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Abstract :

As a general rule of thumb, the value of the friction coefficient in sliding contacts is very often connected to the wear rate : increase of the friction is associated with increasing wear. However this rule is not always valid, eg. in brakes a high friction coincides with low wear. When expressing the wear rate of materials in the classical way, the wear volume is usually divided by normal load and sliding distance to evaluate the wear rate. This approach can cause some difficulties in evaluating the wear mechanism. Changes in the friction and therefore in the tangential force or the dissipated energy are not accounted for in this normalized wear rate. However the total material loss, i.e. volumetric wear, is caused by the energy dissipated in the wear contact and any changes in this dissipated energy must have an influence on the wear rate.

It is therefore proposed to express the wear rate in terms of dissipated energy, in analogy with the concept of friction power intensity introduced by Matveesky¹. It is furthermore proposed that the wear volume will be linearly proportional to the dissipated energy as long as the wear mechanism does not change, and this independent of any changes in the coefficient of friction.

This approach was used in the investigation of the sliding wear of TiN in varying relative humidity, both with a linear reciprocating test and with a pin-on-disk test. Although the evolution of friction proves highly sensitive to the ambient humidity, one single linear dependency of the wear volume on the dissipated energy is found in a given test geometry. The unique wear rate of TiN in reciprocal sliding is about 10 times higher than in a pin-on-disk test, indicating that the reciprocal test is more aggressive. This is due to the abrasive action of third body particles that are ejected from the contact in pin on disk testing but remain in the contact in the reciprocal sliding test.

When the same approach is used for (TiAl)N coatings and for TiN/(TiAl)N multilayered coatings, the unique correlation between wear volume and dissipated energy depends strongly on the relative humidity. In this case, it can be concluded that the wear mechanism depends significantly on the relative humidity. It can be shown that the best performance can be obtained for a multilayered TiN/(TiAl)N coating with very thin interlayers and a 1:1 ratio of TiN and (TiAl)N.

¹ Matveesky, R.M., The Critical Temperature of Oil with Point and Line Contact Machines, ASME Transactions, 87 (1965) 754