Proceedings of SAKURA Symposium on Mechanical Science and Engineering, pp. 8-10, November 2017

Agricultural-waste based polymeric composite as a new self-lubricating antifriction material

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Keywords: Palm kernel; friction; wear; antifriction material

ABSTRACT – The purpose of this study is to investigate the potential of oil palm fibre (OPF), kenaf fibre (KF) and palm kernel activated carbon (PKAC) reinforced polymeric composites as a self-lubricating antifriction material. The pin sample was fabricated by hot compression molding method. The dry sliding test was conducted at temperatures between 23 to 150ºC by using a pin-on-disc tribometer according to the ASTM G-99a. The findings provide insights that PKAC/epoxy composite has lower friction coefficient and better wear resistant as compared to other commercial or agricultural-waste based polymeric composites. However, it cannot sustain at high temperature applications.

1. INTRODUCTION

Nowadays, a lot of alternative technologies include thin film coatings [1-2], green lubricants [3-4] and bio/eco-materials [5-6,8-22] have been introduced for sustainability of global need to save energy by reducing friction and wear of components or parts.

Two main commodity plants in Malaysia are oil palm and kenaf. Globally, Malaysia is one of the largest producers and exporters of palm oil, accounting for 11% of the world's oil and fat production, and 27% of the export trade of oils and fats. The palm oil industry generates a large quantity of waste consisting of around 90% of biomass waste and only around 10% of the palm oil [7]. Meanwhile, the developing of kenaf industry is reflected by two important events: The transformation of Malaysian National Tobacco Board (MNTB) to Malaysian National Kenaf and Tobacco Board (MNKTB).

MNKTB and the inclusion of kenaf industry as one of strategic industries under the East Coast Economic Region (ECER) Development Program. Malaysian government has taken the initiative to focus on the development of kenaf-based products by integrating the upstream to downstream processing research and development, towards economic and marketing activities.

The use of agricultural waste as a new composite material has also been found to be renewable and relatively less expensive and ultimately could utilize the waste effectively into wealth [8-9]. Therefore, this motivated us to investigate the potential of agricultural waste to be a new tribological material.

Agricultural waste-based polymer composites have potential uses in sliding bearings in a variety of applications [8-22]. Therefore, the purpose of this study is to investigate the potential of OPF, KF and PKAC reinforced polymeric composites to be a new self-lubricating antifriction material.

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2. EXPERIMENTAL PROCEDURE

The pin material was prepared by mixture of 70 wt.% OPF, KF or PKAC with 30 wt.% epoxy (at a ratio of 4:1; resin:hardener) using hot compression method.

The dry sliding test was conducted at at temperatures between 23 to 150ºC by using a pin-on-disc tribometer according to the ASTM G-99a (Standard test method for wear testing with a pin-on-disk apparatus). JIS-SKD 11(AISI D2) steel disc, as a counter surface was used in this study. Each test was repeated three times to reduce experimental errors. The schematic diagrams of the pin-on-disc tribometer is shown in Figure 1. It was assumed that the disc had negligible wear because there were no weight changes recorded after the test.

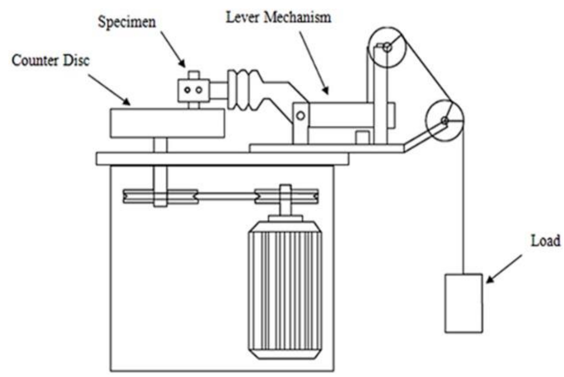

Figure 1 Schematic diagram of a pin-on-disc tribometer

3. RESULTS AND DISCUSSION

Figure 2 shows the most recent studies on the tribological performance of commercial and other agricultural waste-based polymeric composites for comparison purposes. Friction coefficient of KF/epoxy and OPF/epoxy composites decreases with temperature and resulted in increased wear rate. This might be due to softening of epoxy and fibre started to burnout. Although friction coefficient increases drastically with temperature, PKAC/epoxy composite still has lower friction coefficient (at room temperature) and better wear resistant as compared to other commercial or agricultural-waste based polymeric composites. Besides, the value of friction coefficient and wear resistant are like graphite/epoxy composite. This might due to PKAC is composed of carbonaceous, highly porous adsorptive medium that has a similar atomic structure to that of graphite, but in a disorganised form. In addition, the presence of remaining natural oils in palm kernel also contribute to the low friction and wear of PKAC/epoxy composite.

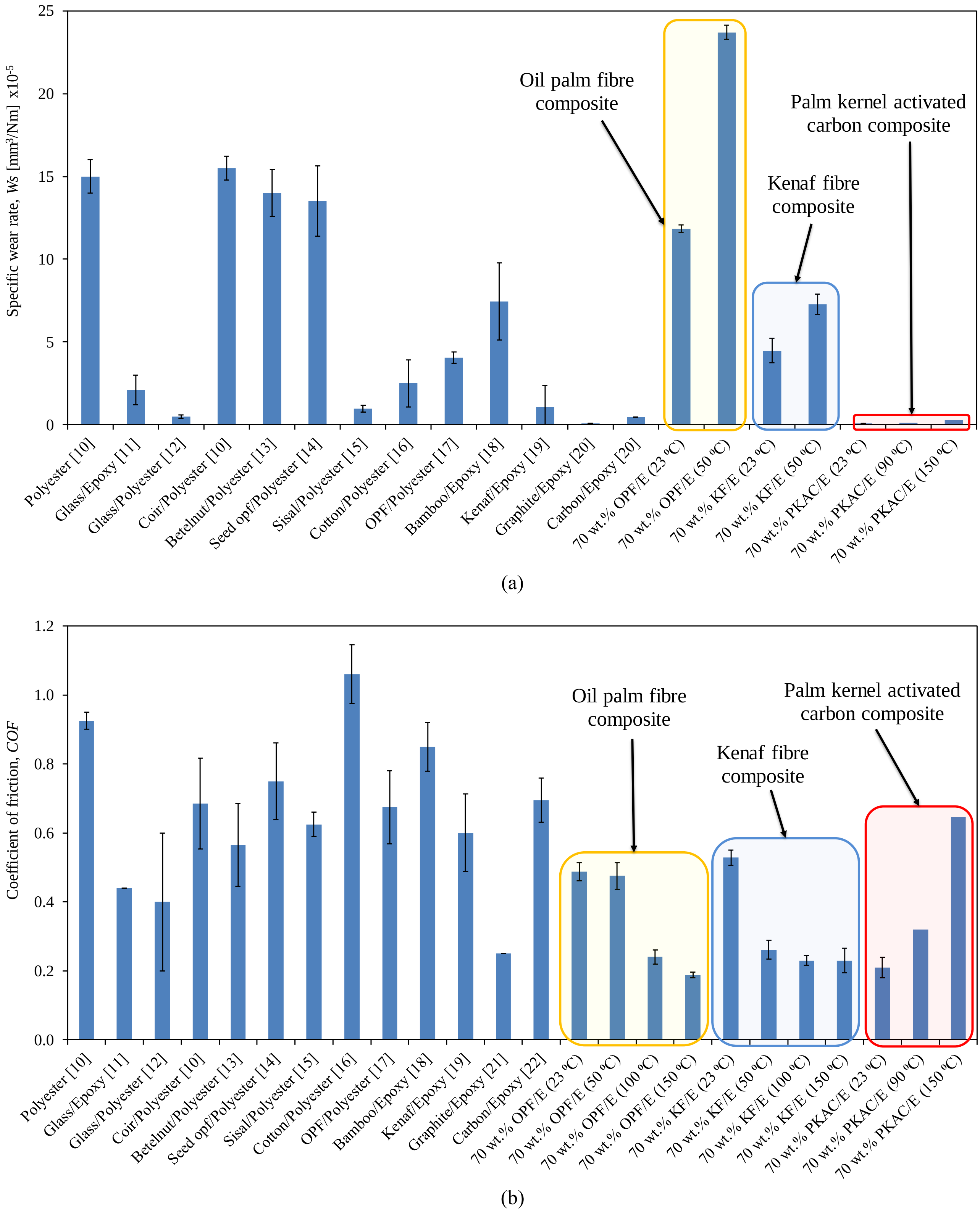

Figure 2 Comparison of (a) friction coefficient and (b) wear specific rate of commercial/agricultural waste-based polymeric composites. The value of wear rate for OPF/E and KF/E at temperature more than 50ºC is very large and cannot be shown in the graph.

4. CONCLUSION

In general, PKAC/epoxy composite has similar friction and wear values as graphite/epoxy composite. Besides, it also has lower friction coefficient and better wear resistant as compared to other commercial or agricultural-waste based polymeric composites. However, agricultural-waste based polymeric composites cannot sustain at high temperature applications.

ACKNOWLEDGMENT

The author gratefully acknowledges contributions from the members of the Green Tribology and Engine Performance (G-TriboE) research group, Universiti Teknikal Malaysia Melaka.

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