Automotive TechTips

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Volume 3 • Issue 3 Part 1 of a 3-Part Series

Maximizing bearing performance and life remains an objective throughout The Timken Company, from design teams and manufacturing associates to our field sales team and distributors. TechTips help you install and maintain Timken® bearings, seals and components to maximize their life and performance and the systems in which they operate. For more information regarding Timken automotive products and services, visit www.timken.com or contact your local Timken distributor.

INADEQUATE GREASE LUBRICATION IN BEARINGS:
OVERFILLING AND UNDERFILLING

The life of a Timken® bearing depends to a great extent on the proper lubrication of the bearing. Lubricants aid in carrying away heat, protecting bearing surfaces from corrosion and reducing friction.

Statistics show that nearly 50 percent of all bearing damage can be attributed to inadequate lubrication. Although a very broad term, inadequate lubrication can be classified into eight basic categories: **1) overfilling, 2) underfilling, 3) incorrect grease, 4) mixing greases, 5) incorrect lubrication systems and intervals, 6) worn-out grease, 7) water contamination, and 8) debris contamination.**

The following offers a quick reference to two of these eight basic categories: **overfilling and underfilling**.

Overfilling

Overfilling a bearing with too much grease can cause excess churning of the grease during operation and high temperatures, resulting in overheating and excess grease purging* (leaking). Overheating occurs because the heat generated cannot dissipate correctly, continually building until damage occurs. As the operating temperature of the bearing rises, the oxidation (breakdown) rate of the grease sharply increases – doubling every 18° F.

**NOTE: During initial start-up, it is common for a properly lubricated bearing to purge a small amount of grease. A slight grease purge is often recommended by original equipment manufacturers, as it acts as a barrier seal to help keep out external debris contamination (Fig. 1). Always follow original equipment manufacturers' recommendations regarding grease purging and correct replenishment amounts.*

An overfilled bearing may also purge grease during initial start-up. However, over time and as temperature rises, excess grease will continue to purge from an overfilled bearing and have a darkened color (Fig. 2).

Fig. 1- 'Clean' grease slightly purging (leaking) from a bearing during initial startup is generally acceptable. The grease is wet and evenly purged. If this slight purge is not causing any problems, leave it alone as it is an effective barrier seal.

Fig. 2- A petri dish containing heavily oxidized grease, which purged from an overfilled bearing. Grease undergoing heavy oxidation often has a very distinguishable black color and burned odor. In addition, it gets stiffer in composition.

Underfilling

Underfilling a bearing with grease can also have adverse consequences. As in overfilling, heat can be generated but for different reasons. When the grease amount is low, a grease starvation condition may be created, causing heat generation or excessive metal wear during operation. If a bearing suddenly becomes noisy and/or the temperature increases, excessive wear may be taking place.

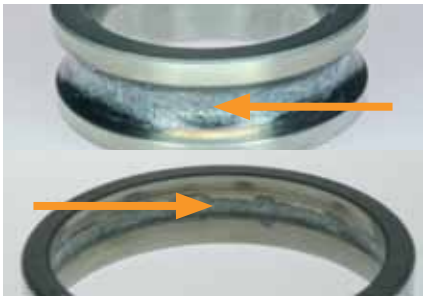
Grease removed from an underfilled bearing showing shiny bearing metal debris.

⚠WARNING ***Failure to follow these warnings could create a risk of serious injury.***

Proper maintenance and handling practices are critical. Always follow installation instructions and maintain proper lubrication.

Never spin a bearing with compressed air. The rolling elements may be forcefully expelled.

Effects of Inadequate Grease Lubrication in Bearings



Ball bearing inner race (above) and outer race (below) burnup: metal-to-metal contact from breakdown of lubricant film.

Tapered roller bearing cone large rib face deformation: Metal flow from excessive heat generation.

Cylindrical bearing outer race and rollers with peeling and moderate wear due to underfilling of lubricant.

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INADEQUATE GREASE LUBRICATION IN BEARINGS:

INCORRECT GREASE; MIXING GREASES; INCORRECT LUBRICATION SYSTEMS AND INTERVALS; AND WORN-OUT GREASE

The life of a Timken® bearing depends to a great extent on the proper lubrication of the bearing. Lubricants aid in carrying away heat, protecting bearing surfaces from corrosion and reducing friction. Statistics show that nearly 50 percent of all bearing damage can be attributed to inadequate lubrication. Although a very broad term, inadequate lubrication can be classified into eight basic categories: **1) overfilling, 2) underfilling, 3) incorrect grease, 4) mixing greases, 5) incorrect lubrication systems and intervals, 6) worn-out grease, 7) water contamination, and 8) debris contamination.** The following offers a quick reference to four of these eight basic categories: **incorrect grease, mixing greases, incorrect lubrication systems and intervals, and worn-out grease.**

Incorrect Grease

The base oil in a particular grease may have a different thickness (viscosity) than what is recommended for your application. If the base oil viscosity is too heavy, the rolling elements may have difficulty in pushing through the grease and begin to skid (Fig. 1). If this occurs, excessive grease oxidation (breakdown) (Fig. 2) may cause premature grease failure and excessive wear of bearing components. If the viscosity is too light, peeling (micro-spalling) and wear (Figs. 3 & 4) may result due to thin lubricant film from elevated temperatures. In addition, the additives contained in a particular grease may be inappropriate or even incompatible with surrounding components in your system.

Fig. 1 - Cylindrical roller flattened as a result of skidding.

Fig. 2 - A petri dish containing heavily oxidized grease. Grease undergoing heavy oxidation often has a very distinguishable black color and burned odor. In addition, it gets stiffer in composition.

Fig. 3 - Needle thrust bearing inner race peeling (micro-spalling) due to thin lubricant film from elevated temperatures.

Fig. 4 - Peeling: Micro-spalling in a tapered roller bearing outer race (above) and inner race (below) due to thin lubricant film from elevated temperature.

Mixing Greases

A bearing may be running well with the correct grease. However, while performing routine maintenance, a technician may decide to lubricate the bearing with a different type of grease. If the greases are not compatible, the grease mixture will do one of two things: 1) soften and leak out of the bearing due to grease thickener incompatibility, or 2) become lumpy, discolored and hard in composition (Fig. 5).

Incorrect Lubrication Systems and Intervals

Maintaining correct bearing lubrication systems and intervals is critical to help prevent premature wear of bearing components. If maintenance schedules are not followed (Fig. 6), lubrication may deteriorate through excessive oxidation (breakdown). Referenced on the front, Fig. 2 shows excessive bearing grease oxidation.

Worn-Out Grease

Grease is a precise combination of oil, thickener and additives (Fig. 7). Grease acts like a sponge to retain and release the oil. As a result of time and temperature conditions, the oil release properties can become depleted. When this occurs, the grease is worn-out (Fig. 8).

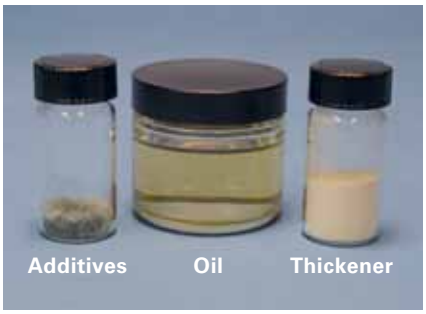

Fig. 7 - Grease is a precise combination of oil, thickener and additives.

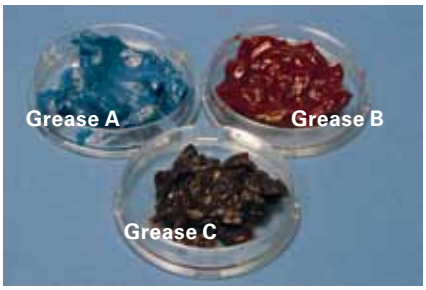

Fig. 5 - Grease A and Grease B are not compatible. When mixed together they become lumpy, discolored and hard in composition (Grease C).

Fig. 6 - A technician records key bearing lubrication data on a maintenance sheet.

Fig. 8 - The above photo shows the same grease at three stages (from left to right): 1) new grease, 2) heavily oxidized grease, and 3) worn-out (failed) grease – the thickener and additives have decomposed and the oil is breaking down.

⚠WARNING ***Failure to follow these warnings could create a risk of serious injury.***

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Never spin a bearing with compressed air. The rolling elements may be forcefully expelled.

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INADEQUATE GREASE LUBRICATION IN BEARINGS:
WATER CONTAMINATION AND DEBRIS CONTAMINATION

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Statistics show that nearly 50 percent of all bearing damage can be attributed to inadequate lubrication. Although a very broad term, inadequate lubrication can be classified into eight basic categories: **1) overfilling, 2) underfilling, 3) incorrect grease, 4) mixing greases, 5) incorrect lubrication systems and intervals, 6) worn-out grease, 7) water contamination, and 8) debris contamination.**

The following offers a quick reference to two of these eight basic categories: **water contamination and debris contamination.**

Water Contamination

Fig. 1 shows the effect of water on grease by comparing fresh grease (left) to a grease emulsified with 30 percent water (right). The fresh grease is smooth and buttery compared to the water laden grease, which is milky white in appearance. As little as 1 percent water in grease can have a significant impact on bearing life.

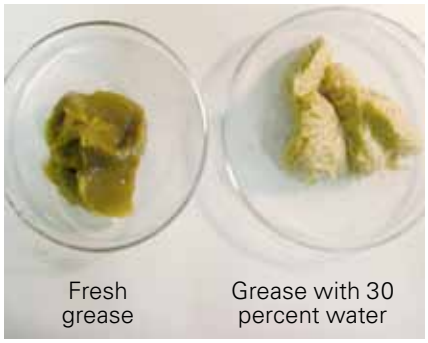

Fig. 1 - Effect of water on grease.

Fig. 2 - Etching

A tapered roller bearing cone and rollers (Fig. 2) and a ball bearing outer race and balls (Fig. 3) show rusting with pitting and corrosion from moisture/water exposure. This condition is referred to as etching.

Fig. 3 - Etching

Quick & Easy Field Test to Determine Water in Grease

An easy, non-technical method of determining the presence of water in grease is known as the 'crackle test.' To perform this test, place a sample of grease on a piece of aluminum foil (Fig. 4) and put a flame under the foil (Fig. 5). If the grease melts and lightly smokes, the presence of water is minimal or absent. However, if the grease crackles, sizzles and/or pops, the grease contains a considerable amount of water. *See warning below.*

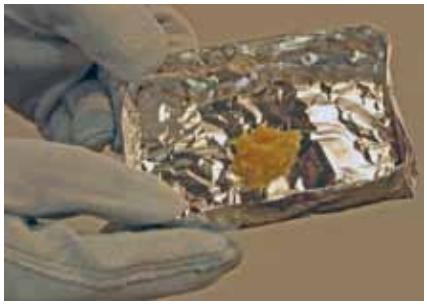

Fig. 4 - Grease sample

Fig. 5 - Crackle test

Debris Contamination

Common causes of external debris contamination include dirt, sand and environmental particles. Common causes of internal debris contamination include wear from gears, splines, seals, clutches, brakes, joints and failed or spalled components. These hard particles travel within the lubrication, through the bearing, and eventually bruise (dent) the internal surfaces. The dents form shoulders that act as surface-stress risers, causing premature surface damage and reduced bearing life.

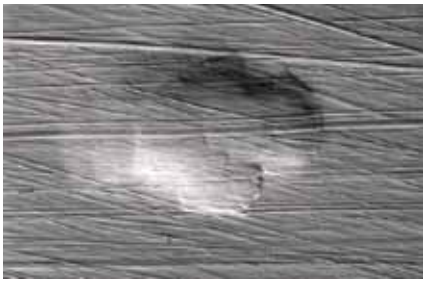

Fig. 6 – Debris contamination

Fig. 6, a photo taken using a microscope, shows a debris contamination bruise on a bearing race. A corresponding surface map of the dent is shown in Fig. 7.

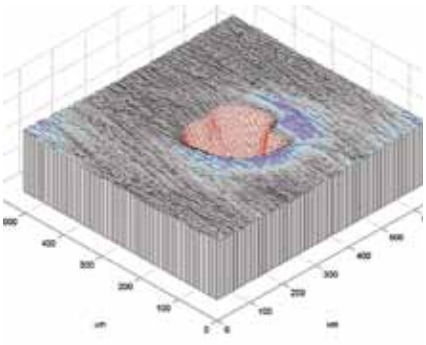

Fig. 7 – Surface map

Fig. 8 - Spalling

Fig. 8 shows a tapered roller bearing inner race (cone) with spalling from debris contamination bruises.

⚠ WARNING ***Failure to observe the following warnings could create a risk of serious injury.***

Proper maintenance and handling procedures are critical. Always follow installation instructions and maintain proper lubrication.

Never spin a bearing with compressed air. The rollers may be forcefully expelled.

Heated grease or water may create a risk of burns or eye damage. Wear suitable personal protective clothing, including eye protection and gloves, when performing a crackle test.

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