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Comparison of tribological properties of POM against steel under different slide-to-roll ratio in dry and oil lubricated contact

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Gearboxes with polymer gears are increasingly used in different applications. However, polymer gear design is not fully reliable, since their tribological behavior under controlled, but realistic conditions, is not fully understood yet. One of the often-overlooked factors in tribological evaluation is the effect of slide-to-roll ratio (SRR). In gear meshing it differs from typical model tribological experiments, which mimic only pure sliding conditions. In this study we analyzed the wear and friction of POM balls in contact with steel discs under different conditions using ball-on-disc experiments with different SRR ratios in dry and lubricated conditions.
Keywords (from 3 to 5 max): polymer, SRR, dry lubrication, oil lubrication

1. Introduction

Tribological behavior of typical polymers used in gear design is mainly studied in pure sliding conditions. However, due to the involute geometry of cylindrical gears, which are the most typical type, the forces, sliding velocities and slide-to-roll ratios vary along the point of contact. Only a few studies so far have been performed under different SRR conditions [1]. Most of them were conducted on twin-disc test rigs, which allow only a limited variation in SRR. Furthermore, in previous studies [2] it was shown that temperature can have a huge effect on the performance of polymer materials. Accordingly, in this work we continued the work presented in [3]: tribological analysis on model tribological tests, where polymer balls were in contact against steel discs under various SRR at two controlled pre-selected temperatures of the polymer material. Moreover, tests were performed under both dry and oil lubricated conditions. Friction measurements, as well as evaluation of wear coefficients and wear mechanisms, were conducted and compared.

2. Methods

A standard mini-traction machine (MTM) was used together with standard PCS instrument samples. The lower specimens were 100Cr6 steel discs with surface roughness of $R_a = 0.2$ µm. The upper samples were POM polymer balls. All tests were conducted at two different temperatures and at the same load in both dry and lubricated conditions. Lubrication was done using synthetic PAO oil. Analysis of the wear mechanisms was conducted using an SEM microscope.

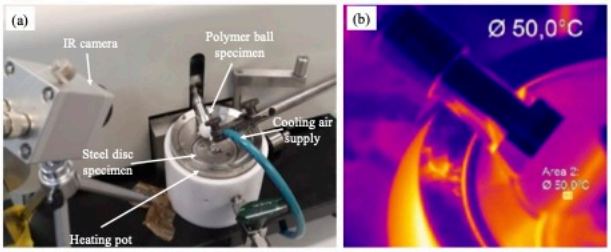

Figure 1: (a) MTM test configuration; (b) thermographic images of polymer ball.

3. Results and discussion

Preliminary results show that the coefficient of friction was highly influenced by SRR, particularly in dry conditions (Figure 2). The wear behavior mostly depended on the tested temperature and lubrication conditions. SEM analysis showed wear mechanisms similar to those already observed in polymer gears, such as the smearing mechanism found in POM gears [3].

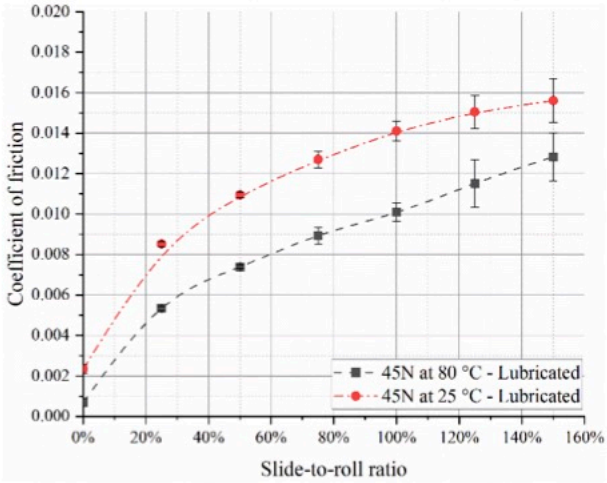

Figure 2: Coefficient of friction results for lubricated contact with different SRR and temperature condition.

4. References

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