Tribology
Module2: Friction

Q.1. Why similar materials have higher coefficient of friction compared to dissimilar materials?

Ans: This is an intrinsic property of a substance that is caused by the shape and structure of its molecules which makes the distribution of orbiting electrons irregular when molecules get close to one another, creating electrical attraction between similar materials compared to dissimilar materials. This attraction increases the value of coefficient of friction between similar materials compared to dissimilar materials.

Q.2. Why does “Stick slip” phenomena occur?

Ans: Stick-slip is a phenomenon where the instantaneous sliding speed of an object does not remain close to the average sliding speed. Insufficient power is being supplied to the sliding surface which is insufficient to overcome friction causing the surfaces to stick momentarily. This phenomenon occurs if the value of static coefficient of friction is higher than the kinetic coefficient of friction. Lesser the difference in values of these coefficients of friction, lesser will be chances of stick slip phenomenon. In such circumstances the slower the feedrate used, the worse Stick-Slip occurs.

Q.3. Why only spherical and conical asperity surfaces are considered in explaining the friction due to ploughing effect? Which surface provide better estimation and why?

Ans: From experience it has been observed that asperities of new surfaces are similar to conical asperities and after running-period the shape of asperity approaches to spherical shape. Generally spherical asperity shape provides better approximation as it simulates working surface closely.

Q.4. To reduce junction growth it is suggested to use contamination (i.e. oxide) layer, but would not this contamination damages the surface once they get detached from the surface?

Ans: Basic purpose of contamination layer is to reduce the interface shear strength, which reduces the chance of junction growth. But the shear strength between parent material and contamination layer should be high. Therefore strong oxides attached to virgin surface is always preferred compared to weak oxides.

Q.5. What are similarities and differences between adhesive, abrasive and "junction growth" friction theories?

Ans: All three theories are related to resistance offered against sliding by interface of two surfaces. All three theories account the contact area, load on the surfaces and tangential force. There is difference in basic approaches adopted by these theories. The adhesion theory is based on the fact that all surfaces are made of atoms and they attract one another by attractive force. The abrasive theory is based on the fact that contact between tribo-pairs only occurs at discrete points, where the asperities on one surface touch the other. The slop of asperities governs the friction force. Sharp edges cause more friction compared to rounded edges. "Junction growth" theory is similar to "adhesive" theory except it considers growth in junction of contact area due to tangential force.

Q.6. "Use of lubricant does not help to reduce rolling friction" then why every roller bearing uses lubricants?

Ans: In every roller bearing, the motion is never perfectly rolling. Sliding occurs between inner ring and rolling elements, outer ring and rolling elements, and cage and rolling elements, therefore friction can be reduce by lubricating the roller bearings.

Q.7. "As it is known that lubricant cannot reduce deformation of surface", is it true for all type of lubricants?

Ans: If lubricant is able to bear and share the imposed load, then lubricant can reduce the deformation.

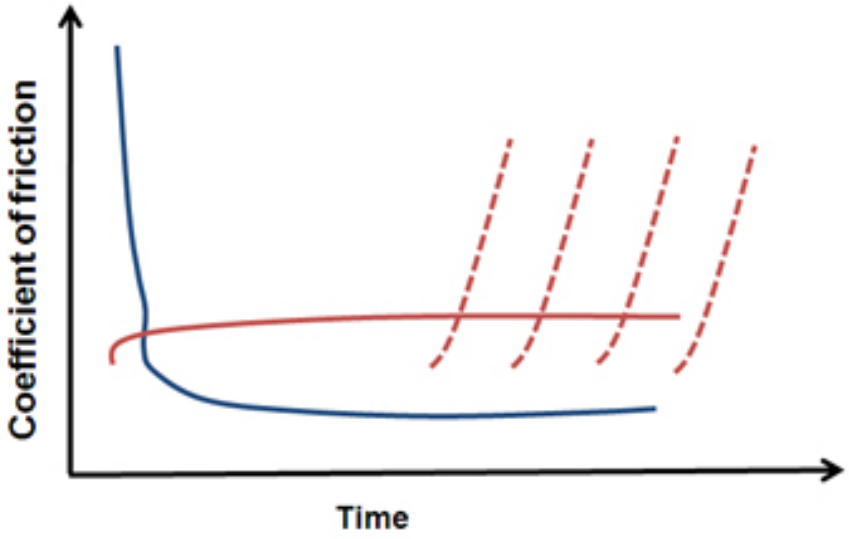
Q.8. Which is the most preferred theory of friction?

Ans: "Junction Growth" theory provides better explanation of friction between surfaces.

Q.9. Between adhesion and abrasion which is more prevalent and which causes more damage to the surface?

Ans: It is very difficult to state which mode of friction is prevalent. If surfaces are virgin (no contamination, no lubrication) adhesion will be more prevalent compared to abrasion. If surfaces are new (surfaces are rough), then abrasion is more prevalent compared to adhesion. Further abrasion may leads to adhesion, and adhesion may leads to abrasion. Adhesion generally causes more damage to the surfaces compared to abrasion.

Q.10. Explain the following graph:



Ans: In above figure there are three different kinds of line: Blue line, red continuous line, and red dotted lines. Blue line indicates that the friction is initially high as the time progresses it becomes stable. This is particularly true for boundary and mixed lubrication cases. Red continuous line indicates almost constant value of coefficient of friction, which generally happen under hydrodynamic lubrication regime. Finally red dotted lines indicate the possibility of surface deterioration of surface with time, which leads to high coefficient of friction.

Q.11. What is junction growth? Is it favorable or unfavorable?

Ans: "Junction growth" is a hypothesis to explain the friction between two surfaces. As per this theory, the area of contact or junction increases (as expressed by following equation) with increase in tangential force till it reaches to limiting value.

$$\delta A\,\tau_Y = \sqrt{\left(\frac{\delta W}{2}\right)^2 + \delta F^2}$$

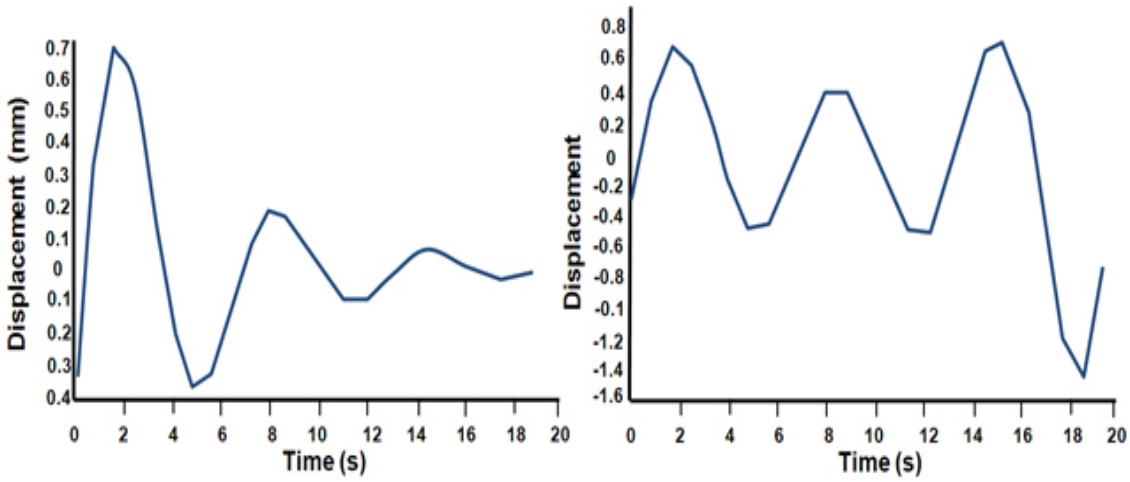
F = f(A) ????

Friction increases area of contact

Constant

To reduce the friction junction growth is unfavorable. Friction increases with increase in junction growth.

Q.12. Which of following figure indicates stability and why?



Ans: The 1st graph indicates the stability of system as displacement is reduced with time.

Q.13. Why total □ should not exceed 0.3?

Ans: Based on old friction it was interpreted that coefficient of friction will not exceed 0.3. In reality it can be even more than one, particularly for the case of similar material pair.

Q.14. Why Static friction is higher than kinetic friction ($\mu_s > \mu_k$)?

Ans: Generally surfaces are rough and stresses at contacting asperities are higher. Under these conditions the interlocking of the irregularities and cold welding of two surfaces occur. These causes result static friction. Once the movement starts, surfaces do not get sufficient time to settle down and form cold junctions. Therefore kinetic friction is lesser that static friction.

Q.15. To explain ploughing component of friction, conical and spherical shapes of asperities were considered. What if (half cone angle) = 0^o or R (radius of hemisphere) = 0?

Ans: Both these cases are pointing towards very sharp peaks (asperities) which lead very high frictional resistance and may get broken during first sliding cycle, which results in change in geometry of asperity.