The effect of oil treatment on wear property of medium carbon steel

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ABSTRACT – Self-lubricating materials are used in industry as a means to reduce friction and facilitate motion of machine components. With self-lubricating materials, the need for lubrication circulation system is reduced or eliminated. In this current study, the effect of oil treatment on wear characteristics of medium carbon steel obtained from a company were investigated. Abrasion Resistance Tester TR-600 was deployed to measure volume loss and subsequently determine the corresponding specific wear rate. Based on the results, it was found that treated materials have better wear resistance compared to the untreated ones. A difference of 34.5% in the accumulated volume mass between untreated and treated cases was recorded.

1. INTRODUCTION

These days, medium carbon steel has been made to produce roller chain that is widely used in many industries. A roller chain is a set of journal bearing that joint together and articulate as they enter and leaves the sprockets. This movement made pins and bushings to wear. If the pins and bushings are not in good condition, the roller chain will experience wear regardless of other factors [1].

Treated materials, such as self–lubricating, have gotten a great attention from manufacturers especially in applications where normal lubrication is difficult or impossible [2]. From a mechanical point of view, chain bush made from self-lubricating materials are good substitutes for non-self-lubricating material due to beneficial characteristic in several aspects such as low coefficients of friction, minimal maintenance, low cost and simple installation [3]. Countless authors have studied the dry sliding wear behavior of different materials including carbon steel [4-5] but literatures on the sliding characteristic of oil treated carbon steel under lubricated conditions were limited. In manufacturing process of chain bush, an oil treatment process has been included but studies looking into the effect is lacking. Hence, this study aims to investigate the effect of oil treatment on the abrasive wear profile of medium carbon steel obtained from a company.

2. WEAR

Wear can be defined as the interactions between two surfaces that slide, rolls or impacts with each other within a working environment that may result in loss of material from the surface. Abrasive wear occurs when a surface of rough, equal or greater hardness are sliding across a softer surface. Hard particle embedded in a harder surface occupied the space between two sliding surfaces and act like cutting tool to remove material from the surfaces. This particle size is either equal or slightly bigger than the space between two sliding surfaces. A specific wear rate, Wr can be determined by using Archard wear model [6].

$$Wr = (\Delta m) / (L \, x \, \rho \, x \, F) \quad (1)$$

Where Δm is mass loss (kg); F is applied force (N), ρ is density ($\mathrm{kg/m^3}$); and L is sliding distance (m).

3. APPARATUS AND MEASUREMENT

Figure 1 shows the Abrasion Resistance Tester deployed and the corresponding schematic diagram. The abrasive wheels are made of silicon carbide. Different samples were prepared and categorized accordingly for easy identification and analysis: untreated sample for 200 RPM (Sample 1), untreated sample for 300 RPM (Sample 2), treated sample with fully synthetic oil for 200 RPM (Sample 3), treated sample with fully synthetic oil for 300 RPM (Sample 4), treated sample with semi synthetic oil for 200 RPM (Sample 5) and treated sample with semi synthetic oil for 300 RPM (Sample 6). Two types of oils were used namely fully Synthetic engine oil (5W/40) and semi Synthetic engine oil (10W/40). The diameter and thickness of the sample is 122mm and 1.2mm respectively.

The tests were run at different sliding speeds (200 RPM and 300 RPM) at a specific load of 24.5 N.

4. RESULTS AND DISCUSSION

The results for cumulative mass loss at 200 RPM and 300 RPM are shown in Figure 2 and 4 respectively. The corresponding results of wear rate are given in Figure 3 and 5 for 200 RPM and 300 RPM respectively.

In Figure 2 and 3, the mass loss of all samples increases with increasing sliding distance. Based on the results, untreated samples have the highest cumulated mass loss over sliding distance. In Figure 2, the highest difference in the accumulated volume mass between untreated and treated samples (treated with fully synthetic oil) is 34.5%.

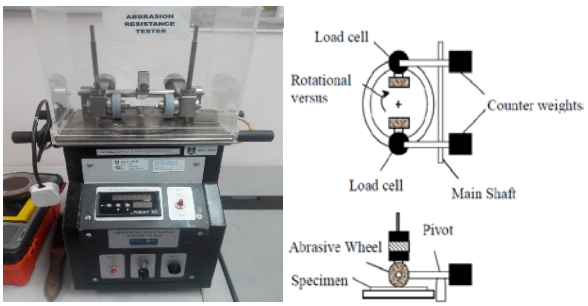

Figure 1 Abrasion Resistance Tester and the schematic diagram.

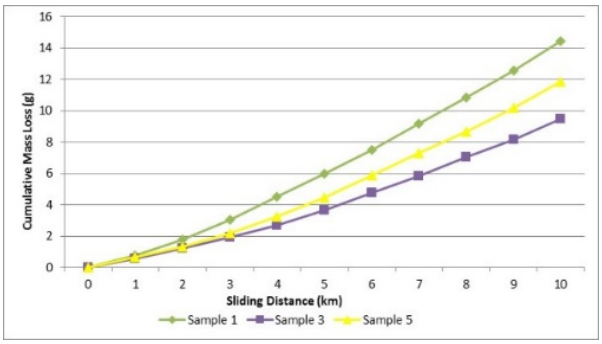

Figure 2 Cumulative mass loss at 200 RPM.

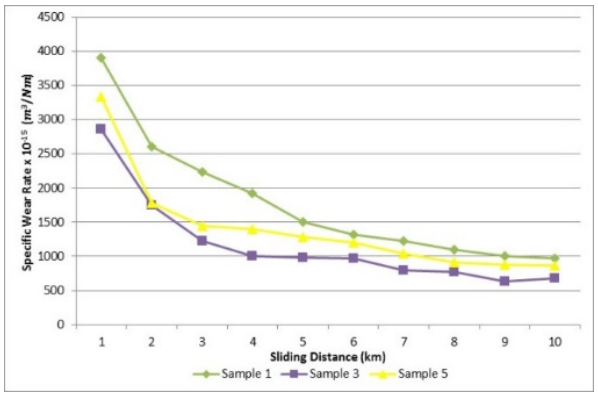

Figure 3 Specific wear rate at 200 RPM.

In Figure 3 and 5, the profiles of specific wear rate for all cases have similar trend. In the region before 5 km distance, the slope tend to be sharper indicating higher wear rate. Running in is likely in the region of 1 to 2 km of sliding distance. Previous studies [6-7] have obtained similar profiles for the case of kenaf and OPEFB composites.

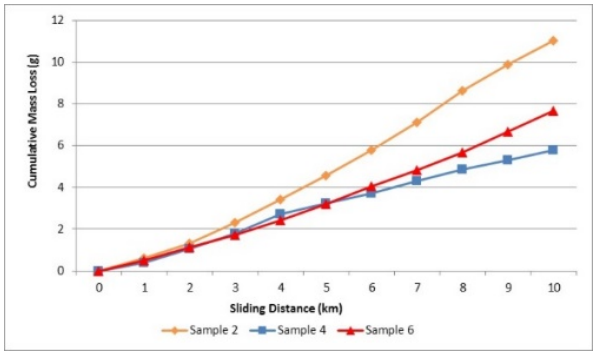

Figure 4 Cumulative mass loss at 300 RPM.

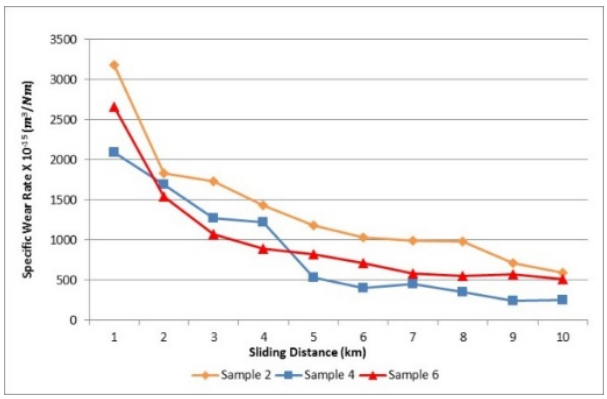

Figure 5 Specific wear rate at 300 RPM.

5. CONCLUSION

Dry sliding wear tests have been conducted to investigate the effect of oil treatment on wear characteristics of medium carbon steel. The results indicate that the mass loss and specific wear rates for both types of treated samples with oils are lower compared to untreated samples. The highest difference in the accumulated volume mass between untreated and treated samples at 200 RPM is 34.5% for those treated with fully synthetic oil. This preliminary study indicates that oil treatment has promising potential in reducing cost due to wear in application such as chain system.

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