Worm Gear Lubrication ...

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Worm gears operate under difficult conditions, presenting unique lubrication demands. They serve as speed reducers in many different industries and applications. This article addresses how effectively lubricated worm gears affect worm gear performance.

Worm gears are used in various industries and machinery applications. They are unique in their ability to achieve large speed reductions in a compact space. They can transmit high loads at high-speed ratios. Ratios of 20:1 up to 60:1 and higher are normally achieved. .... There are three major types of worm gears:

1. Non-throated - a helical gear with a straight worm. Tooth contact is a single moving point on the worm drive. This leads to high unit loads and wear.

2. Single-throated - has concave helical teeth which wrap around the worm. This leads to line contact, permitting higher loads without excessive wear.

3. Double-throated - called a cone or hourglass. It has concave teeth both on the worm and helical gear. This increases from line contact area permitting increased loading and lower wear.

Worm drives are inefficient because the gears experience sliding rather than rolling contacts, leading to operating temperatures much higher than other gear types. Spur gears normally operate at 28°C over ambient temperatures while worm gear temperatures typically rise 50°C over ambient.

The following factors affect worm gear efficiency:

- Lead angle of the worm
- Sliding speed
- Lubricant
- Surface quality
- Installation conditions

Worm Gear Lubrication

Due to the sideway sliding motion in worm gears, it is difficult to maintain a hydrodynamic oil wedge. This results in gears operating under boundary lubrication conditions. Also, high operating temperatures that approach 88°C and higher usually require oils with an ISO VG of 460 (AGMA Class 7) and higher. They also require good thermal and oxidative stability.

The types of oils most commonly used to lubricate worm gears are compounded mineral oils, EP mineral gear oils and synthetics. Each has its own unique characteristics and all three types are used successfully

Worm Gear Lube Types

Compounded Gear Oils

These lubricants have been used extensively in worm gears with great success in a wide variety of applications. Compounded gear oil is a mineral basestock with normal rust and oxidation inhibitors that is blended with four to six percent acidless tallow or synthetic fatty acid (the compounding agent). The surface-active compounding agent gives these products excellent lubricity and prevents sliding wear in worm gears.

Many OEMs recommend compounded gear oils. Compounded oils were initially used as steam cylinder lubricants because of their ability to adhere to cylinder walls in the presence of steam. The temperature limitation of compounded oils is approximately 82°C. Because compounded lubricants are difficult to use out of this temperature range, they are often replaced with EP gear oils for consolidation purposes.

Most applications normally use an AGMA Class 7 or 8 compounded oil (ISO VG 460 and 680). In some cases, an 8A (1000 VG) is used. The viscosity selection depends on the worm's type, size, speed and operating temperature. Refer to the OEM for specific viscosity recommendations.

Extreme Pressure (EP) Gear Oils

EP mineral gear oils are used more extensively in worm gears. Under conditions of high pressure and temperature, the EP (antiscuff) additive reacts with the metal surface to form a soft, slippery chemical layer which prevents severe wear and welding. Previously, there was a concern that sulfur-phosphorous EP additives would react with the bronze gear. However, new EP additive technology used by most of the major lubricant suppliers has reduced the corrosive attack by utilizing nonactive sulfur. EP lubricants work particularly well when shock loading occurs. EP gear oils also protect steel gears better than compounded gear oils.

Typical recommendations are for both AGMA 7 and 8 viscosity grades. Like compounded gear oils, EP gear oils limit operating temperatures to under 82°C.

Synthetic Worm Gear Oils

Two major types of synthetic gear oils have been used successfully in challenging conditions with worm gears: polyalphaolefins and polyalkelene glycols.

Polyalphaolefins (PAOs) are the most common type of synthetic lubricant. They have good high and low temperature properties and are compatible with most mineral oils. Unlike some synthetics, PAOs don't attack paints or seals. Most formulations contain a small amount of organic ester or antiwear mineral that improves boundary lubrication conditions. Products that contain EP additives are also available. There are no major disadvantages, other than cost, when using PAOs as worm gear lubricants.

Polyalkylene glycols (PAGs) are excellent for worm gear applications. They possess superior lubricity properties and have good low and high temperature properties. The Viscosity Index of PAGs is higher than most synthetics, approaching 280. Therefore, a lower initial viscosity grade can be used minimizing internal friction resulting in improved worm gear efficiency. Most PAGs contain antiwear properties but there are no formulations with EP additives.

Besides cost, a major disadvantage of polyalkylene glycols is their incompatibility with other fluids. They also attack paints, seals and polycarbonate sight glasses.