

# Friction Explanation

If we examine the surface of a finely polished metal plane under a microscope, we see that the surface which we thought was flat is actually a series of hills (asperities) and valleys (troughs). When one plane surface is brought in contact with another, there are few actual contact points. These correspond to the limited number of high asperities on one surface which are in contact with corresponding asperities on the other. We therefore define friction as the force resisting motion when the asperities of these surfaces in contact are moved relative to each other. Friction will vary in degree depending on the materials and load applied. It is always present wherever motion exists, and is undesirable in the operation of bearings, gears, and other machine parts.

## Sliding Friction

For plane surfaces in contact, the junctions at which surface asperities touch must bear the total load, generating very high pressures and causing adhesion (welding) of one asperity to another. The force of sliding friction is the force needed to shear these junctions, the strength of which will depend on the load and the area of actual junction contact. A piston sliding in a cylinder or a shaft revolving in a plain bearing would produce this type of friction.

## Rolling Friction

Rolling friction is developed when a polished cylindrical or spherical body is rolled over a plane surface. The forces involved are more complex, but are considerably less than those developed during sliding friction. Heavy objects are generally moved on rollers rather than skids in order to take advantage of this difference. Ball and roller bearings develop rolling friction.

## Fluid Friction

By contrast the cohesive forces of fluids such as oil, are only a fraction of those in solids. When the molecules of a fluid move past each other, they generate much less friction than solid surfaces because less force is needed to overcome the cohesive forces in the fluid. Fluid friction is, therefore, considerably less than either the sliding or rolling friction of solid bearing surfaces.

Friction always produces heat, the amount of heat being greatest with sliding friction, less with rolling friction, and least with fluid friction. The most important function of a lubricant, then, is to prevent metal-to-metal contact, or, to minimize friction between metal surfaces in motion with respect to each other.

## How To Reduce Friction

It is by taking advantage of the lower cohesive forces in fluids that lubricating oils reduce the friction of bearing surfaces. When a lubricant is injected between two metal surfaces which are pressed together and in motion relative to each other, the lower cohesive forces of oil are substituted for the higher metallic sliding or rolling friction generated on the unlubricated surfaces. The oil film which is formed separates the two metal surfaces and tends to keep them separated. The more effective the oil film, the greater the reduction of friction. But friction can never be totally eliminated, so even the best lubrication is a compromise with various types and amounts of friction.

Power is always consumed in overcoming friction, but when the surfaces of solid bodies in motion are lubricated the substitution of fluid friction for dry friction reduces the amount of power needed to move the solid bodies and overcome friction. This leaves more power available for useful work. Also, since heat generated is closely related to power consumed, a reduction in power consumption means a lower operating temperature.