Gear oil

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Gear oil is a lubricant made specifically for transmissions, transfer cases, and differentials in automobiles, trucks, and other machinery. It is of a higher viscosity to better protect the gears and usually is associated with a strong sulfur smell. The high viscosity ensures transfer of lubricant throughout the gear train. This is necessary since the devices needing this heavy oil do not have pumps for transferring the oil with only a portion of the lowermost gears bathed in an oil sump. This heavy oil can create viscous drag leading to inefficiencies in vehicle operation. Some modern automatic transaxles (integrated transmission and differential) do not use a heavy oil at all but lubricate with the lower viscosity hydraulic fluid, which is available at pressure within the automatic transmission.

Most lubricants for manual gearboxes and differentials are hypoid gear oils. These contain extreme pressure (EP) additives and antiwear additives to cope with the sliding action of hypoid bevel gears.

EP additives which contain phosphorous/sulfurous compounds are corrosive to yellow metals such as the copper and/or brass used in bushings and synchronizers; the GL1 class of gear oils does not contain any EP additives and thus finds use in applications which contain parts made of yellow metals.

GL-5 is not necessarily backward-compatible in synchro-mesh transmissions which are designed for a GL-4 oil: GL-5 has a lower coefficient of friction due to the higher concentration of EP additives over GL-4, and thus synchros can not engage as effectively. Also, transmissions which explicitly call for GL-4 oil may have been designed around this lower concentration of EP additives and thus may contain yellow metal parts which GL-5 will corrode.

API ratings

Gear oils are classified by the American Petroleum Institute using GL ratings. For example, most modern gearboxes require a GL-4 oil, and separate differentials (where fitted) require a GL-5 oil. It is important that purchasers check the oil against the vehicle manufacturer's specification to ensure it does not contain any aggressive chemicals that may attack *yellow metal* gear components, such as phosphor bronze.

API viscosity ratings for gear oils are not directly comparable with those for motor oil, and they are thinner than the figures suggest. For example, many modern gearboxes use a 75W90 gear oil, which is actually of equivalent viscosity to a 10W40 motor oil. Multigrade gear oils are becoming more common; while gear oil does not reach the temperatures of motor oil, it does warm up appreciably as the car is driven, due mostly to shear friction (with a small amount of heat conduction through the bellhousing from the engine block).

Fully synthetic gear oils are also used in many vehicles, and have a greater resistance to shear breakdown than mineral oils.

API classification subdivides all transmission oils into 6 classes:

- API GL-1. Oils for light conditions. They consist of base oils without additives. Sometimes they contain small amounts of antioxidizing additives, corrosion inhibitors, depressants and antifoam additives. API GL-1 oils contain no EP addives, are designed for spiral-bevel, worm gears and manual transmissions with synchronizers, in trucks and farming machines.
- API GL-2. Oils for moderate conditions. They contain anti-wear additives and are designed for worm gears. Recommended for proper lubrication of tractor and farming machine transmissions.
- API GL-3. Oils for moderate conditions. Contain up to 2.7% anti-wear additives. Designed for lubricating bevel and other gears of truck transmissions. Not recommended for hypoid gears.
- API GL-4. Oils for various conditions - light to heavy. They contain up to 4.0% effective anti-scuffing additives. Designed for bevel and hypoid gears which have small displacement of axes, the gearboxes of trucks, and axle units. These oils are standard for synchronized gearboxes, especially in Europe, and may also be recommended for non-synchronized gearboxes of US trucks, tractors and buses and for main and other gears of all vehicles. GL-4 oils may also be used in many limited-slip differentials.
- API GL-5. Oils for severe conditions. They contain up to 6.5% effective anti-scuffing additives. The general application of oils in this class are for hypoid gears having significant displacement of axes, generally non limited-slip differentials. They are recommended as universal oils to all other units of mechanical transmission (except synchronized gearboxes specifying GL-4). Some GL-5 oils in this class, which have special approval of vehicle manufacturers, can be used in synchronized manual gearboxes. API GL-5 oils can be used in limited slip differentials only if they correspond to the requirements of specification MIL-L-2105D or ZF TE-ML-05. In this case the designation of class will be another, for example API GL-5+ or API GL-5 LS.
- API GL-6 is not applied any more as it is considered that class API GL-5 well enough meets the most severe requirements. When API GL-6 was still in use, it denoted oils for very heavy conditions (high speeds of sliding and significant shock loadings). They contained up to 10% high performance anti-scuffing additives. They were designed for hypoid gears with significant displacement of axes. However, in 2011 at least one company offers new polyol ester based API GL-6 oil, mostly for racing applications. The application is limited to certain types of manual transmissions, but improvements in BSFC of about 5% in standard weather and driving conditions and up to 15-20% in cold extremes (arctic weather conditions) can be expected.

References