Comparison of Adhesive Force of Additive's Layer on The Rubbed Surface Using Microscopic Methods

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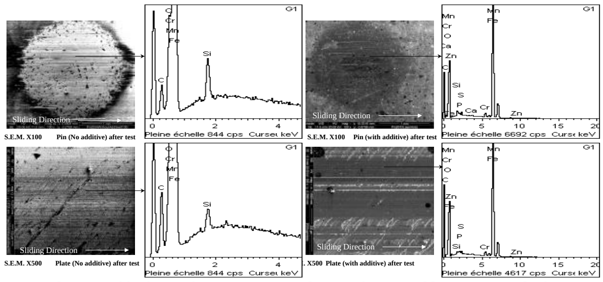
Aim of this study is to investigate the protective layers formed by lubricant additives on rubbed surfaces for a base-oil and fully formulated oil. A reciprocating pin-on-plate test rig was used; adhesive force of the protective additive layers formed on surfaces of pin and plate was measured and compared according to the non-layers. Wear tracks were examined using optical microscopy, electron microscopy with X-Ray diffraction analysis and atomic force microscopy (AFM) techniques. It can be concluded from the peaks of X-Ray spectroscopy that Ca, Zn, S and P elements were detected in the wear track of both pin and plate those tested with commercial oil this can be attributed to the protective additive's layers but no elements were found for the base oil test as expected (Fig.1).



a) Pin-plate tested by base oil b) Pin-plate tested by commercial oil

Fig.1 S.E.M. and X-Ray of pin and plate surface tested by drop of base oil (a) and SAE-20W50 engine oil (b) in boundary lubricated conditions.

The main reason is that satisfactory degradation of the surface permitted to activate lubricant additives to form protective layers. Adequate and sufficient surface degradation allows the sliding surface to be satisfactorily reactive to form high percentage of protective additive's layers and cover uniformly the whole wear track in boundary lubricated conditions. The wear lines of pin and plate wear track tested with base oil are more remarkable than those with commercial oil Fig.2). Adhesive force measurements by AFM showed higher values in pin and plate surface rubbed with commercial oil than those with base oil (Table 1).

Table-1 Adhesive force measurements (nN)

Pin surface non rubbed	Pin surface rubbed with base oil	Pin surface rubbed with 20W50 oil	Plate surface non rubbed	Plate surface rubbed with base oil	Plate surface rubbed with 20W50 oil
13 +/-0.23	63.2 +/-0.7	87.4 +/-0.94	35.3 +/-0.52	125.5 +/-1	144.5 +/-0.83

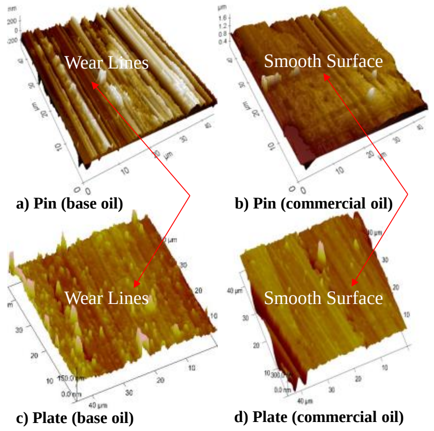


Fig.2 The morphology of the pin (a, b) and plate (c, d) surface by AFM imaging for base and commercial oil.

There is an increase of adhesion with the speed of friction for the pin and plate tested with commercial oil comparing to the base oil (Fig.3).

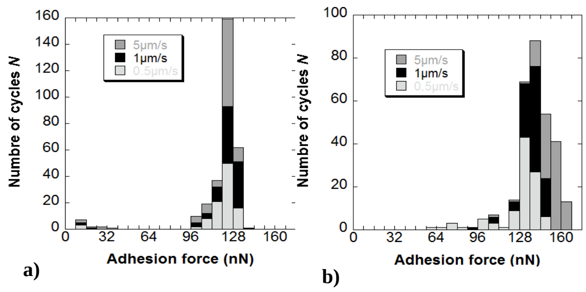


Fig.3 Friction velocity variation during adhesion force measurement for base oil (a) and commercial oil (b).

The primary reason is that the viscoelastic effect of additive's layer which augments adhesion on the protected surface which is discussed in the paper.

References

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