

Tribology

Module1: Introduction

Q.1. To what extent in general does a lubricant reduce friction between surfaces?

Ans: The extent to which lubrication reduces the friction between two surfaces is governed by two factors:

- 1) The shear strength of lubricant layers. Lesser shear strength results in lesser friction.
- 2) Levitation capability of lubricant. If lubricant is able to separate two surfaces completely (no contact among asperities), it will reduce friction, provided separation between surfaces is not beyond a certain limit. In broad sense friction can be reduced by 10-1000 times.

Q.2. What's the relationship between safety/reliability and lubricant efficiency? Is there any proportionality relation between them and if so what is the proportionality constant?

Ans: It is a very vague question, there is no definite answer. Lubricant is a substance that reduces friction. Excessive friction may cause excessive wear which may reduce the efficiency of mating surfaces and lead to some other failure mode (i.e. excessive stress, fracture). Therefore there is no definite relationship between safety and lubricant efficiency.

Q.3. If magnetic bearings are able to provide frictionless and zero-wear performance, then why these bearings are not able to replace regular bearings?

Ans. Here regular bearings mean liquid/solid/gaseous lubricated bearings. The main advantage of these bearings is high value of load-carrying-capability/cost ratio compared to magnetic bearings. Magnetic bearings are restricted to ferromagnetic materials and may attract ferromagnetic debris from environment. Therefore at present magnetic bearings are limited due to low load/cost ratio and material usage.

Q.4. What kind of lubricant is applied on disks and why doesn't it get transferred to the user's hand while handling it?

Ans. Hard disk drives are provided with monolayer lubricant, which act as solid lubricant. The work surface of hard disk is protected; therefore user cannot touch that surface. However, surface of CD/DVD does not contain any lubricant, as reading/writing is performed through optical means (without any mechanical contact) and there is no need of lubricant.

Q.5. What kind of lubricant is there in human joints? Can this lubricant be used as a substitute to the other lubricant used in various applications?

Ans. Synovial fluid lubricates the human joints. This is a natural boundary lubricant and research is being performed to make similar kind of lubricant. However, in manmade machines load-speed conditions are much more severe and we require much better (in terms of load speed temperature characteristics) lubricants compared to synovial fluid.

Q.6. What is adhesive wear? “Adhesive wear causes uneven surface that leads to reduction in mechanical contact. For same imposed load, reduction in mechanical contacts, increases the level of stress and hence chances of failure.” Explain?

Ans. Adhesive wear is a mechanism of wear involving shear of localized welding of micro-asperities during sliding contact, as for example between two bearing surfaces. Micro-shearing or tearing causing the removal of surface material (wear) can be termed as adhesive wear. This micro-shearing of contacting surfaces may cause uneven surface and reduce the contact area. If stress is represented as Force/Contact area; then reduction in contact area increases the stresses. If stress increases beyond permissible stress, mechanical failure occurs.

Q.7. How many types of magnetic bearings are there? How are they different from each other? Where are they used?

Ans. There are two types of magnetic bearing technologies in use today – passive and active. Passive bearings (made of permanent magnets) are similar to mechanical bearings in that no active control is necessary for operation. In active systems (based on electromagnets), non-contact position sensors continually monitor shaft position and feed this information to a control system. This in turn, passes the current to the actuator via current amplifiers. These currents are converted to magnetic forces by the actuator and act on the rotor to adjust position. Magnetic bearings are used where lubricant is restricted to avoid continuous monitoring, maintenance, etc.

Q.8. Explain the “Bath tub curve”.

Ans. The bathtub curve is basically used to identify the failure rate with respect to operating life of components. It comprises of three parts:

- Early failure rate (Infant mortality period).
- Constant failure rate (Stable failure period).
- Increasing failure rate (wear-out failure period).

The initial region that begins at time zero when a product is new is characterized by a high but rapidly decreasing failure rate. Operating parameters need to be decided with a lot of care so that it is complied with other components and product can see its useful life.

After infant mortality period roughly constant failure period (hopefully) start and that remains for the majority of the useful life of the product. This long period (also called as **Stable failure period**) is designed with optimum value of parameters.

Finally, the failure rate begins to increase as materials wear out and product starts losing its design function. In other words product loses its intended function.

Q.9. How smooth is smooth enough for reducing the friction to minimal?

Ans: To answer this we can use figure provided by Tomlinson

