Dodge® mounted bearings: grease basics

There are many bearing lubricants on the market that vary by oil viscosities, base type and additives. When properly selected, each feature serves a distinct purpose toward the successful functionality of the bearing.

Grease lubricants are semi-fluid substances that contain oil and a soap base thickener. The oil is the effective substance that separates the rolling elements (balls or rollers) and raceways, prevents metal on metal contact and reduces friction. The soap base acts as a sponge or carrier that feeds oil to these surfaces to maintain the oil film thickness. They are also used to transfer heat, debris and wear particles away from these surfaces.

There are three main types of lubrication conditions: hydrodynamic, boundary and elastohydrodynamic. Hydrodynamic lubrication occurs when the oil film is adequate to fully support the rolling elements from the raceways within the bearing under load. Boundary lubrication occurs when these same surfaces interact with each other; with no oil film separation. Elastohydrodynamic (EHL) lubrication is when both hydrodynamic and boundary conditions exist. Under an EHL condition the bearing load causes elastic deformation of the raceways and compresses the oil to a solid-like state between the interacting surfaces. Under an EHL condition there may still be some metal contact depending on the surface asperities and microscopic variations in the surface finish. Mounted bearings normally operate in an EHL condition.

Greases are composed of 75% to 95% oil, 5% to 20% thickener and additional additives. The oil is used to lubricate the bearings and is either a petroleum (mineral) or synthetic oil. The soap thickener is used to retain the oil in suspension much like a sponge. The additives provide additional properties to improve the bearing's load and wear characteristics, expand the lubricant's temperature range reduce friction and/or enhance the lubricant's anti-corrosion properties.

As previously stated, the bearing rollers and raceways are separated by a thin film of compressed oil in the load zone (area in the bearing where the rolling elements and raceways are actually in contact). The ability of the oil to maintain the separation will depend on the actual operating temperature, load, and the viscosity of the oil. Oil viscosity is the measurement of the fluid's resistance to flow and its properties are used to select the proper oil for the application. Lubricating oils with a low viscosity are very light with a water-like consistency. They are commonly used for high speed, lightly loaded applications. Lubricating oils with a high viscosity are heavy, thick and molasses-like in consistency. They are used for low speed, heavily loaded applications. The film thickness of the oil is important to minimize bearing wear and heat. If the film thickness becomes too thin then the asperities on the bearing components make contact with each other and shear, creating wear particles and additional heat due to friction. Use of lubricants with too high viscosity can also lead to high temperatures due to friction as the lubricant will resist the rolling elements from rolling through the load zone.

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The thickener is a metallic soap that holds the oil in suspension and allows the oil to 'flow' into the load zone. Thickeners are unidirectional; oil will separate from the lubricant gradually as required, however oil will not be reabsorbed. This contributes to service life limitations of the lubricant and is another reason it is necessary to re-lubricate bearings routinely. Re-lubrication renews the lubricant's ability to hold and distribute the oil in the bearing. Different thickeners are available however the most common is lithium because lithium-based greases have a wide usable temperature range and are inexpensive.

Lubricants without supplementary additives are often satisfactory when properly selected for the application based on the load, operating temperature and speed. A properly selected lubricant will provide sufficient oil film thickness to support the load and operating conditions. However, when proper additives are incorporated into the lubricant, the overall performance improves. Some chemical additives directly adhere to the bearing components to provide corrosion and anti-wear (AW) resistance. Some absorb moisture contamination and prevent a damaging reaction with the bearing surfaces. Extreme pressure (EP) additives are used to provide properties whenever loading is 'extremely' high that cause the asperities on the surface to shear and expose bare metal. EP additives are then activated that chemically coat the metal surfaces. The activation is created by the high frictional heat that is created due to the shearing and the frictional force on the surface. It is important to note, however, that additives in lubricants can be incompatible. It is recommended to use the same type of grease when re-lubricating.

Molybdenum disulphide is another additive that is popular. Molybdenum disulphide is black in color and is added to lubricants for its low frictional properties. It is also stable in high temperature environments up to 350°C. Molybdenum disulphide is a solid that has a trigonal prismatic crystal layered structure where the molybdenum atoms are sandwiched between layers of sulfur atoms. This structure results in a material that has low shear strength and low coefficient of sliding friction. Molybdenum disulphide particles are distributed in the lubricant and adhere to the surfaces minimizing metal to metal asperity contact while the base oil provides the film strength to support the bearing load. The molybdenum disulphide particles on the metal surfaces provide temporary lubrication when the base oil is depleted due to use, evaporation to heat, or absorbed by contaminants. High temperature lubricants use molybdenum disulphide as they can withstand the high temperature. Mineral oils in the lubricant can flash, burn or evaporate at temperatures above 350° F (~175°C), when this happens the molybdenum disulphide particles are left to lubricate the bearing.

Unfortunately, the use of lubricants with molybdenum disulphide does have a major drawback on bearing performance. Molybdenum disulphide increases skidding of the rolling elements due to the low frictional properties of the lubricant. Skidding causes damage to the race surfaces creating wear and flat spots. It also has an inherent nature to build up on the surfaces. Cage failures can result due to cage loading as the rollers are being dragged through the load zone. The uses of these lubricants are not generally recommended by Dodge due to the damage that can be created to the bearing and the decrease in life that can result. Lubricants with molybdenum disulphide are useful on applications where lubrication intervals are marginal, as they will provide temporary lubrication between re-

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lubrication intervals. However, they are not necessary. Applications where the bearings have been properly applied and lubricated with as standard lubricants will provide adequate life. It is important to remember that lubricants with molybdenum disulphide have caused bearing skidding problems.

In conclusion, when re-lubricating it is important to know what type of lubricant is being used and select a lubricant that has the same thickener to ensure compatibility. Select the proper lubricant to fit the application based on the loading conditions, speed and operating temperatures. Remember that additives are used to assist in extending the life of the lubricant and are not a substitute for prudent re-lubrication practices.

For questions, contact Dodge C.O. Engineering at 864-284-5700 or email: Engineering@dodgeindustrial.com