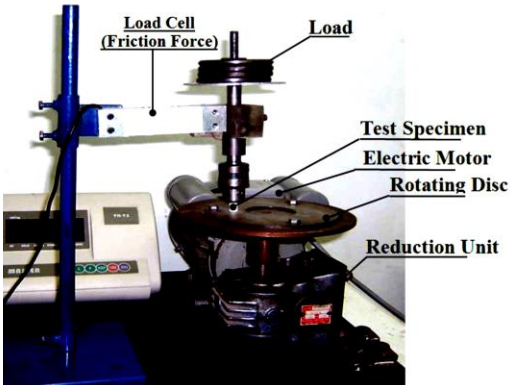

Fig. 1 Pin-on-Disc.

3. Results and Discussions

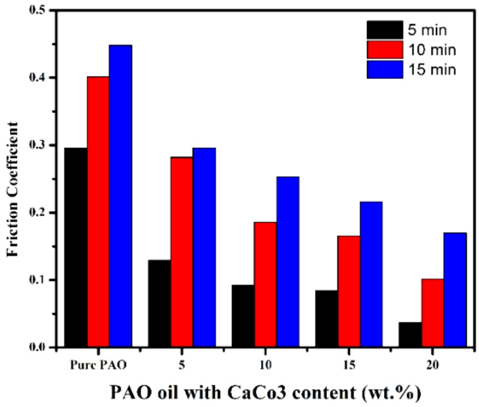

Fig. 2 Comparison between effect of different contents of $Caco_3$, added to PAO as solid additive, on friction values.

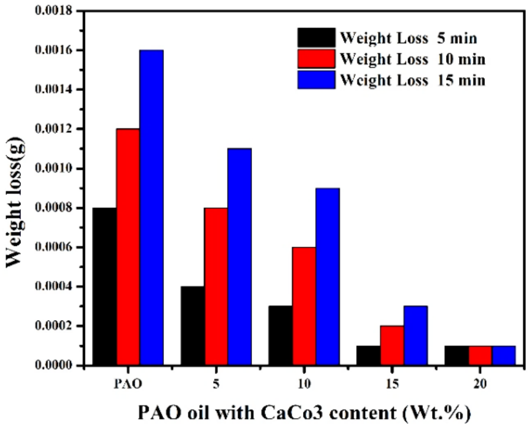

Fig. 3 Behavior of PAO filled by different contents of $Caco_3$ on wear values.

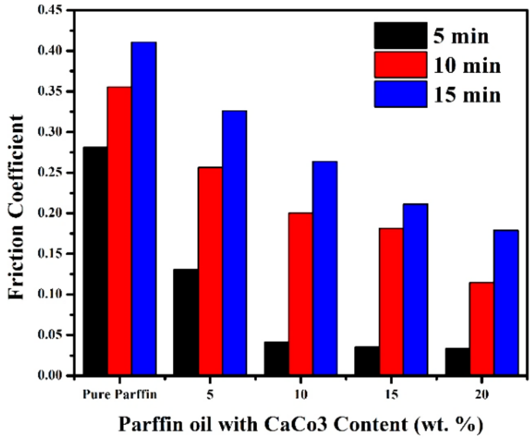

Fig. 4 Effect of addition of different contents of calcium carbonates to paraffin oil on friction coefficient.

Figure 2 indicates the effect of adding different contents of micro particles of calcium carbonates to paraffin oil on friction coefficient values after 5, 10 and 15 Minutes. Where adding variable amount of graphite particles decrease friction values, where friction coefficient was 0.29, 0.39, 0.45 after 5, 10, 15 mins respectively for pure addition of paraffin oil, and friction coefficient reduced after adding 20 wt. % content of micro particles of calcium carbonates and reached to be 0.005, 0.1, 0.15 after 5, 10, 15 min of test. Meanwhile, Fig. 4 shows, weight loss (g) was 0.0008, 0.0012, 0.0016 after 5, 10, 15 minutes. After adding 20 wt. % of graphite powder to PAO oil, wear loss reduced to be 0.0001 (g) approximately. That means micro particles of calcium carbonates reduced friction and formed a conformal protective coating on the sliding contact interfaces. This reason facilitates shear and slow down scratching between steel surfaces.

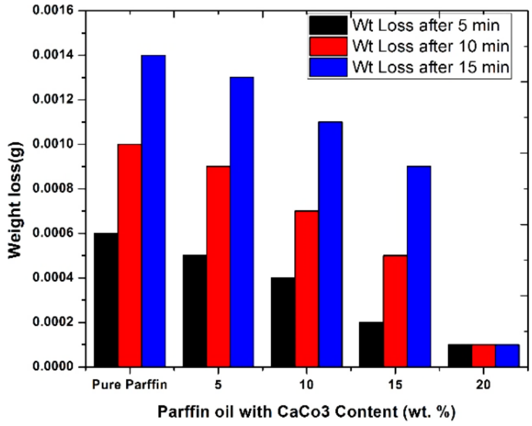

Fig. 5 Weight loss of steel specimen lubricated with paraffin oil with different contents of calcium carbonates particles.

4. Conclusion

Based on the results of the experiments, spherical calcium carbonates had good dispersity and uniform particle distribution in the lubricated oils. The results indicated that the $CaCO_3$ additive, as a solid lubricant, exhibits good performance in wear and friction reduction of the steel specimens when added to POA. 20 wt. % additive concentration is the optimal concentration.

REFERENCE

1. Adam Piasecki, Mateusz Kotkowiak, Natalia Makuch, Michał Kulka; Wear behavior of self-lubricating boride layers produced on Inconel 600-alloy by laser alloying, Wear 426–427 (2019) 919–933.
2. Dalai Jin a, Linhai Yue; Tribological properties study of spherical calcium carbonate composite as lubricant additive, Materials Letters 62 (2008) 1565–1568.
3. Wang Renbing; Study on tribological properties and mechanism of CaCO3 nanoparticles as additives in lubricating oils. Shanghai: Shanghai Maritime University, (2002).
4. C. Donnet, A. Erdemir, “Historical developments and new trends in tribological and solid lubricant coatings”, Surface and Coatings Technology 180 –181 (2004) 76–84.
5. Dalai Jin, Linhai Yue, “Tribological properties study of spherical calcium carbonate composite as lubricant additive”, Materials Letters 62 (2008) 1565–1568.