machine design

Engineering Essentials: Lubrication Tips for Plastic Gears and More (Part 2)

Motion System Design
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To learn the tricks of caring for industrial drives, especially optimum lubrication methods, takes many years of field experience, or learning from others with experience.

Plastic components

Q: What lubricant (if any) should I use on plastic bearings and gears?

A: Many engineers and maintenance personnel have misconceptions that plastic components either require special plastic lubricants or no lubricants.

Wherever possible, you should lubricate plastic components to reduce friction and wear, and increase component life. Tests show that lubricated plastic sliding bearings last up to five times longer than nonlubricated ones.

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Even self-lubricating plastic materials, such as PTFE (Teflon), benefit from lubrication, Figure 1. At speeds over 1 rpm, friction for a nonlubricated Teflon sleeve bearing increases, whereas it decreases for a lubricated bearing.

To optimize lubrication of plastic components, you should abide by one basic guideline: *choose a lubricant that is compatible with the plastic material.* Compatibility must be verified under all anticipated adverse conditions of load, speed, and environment. Incompatible plastic-lubricant combinations often cause operating problems such as stress cracking or failure of the plastic component.

Table 1 gives general compatibility guidelines. For more specific information, consult the manufacturers of the plastic component and lubricant.

Q: What affects the compatibility between lubricants and plastics?

A: Compatibility factors include the lubricant's chemistry (base oil, thickeners, and additives), viscosity, and aging resistance.

Chemistry. Typically, lubricants based on silicone, PFAE (perflourinated), most synthetic hydrocarbons

(SHC or PAO), or mineral oils work well with plastics. Lubricants based on esters or polyglycols are generally not compatible with plastics, although there are exceptions depending on the type of plastic.

Incompatible lubricants cause plastics to lose dimensional stability or structural integrity, or become discolored. To check for compatibility, manufacturers test physical properties of the plastic material including volume, weight, elongation, strength, and hardness. Each manufacturer sets limits on the allowable change in these material properties, typically 7 to 10%. In evaluating such tests, be sure they reflect your worst case conditions. Both lubricants and plastic materials are more prone to changes at higher temperatures or in adverse environments, especially with high dynamic loads.

Additives sometimes cause a lubricant to react with plastic. For example, solid additives, such as graphite or molybdenum disulfide (moly), can penetrate and weaken a plastic component and should generally be avoided. On the other hand, PTFE solid additives are useful in specific cases such as reducing startup friction or providing dry lubrication.

EP additives used in lubricating metal parts are not recommended for plastic parts. Moreover, large amounts of corrosion protectors or metal deactivator additives used with metal parts are also unnecessary for plastics.

Viscosity/NLGI grade. High-viscosity oils, generally ISO VG 100 or more, are less apt to penetrate and adversely affect plastic materials. For greases, an NLGI 1 or 0 consistency reduces friction and grease-induced noise (grease slap).

Aging resistance. As lubricants age, they are more likely to attack plastic. Therefore, long-term plastic applications call for synthetic lubricants, which have a high aging resistance. Outgassing byproducts of plastic, such as formaldehyde or styrene, accelerate the lubricant aging process.

Recommendations. Mineral-oil-based lubricants don’t attack most plastic materials and offer excellent performance for the dollar in general plastics applications.

However, with the trend to higher operating speeds, higher temperatures, and longer operation, companies are turning to synthetic lubricants, such as hydrocarbon (PAO) types, for plastic bearings and gears. PAO’s offer high aging resistance, compatibility with most plastics, and long-term lubrication within a temperature range of -60 to 320 F.

PFAE lubricants are one of the most compatible types, even with hard-tomatch plastics. Similar to PAO oils, they offer a good balance between adhesion and wetting of plastic surfaces. Probably their widest use is for extreme temperature applications, up to 500 F. Because of their high cost, use PFAE oils only where necessary.

Silicone-based lubricants also show excellent compatibility. They are suitable for low load applications and a wide temperature range (typically -90 to 425 F).

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