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Effect of surface texturing on friction coefficient between aluminum and alloy tool steel under lubricated sliding contact

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ABSTRACT – Recently, it has been identified that controlled porosity on a tribological surface can contribute to friction reduction at sliding contact interfaces. The present paper verifies the effect of micro-pit on the frictional properties of aluminum against SKD 11(alloy tool steel).Pin-on-disk tests modeling the contact between block surface and planar faces were carried out for a variety of sliding speed. It was found that the tribological characteristics depended greatly on the embedded micro-pit or without micro-pit, whilst the micro-pits shape did not significantly affect the friction coefficient regardless of rounded shape.

1. INTRODUCTION

Surface texturing occurs as an option of surface engineering, resulting in improvement in load capacity, coefficient of friction and wear resistance. The dimple (micro-pit, hole, oil pocket or cavity) can serve either as a micro-hydrodynamic bearing in cases of full or mixed lubrication, a micro-reservoir for lubricant in cases of starved lubrication or a micro-trap for wear debris in either lubricated or dry sliding [1,2]. Presence of dimples or micro-pit introduces oil reservoirs, which cause smaller coefficient of friction [3]. Surface texturing is also successfully applied to mechanical seals, resulting in increase in seal life [4]. Surface texturing of the block surface resulted in significant improvement in wear resistance in comparison to a system with un-textured samples. The fundamental aim of this work is to study experimentally the possibility of improving tribological performance of sliding surface by oil pockets creation on the modified pin.

2. METHODOLOGY

2.1 Material and Lubricant

Block pin samples were prepared with three different sizes as illustrated in Figure 1 and micro-pit that is embedded at the modified block pin, as shown in Figure 2. Hydraulic oil was used as a test lubricant in this experiment. Surface modification has been made on the surface using micro-pits with 2mm spacing for each micro-pit.

2.2 Tribological Testing

Before starting the experiment, the block pin and disk need to be cleaned using acetone to confirm that there is no additional particle on the surfaces. Then, the machine of each experiment was set up (Figure 3) according to the parameter set up by the researcher. The block pin was firmly attached to hardened jaws specimen holder parallel to the plain disk to ensure that the pin and disc touch the maximum contact surface. Then, all parameters such as speed (RPM) and time were inserted.

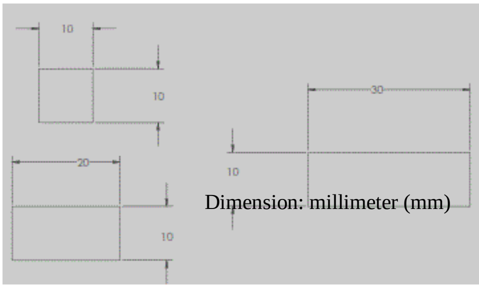

Figure 1 Schematic drawing of modified pin to surface contact.

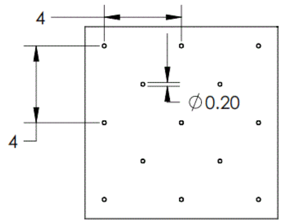

Figure 2 Schematic drawing of micro-pit at surface contact.

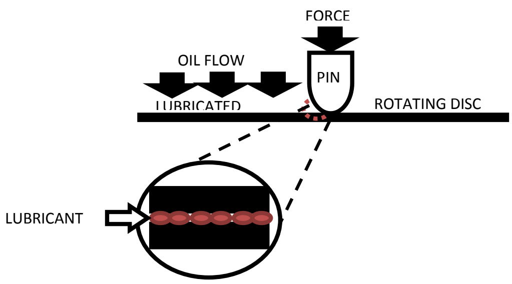

Figure 3 Schematic of pin on disc tribo-tester mechanism.

3. RESULTS AND DISCUSSION

Figure 5, 5 and 6 illustrate the friction coefficient at different sliding speeds against the normal load according to ASTM G99-95a. As shown in the graph above, the friction coefficient for micro-pit surfaces decreases compared to the surface without micro-pit.

This is attributed mainly to the fact that the micro-pit on the surface can restore lubricant, thereby decreasing friction. In addition, the micro-pit embedded on the surface can contain wear particles, and thus the friction coefficient will decrease. In this case, increase in sliding speed caused a decrease in frictional resistance for samples both with and without embedded micro-pits. The coefficient of friction decreased when the normal load increased for the smallest speed. However, when speed was higher, the character of changes in the coefficient of friction was different for sliding pairs for both samples. This is because lubricant acts under mixed lubrication condition. The oil trapped in the oil pocket is a secondary source of lubricant, which causes a reduction in the frictional resistance [5, 6]. It seems that in the analyzed case, what is very important is high decrease in the friction force due to surface texturing for higher mean speeds and smaller loads. This may be because the oil contained in the micro-pits is sufficient source of lubricant in case of starved lubrication.

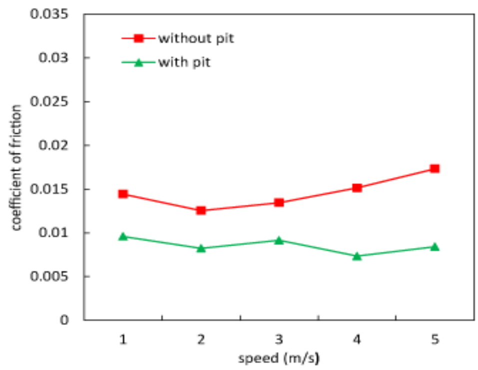

Figure 4 Block pin (size: 10mm x 10mm) with applied load 10N.

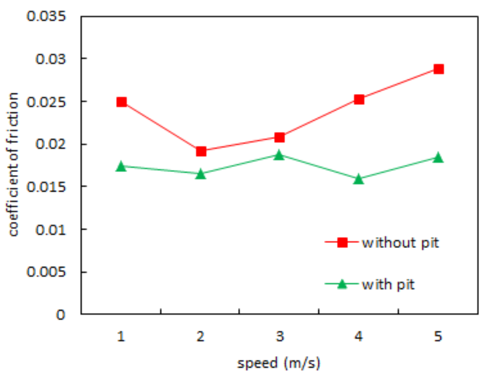

Figure 5 Block pin (size: 20mm x 10mm) with applied load 10N.

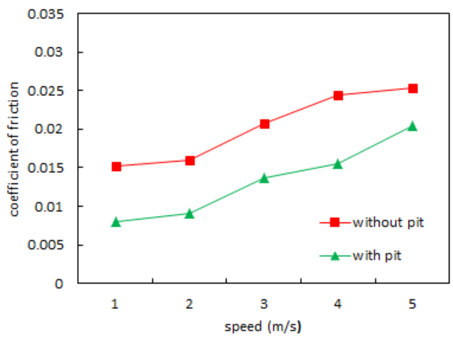

Figure 6 Block pin (size: 30mm x 10mm) with applied load 10N

4. CONCLUSIONS

Tribological behavior of modified pin with micro-pit or without micro-pit was compared using pin-on-disk machine. Surface with micro-pit show value of coefficient of friction is low compared to the plain surface of modified pin. The beneficial oil pockets/micro-pit influence was mainly evident in conditions of better lubrication, when the friction force decreased for all sizes of block. This effect was bigger for higher sliding speeds and smaller loads. These results suggest that lubrication regime oil pocket effect is of prime importance.

5. ACKNOWLEDGEMNT

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