Tribology
Module2: Friction

Q.1. Instead of providing lubrication between two rubbing surfaces, is it advisable to improve the surface finish of the two surfaces to reduce friction?

Ans: Friction occurs due to ploughing (due to surface roughness) and adhesion (due to surface smoothness). This means improving surface finish would definitely help in reducing the friction caused by ploughing and micro-cutting, but increase friction caused by molecular attraction between tribo-pair. Lubricant reduces molecular attraction between tribo-surfaces, therefore lubrication (in form of solid / liquid / gaseous) is essential to reduce friction. In addition liquid lubricant has some other advantages also like cooling, transferring of wear debris etc. Also achieving high surface finish would be very costly as compared to providing lubrication.

Q.2. Since coefficient of friction is dependent on various parameters such as temperature, surface roughness and hardness how can we quantify the coefficient for a particular material in general?

Ans: Coefficient of friction is a system property. It may be defined for a pair of materials, for particular environment condition. In other words coefficient of friction cannot be defined for a may vary significantly.

Q.3. Is there any other alternative to reduce the adhesion component of friction without lubrication?

Ans: No. Lubrication is a generic term. Reducing chemical activities between tribo-surface may be treated as lubrication. In other words, choosing appropriate surface coating or surface treatment, which reduces chemical affinity between tribo-material and provides wear-resistant surface, is part of lubrication mechanisms.

Q.4. What is friction instability and how it is related to stick slip process?

Ans: Friction instability generally occurs due to large difference in the value of static and kinetic coefficients of friction. Similarly stick-slip phenomenon occurs due to huge variation in static and kinetic coefficient of friction. Ideally lubricated condition having kinetic coefficient of friction equal to 0.00025 shall be preferred, but there is a possibility of high value of static coefficient of frictions. If we assume that static coefficient of friction under lubricated conditions is equal to 0.01 and kinetic coefficient of friction is equal to 0.00025, then this lubricated contact may not be preferred. This huge difference between static and kinetic friction coefficients provide negative damping and initiate a “stick-slip” process. Instantaneous sliding speed of an object does not remain close to the average sliding speed and friction coefficient decreases as velocity increases.

Q.5. What is the difference between static and kinetic coefficients of friction and what is the practical significance of these two terms?

Ans: **Static friction:** Static frictional force will increase to prevent any relative motion up until some limit where motion occurs. It is that threshold of motion which is characterized by the coefficient of static friction. The coefficient of static friction is typically (but not necessary) larger than the coefficient of kinetic friction.

Kinetic friction: Kinetic friction force acts at interface of two relatively moving surfaces. The kinetic frictional resistance is almost constant over a wide range of sliding speeds. The kinetic coefficient is typically less than the coefficient of static friction, reflecting the common experience that it is easier to keep something in motion across a horizontal surface than to start it in motion from rest. Often starting force is calculated based on static friction while energy loss is calculated based on kinetic friction force.

Q.6. Why are junctions formed at the region of contact between two surfaces?

Ans: All surfaces are made of atoms. All atoms attract one another by attractive force. For examples, if we press steel piece over indium piece they will bind across the region of contact. This process is sometimes called "cold welding or junction" since the surfaces stick together without the application of heat. It requires some force to separate the two surfaces. If we now apply a sideways force to one of surfaces, the junctions formed at the regions of real contact will have to be sheared if sliding is to take place. The force to do this is the frictional force. Due to high stress those asperities suffer plastic deformation, which permits strong adhesive bonds among asperities. Such cold formed junctions are responsible for the adhesive friction.

Q.7. What is ploughing effect?

Ans: When two bodies in contact have different hardness the asperities on the harder surface may penetrate into the softer surface and produce grooves on it, if there is relative motion. This is called ploughing effect.

Q.8. Out of spherical asperity and conical asperity which is more significant for increase in the coefficient of friction and why?

Ans: Conical asperities are much more severe than spherical asperity for increase in coefficient of friction. Conical asperity has comparatively more ploughing effect. The tip of the conical asperities may break, further adding to the debris which would further add to the friction.

Q.9. How does lubrication help in reducing the coefficient of friction?

Ans: Lubricants reduce the friction between sliding surfaces by reducing shear strength of interface. The interface shear strength in the presence of lubricant is generally very low compared to shear strength of any of material in tribo-contact. In addition lubricant fills the surface cavities and making the surfaces smoother, which help one surface to slide over another easily and thus reducing friction.

Q.10. What are various methods to reduce friction instability?

Ans: The best alternative to reduce friction instability is to choose the appropriate lubrication mechanism that maintains negligible difference in values of static and kinetic coefficients of friction.

Q.11. While designing a mechanical system should the selection of material for a tribological pair be based on the coefficient of friction or on the basis of functional requirement?

Ans: Functional importance of material is the primary requirement. It plays the most crucial role in the material selection. Friction can be handled by choosing pairing materials, surface treatment, coating, lubricant, etc. Right choice is "overall economic solution", which may require few practical trails, before finalizing complete design.

Q.12. In a tribological pair wear of softer material takes place much faster rate,S0 is it advisable to use materials of same hardness?

Ans: Choosing same hardness of tribo-pair shall reduce abrasive wear, but adhesive, corrosion, fatigue and fretting wear may continue. Therefore material and corresponding lubricant selection must be able to minimize all kinds of wear phenomena.