A Shocking Approach to Lubrication

Lubrication is another issue that requires frequent attention. Oil keeps many machine components running smooth, but in some applications, such as semiconductor manufacturing, oil becomes a contaminant. And in applications where low friction is critical, oil actually bogs down moving parts so much that designers seek components that can run without oil. Eliminating oil may seem ludicrous to some designers, but engineers at **Champion Bearings, Inc.** Palm Springs, California, have found a way to use solid-film lubricants and decrease friction to less than that of oil-lubricated systems. The underlying principle of lubrication is that oil maintains a boundary between two moving parts.

On a microscopic level, part surfaces resemble hills and valleys. If these surfaces come into contact and slide across each other, they generate friction and heat. If enough heat builds up, the tow surfaces briefly melt together. This phenomenon is called micro weld adhesion. As the components continue to move, the micro welds break apart and remove material from the component surfaces.

To resolve this problem without using oil or grease, Richard Kay, CEO of **Champion Bearings**, uses a process called Ion deposition to electrically adhere solid-film lubricants to part surfaces. When this process is used on ball bearings, for instance, assembled bearings are mounted and rotated in a vacuum chamber filled with argon gas. The material to be ion doped, such as tungsten disulfide, is heated electrically to its boiling point. Argon ions accelerated by electrical voltages collide with atoms of evaporated tungsten disulfide. This imparts kinetic energy in the tungsten disulfide in the direction of the bearings and lodges the material into the microscopic valleys on the bearing surfaces. ”We don’t change the dimensions of the bearings very much when we do this,” reports Kay. “We lay down about 2,000 angstroms of tungsten disulfide or molybdenum disulfide.” Although solid-film lubricants have been around since the 1960s, Champion has developed hybrid bearings using raceways coated with ion deposition, ceramic balls, and a Teflon- based retainer material, called Beraloy. As a result of this development and other emerging technologies that require hybrid bearing, the company has seen a recent surge in interest in its products.

General Motors, for instance, is currently using **Champion**’s hybrid bearings and gears coated with ion deposition in the transmission of a prototype hybrid electric/diesel automobile. GM engineers are hoping that torque savings from the components will reduce power consumption by at least 200 W. Semiconductor manufacturing is another growing industry for oil-free components. Oil-lubricated bearings cannot be used in semiconductor manufacturing because many processes take place in vacuum chambers. This can cause out gassing in conventional bearings. Also, in many semiconductor-manufacturing applications induced voltages in rotors become capacitively coupled to motor shafts. These voltages sometimes exceed the dielectric strength of bearing lubricants. The resulting current flows from the shaft through the bearing lubricants and to the grounded motor frame. This produces high rolling resistance, pitting the bearing races and leading to premature failure. Frosted, fluted, or corrugated patterns sometimes found on surfaces of inner races of antifriction bearings are often the result of these electromagnetic forces.

These problems can be overcome using nonconductive ceramic balls running between inner and outer steel races, as in hybrid bearings. Besides eliminating race fluting, ceramic balls run considerably cooler than steel balls because they are not as susceptible to micro weld adhesion. This can occur with marginal lubrication due to welding of peaks of steel contacting each other under extremely high pressure.

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