Manual Transmission Lubricants

Technical Bulletin

Fact Sheet No. 118

Regardless of the type of gearbox or gear set involved, a gear lubricant has three main performance functions:

- To reduce gear tooth wear to a minimum,
- To provide maximum cooling of the gears in the gear case,
- To ensure that the gears achieve their highest designed mechanical efficiency.

Gears in operation involve both sliding and rolling motion and the type of gear set will determine which of these types of motion predominate. There are three types of gear sets:

1. Straight-cut spur gears that have a predominantly rolling motion,
2. Hypoid gears with a predominantly sliding motion,
3. Worm drive gear sets, which are also predominantly a sliding motion.

Most automotive gearboxes utilise helical gears, and these involve both rolling and sliding motion. Helical gears are quieter in operation and have greater load-carrying capacity than spur gears as there is always more than one gear tooth in contact at all times to carry the load. It is the relative degree of rolling/sliding motion of the gears in mesh that, to a large extent, determines the type of lubricant required for their satisfactory operation.

Transmission Fluid Requirements

Viscosity

The viscosity or fluid thickness is the most important characteristic of the transmission lubricant. It must be high enough to support the expected loads encountered by the gears and still be able to readily flow, even at low ambient temperatures, between the gear teeth and into bearing spaces. It also has to be able to easily flow into the "synchro" units and not impede their operation by being too thick. In addition, it has to provide the necessary cooling for the transmission.

It is estimated that only 2% to 3% of the lubricant is required for lubrication and the remaining 97% to 98% is required for cooling. Lubricants exhibit thickening under load and this thickening or increase in viscosity assists in ensuring that they are able to accommodate the high loads generated by the meshing gears.

Resistance to Oxidation

As gear oils are subjected to high temperatures in operation and this, together with their agitation with air and contact with various metals which act as catalysts, subjects them to oxidation. This oxidation produces sludge and acidic compounds which tend to thicken the oil and attack metal surfaces.

Pour Point

In areas of low ambient temperature, gear oils must have a suitably low pour point so they are able to readily flow between the gear teeth and into bearing spaces to ensure component protection at the commencement of operation.

Demulsibility

While the entry of water into a transmission should be avoided, this can occur either through operation in "flood" conditions or through condensation under certain circumstances. It is essential that any water readily separates from the gear lubricant.

Corrosion Protection

Any corrosion of gear teeth is undesirable as this can lead to premature wear because it destroys the gear teeth contact surfaces, resulting in higher tooth loading. In addition, it introduces abrasive material into the unit which can grind away the gears. This corrosion, or rust, is formed by the action of air, water and steel together in the unit concerned.

Anti Foam

Foam formation in a gear lubricant has two detrimental effects. Any foam formed has poor load-carrying capabilities, and hence wear of the gear teeth can increase. In addition, foam increases the possibility of oxidation as it intimately mixes air with the lubricant.

Viscosity Grades

As already mentioned, correct viscosity for automotive transmissions is vitally important. If the lubricant is too low in viscosity (oil too thin) it may not provide sufficient film thickness to carry the applied loads, resulting in metal to metal contact and possible gear failure. On the other hand, if the viscosity is too high (oil too thick), then channelling may occur and the lubricant will not flow into the critical areas between the gear teeth and into bearing spaces. In addition, too high a viscosity can result in the lubricant producing a cushioning effect in the gearbox "synchros" and preventing their correct action.

The viscosity grades for manual transmission oils are determined by the Society of Automotive Engineers (SAE) and are outlined in the table below.

SAE Grades	Viscosity mm^2/s @ 100°C	
	min.	max.
75W	4.1	no requirement
80W	7.0	no requirement
85W	11.0	no requirement
90	13.5	<24
140	24.0	<41
250	41.0	no requirement

Performance Classification

The API (American Petroleum Institute) GL Service Classification was developed to outline the performance of gear oils. This system classifies gear oils from GL-1 (the least demanding service) through to GL-6 (the most demanding service) according to their required performance, and it is widely accepted by the automotive industry. A brief outline of the API GL Classification follows.

API GL-1 Designates the type of service of manual transmissions operating under mild conditions, with low gear tooth pressures and minimum sliding action. This service is generally satisfied by the use of oils that do not contain antiwear or EP additives.

API GL-2 Designates the type of service of automotive worm drive axles operating under conditions of load and sliding velocities such that GL-1 lubricants will not afford the necessary protection to the gears. GL-2 lubricants usually contain antiwear or very mild EP additives, which afford protection for worm gears.

API GL-3 Designates the type of service of manual transmissions and spiral bevel axles operating under moderately severe conditions of load and speed. GL-3 lubricants are usually fortified with antiwear additives as they require load-carrying capacity greater than GL-1. API CC or CD quality engine oils of the appropriate viscosity are often specified for GL-3 service.

API GL-4 Designates the type of service of spiral bevel and hypoid gears operating under moderate speeds and loads. These oils are not as heavily fortified as GL-5 oils and are used in selected manual transmissions and transaxle applications.

API GL-5 Designates the type of service of hypoid automotive rear axles where the degree of offset of the pinion contributes to high sliding loads at high speed and/or high torque conditions. These oils are highly fortified to provide wear protection for the hypoid axle assemblies. Where these axles are also fitted with limited slip differentials the additional frictional requirements for these units are defined by the axle manufacturer.

API GL-6 Designates the type of service of hypoid gears with very high pinion-offset. Such designs typically require additional protection against scoring above that afforded by GL-5 oils.

In addition to the API GL Classification, the Original Equipment Manufacturers (OEMs), who often have their own specifications, also determine gear oil performance requirements. The US Military authorities also define gear oil performance with their MIL-L-2105 specifications. MIL-L-2105 equates to API GL-4, and MIL-L-2105B equates to API GL-5. The latest MIL-L-2105D specification is for multigrade gear oils, now coming into service.

Future Trends

With improved manufacturing techniques, gearboxes are becoming smaller in size as the internal components are manufactured to closer tolerances. Five-speed units are now common, and six-speed gearboxes are appearing. Generally these closer tolerances require thinner or lower viscosity lubricants to allow satisfactory operation of the synchro units to ensure smooth gear changes. The trend is also for gearboxes to be filled-for-life as in many instances they are no longer fitted with drain plugs. The various specifications that cover gear oil performance are also under review to reflect the requirements of the lubricant to meet these new criteria. Many OEMs are now specifying automatic transmission fluids for use in manual transmissions and this trend will continue as low-viscosity fluids create less drag, which equates to better fuel efficiency.

Selection of Gear Lubricants

There is no simple rule when it comes to the selection of a gear lubricant for an automotive gearbox. The design of the box (its size, whether conventional synchromesh, transaxle, or 4WD), the expected vehicle operation (high speed, off-road), ambient operating temperatures, type of shift mechanism, etc., all contribute to the determination of the type of lubricant required. In all cases, the only way to ensure satisfactory operation is to refer to the manufacturer's specifications for the correct grade of lubricant and the correct drain interval.

QUESTIONS & ANSWERS

Q. I recently changed the oil in my gearbox and now my gears grate when changing. Why is this?

A. Obviously you have chosen an incorrect lubricant. Either the viscosity is too high, or the performance spec is incorrect. For example, if API GL-4 is specified and you have used API GL-5 this problem can occur. To overcome this problem you need to change to the correct viscosity/performance spec lubricant.

Q. Why do I have difficulty changing from 1st to 2nd gear when my car is cold?

A. This very common complaint is due to the fact that, when cold, the viscosity of the lubricant is high (thick) and this creates drag which affects the operation of the synchro rings. As the oil warms up the problem disappears. Check to make sure you are using the correct grade and viscosity lubricant. Adding Nulon G70 Gearbox & Differential Treatment generally alleviates this problem.

Q. I have heard that using additives in gearboxes upsets the operation of the synchro rings. Is this true?

A. With some additives this can be true. It can be due to the fact that the additive may contain a viscosity index improver, or tackifier. Either will make the oil thicker and create more drag, thus affecting the synchro operation. Some additives also contain certain types of friction modifiers that alter the friction, which can adversely affect synchro operation. We should point out that Nulon G70 Gearbox & Differential Treatment is specifically formulated for gearbox use and does not alter viscosity, nor does it alter the friction between the synchro ring and the cone.

Nulon is an all-Australian company and all of its products are developed to cater for Australian conditions. Nulon prides itself on staying abreast of the needs of Australian motors. The information contained in this Fact Sheet is not readily available elsewhere. This is yet another example of providing critical information to consumers.

Should any of our valued clients require more technical, unbiased information on this subject, they are welcome to write or phone us on:

Nulon Products Australia Pty Ltd
Unit 1, 4 Narabang Way
BELROSE NSW
AUSTRALIA 2085

Phone: +61 2 9450 1791
Freecall: 1800 67 99 22
Fax: +61 2 9450 2448
Freecall: 1800 67 99 70
Website: www.nulon.com.au
Email: technical@nulon.com.au