# DON'T FORGET THE GEAR OIL

Maintaining a vehicle requires the use of many lubricants, each specifically designed to perform a certain task or set of tasks. The most common lubricant requiring routine attention from motorists is engine oil. Gear oil, on the other hand, is oftentimes overlooked when it comes to scheduled maintenance.

## Gear Oil Basics

High quality gear oils must lubricate, cool and protect geared systems. They must also carry damaging wear debris away from contact zones and muffle the sound of gear operation. Commonly used in differential gears and standard transmission applications in commercial and passenger vehicles, as well as a variety of industrial machinery, gear oils must offer extreme temperature and pressure protection in order to prevent wear, pitting, spalling, scoring, scuffing and other types of damage that result in equipment failure and downtime. Protection against oxidation, thermal degradation, rust, copper corrosion and foaming is also important.

## Gear Oil and Motor Oil Are Not the Same

Gear oil differs from motor oil. Most people assume that SAE 90 gear oil is much thicker than SAE 40 or 50 motor oil. However, they are the same viscosity. According to AMSOIL Technical Drivetrain Products Manager Kevin Dinwiddie, the difference is in the additives.

"Motor oil has to combat byproduct chemicals from gasoline or diesel ignition and should contain additives such as detergents and dispersants," said Dinwiddie. "Since an internal combustion engine has an oil pump and lubricates the bearings with a hydrodynamic film, the need for extreme pressure additives such as those used in gear oils does not exist in engines."

Engine oils and gear oils both have anti-wear additives, and they both must lubricate, cool and protect components, but gear oils are placed under extreme amounts of pressure, creating a propensity for boundary lubrication, a condition in which a full fluid lubricating film is not present between two rubbing surfaces. For example, differentials in cars and trucks have a ring and pinion hypoid gear set. A hypoid gear set can experience boundary lubrication, pressures and sliding action that can wipe most of the lubricant off the gears. To combat this extreme environment, extreme pressure additives are incorporated into the oil. AMSOIL uses an extra treatment of extreme pressure additives in its gear oils in order to reduce wear and extend the gear and bearing life.

### Additional Differences

Because many of the components found in the drivetrain consist of ferrous material, the lubricant is required to prevent rust and possible corrosion to other materials. Rust and corrosion problems are not nearly as prevalent in engines.

The many small and intricate components that make up gear sets found in the drivetrain can be quite noisy and may be subjected to shock loading. The viscosity and extreme pressure formulation of gear oil quiets gears and dissipates shock loading.

The rotating motion of the gear sets also tends to churn the lubricant, resulting in foaming. If a gear lube foams, the load carrying capacity is significantly reduced because the air suspended within the oil is compressible. For example, when the gear teeth come into contact with each other any trapped air bubbles will compress, therefore reducing the thickness of the separating oil film. In turn, this reduction could lead to direct metal-to-metal contact between gear teeth and result in accelerated wear. The gear oil must have the ability to dissipate this entrapped air, insuring a sufficient lubricating film exists to protect the gears from contact wear.

## Typical Drivetrain Fluid Additives

Much like engine oil, the chemical compounds, or additives, added to drivetrain base stocks either enhance existing properties or impart new ones. Some of the additives that may be found in a drivetrain fluid include the following:

- **Extreme pressure and/or antiwear agents -** These additives are used to minimize component wear in boundary lubrication situations.
- **Pour point depressants -** This type of additive is used to improve low temperature performance.
- **Rust and corrosion inhibitors -** These are used to protect internal components.
- **Oxidation inhibitors -** These additives are used to reduce the deteriorating effects of heat on the lubricant, increasing the lubricant's service life.
- **Viscosity index improvers -** These allow a lubricant to operate over a broader temperature range.
- **Anti-foam agents -** These are used to suppress the foaming tendency and dissipate entrapped air.
- **Friction modifiers -** The required degree of friction reduction can vary significantly between differing pieces of equipment in drivetrain applications. In some cases, friction modifiers may be required to obtain the desired results.

## Gear Design Dictates Lube Design

Gear designs vary depending on the requirements for rotation speed, degree of gear reduction and torque loading. Transmissions commonly use spur gears, while hypoid gear designs are usually employed as the main gearing in differentials. Common gear types include the following:


### *Spur*

Spur (straight cut) gears are widely used in parallel shaft applications, such as transmissions, due to their low cost and high efficiency. The design allows the entire gear tooth to make contact with the tooth face at the same instant. As a result, this type of gearing tends to be subjected to high shock loading and uneven motion. Design limitations include excessive noise and a significant amount of backlash during high-speed operation.

### *Bevel*

Bevel gears (straight and spiral cut) transmit motion between shafts that are at an angle to each other. Primarily found in various types of industrial equipment, as well as some automotive applications (differentials), they offer efficient operation and are easy to manufacture. As with spur gears, they are limited due to their noisy operation at high speeds and are not the top choice where load carrying capacity is a requirement.

### *Worm*

Worm gear sets employ a specially-machined "worm" that conforms to the arc of the driven gear. This type of design increases torque throughput, improves accuracy and extends operating life. Primarily used to transmit power through non-intersecting shafts, this style of gear is frequently found in gear reduction boxes as it offers quiet operation and high ratios (as high as 100:1). Downfalls with this type of gear set are its efficiency, high price per HP and low ratios (5:1 minimum).

### *Hypoid*

Hypoid gear sets are a form of bevel gear, but offer improved efficiency and higher ratios over traditional straight bevel gears. Commonly found in axle differentials, hypoid gears are used to transmit power from the driveline to the axle shafts.

### *Planetary*

Planetary gear sets, such as those found in automatic transmissions, provide the different gear ratios needed to propel a vehicle in the desired direction at the correct speed. Gear teeth remain in constant mesh, which allows gear changes to be made without engaging or disengaging the gears, as is required in a manual transmission. Instead, clutches and bands are used to either hold or release different members of the gear set to get the proper direction of rotation and/or gear ratio.

### *Helical*

Helical gears differ from spur gears in that their teeth are not parallel to the shaft axis; they are cut in a helix or angle around the gear axis. During rotation, parts of several teeth may be in mesh at the same time, which reduces some of the loading characteristics of the standard spur gear. However, this style of gearing can produce thrust forces parallel to the axis of the gear shaft. To minimize the effects, two helical gears with teeth opposite each other are utilized, which helps to cancel the thrust out during operation.

### *Herringbone*

Herringbone gears are an improvement over the double helical gear design. Both right and left hand cuts are used on the same gear blank, which cancels out any thrust forces. Herringbone gears are capable of transmitting large amounts of horsepower and are frequently used in power transmission systems.

The differences in gear design create the need for significantly different lubrication designs. For instance, hypoid gears normally seen in automotive differentials require GL-5 concentration and performance of extreme pressure additives.

"This is because of the spiral sliding action that hypoid gears have," said Dinwiddie.

In differential applications that utilize hypoid gears, AMSOIL typically recommends one of the following: SEVERE GEAR Synthetic Extreme Pressure 75W-90 (SVG), SEVERE GEAR Synthetic Extreme Pressure 75W-140 (SVO), SAE 80W-90 Synthetic Gear Lube (AGL), Long Life Synthetic Gear Lube SAE 75W-90 (FGR) or Long Life Synthetic Gear Lube SAE 80W-140 (FGO)

Most manual transmissions have helical gears and do not require GL-5 performance.

"The helical gear is almost a straight cut gear, but on an angle," said Dinwiddie. "There is spiral action and very little sliding action, hence there is less need for extreme pressure additives."

GL-4 gear lubes have half the extreme pressure additives of GL-5 lubes.

In manual transmissions utlizing helical gears, AMSOIL typically recommends one of the following: Synthetic Manual Synchromesh Transmission Fluid (MTF) or Synthetic Manual Transmission and Transaxle Gear Lube (MTG).

### *AMSOIL Provides Gear Oil Options*

AMSOIL carries drivetrain lubricants to meet nearly every application. The synthetic base stocks and top-quality additive packages found in AMSOIL gear lubes and transmission fluids provide the ultimate in wear protection for cars, trucks, outboards, heavy-duty and racing applications.

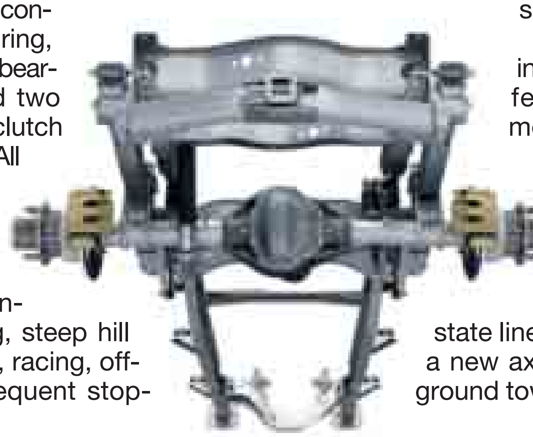
# Change Gear Lube After Break-In Period for Long Differential Life

***Unbeknownst to many motorists, most differential wear occurs during the break-in period. AMSOIL Dealers can do customers and prospects a service, as well as earn more sales, by encouraging them to change their gear lube following the break-in period in order to reduce wear and extend differential life.***

Motorists know when they're supposed to change their motor oil. They have oil life monitors, oil change centers and commercials all telling them when it's time for an oil change. Differential oil changes, on the other hand, often get overlooked. Many people don't even think of the differential when performing routine maintenance on their vehicles and don't realize four-wheel drive trucks have two differentials and a transfer case that all require service. In fact, according to one quick lube company, only one to two percent of their customers purchase a differential gear lube change.

Most differential wear occurs during the break-in period. Because differentials are not equipped with filters, break-in metals are suspended in the oil, causing increased wear as the particles mesh between the gears. Hauling heavy loads and towing heavy trailers cause additional stress to the differential during the break-in period and can cause premature differential damage or failure. Changing the gear lube after the break-in period (about 3,000 miles) is a low-cost maintenance investment that provides a significant payoff, including greatly reduced wear, extended differential gear and bearing life and protection for expensive vehicle investments. Auto manufacturers recognize the importance of draining abrasive break-in materials. As seen in Chart 1, some manufacturers recommend an initial drain interval of between 500 and 3,000 miles.

Differential internal components consist of six gears (one pinion, one ring, two side and two spider gears), six bearings (two pinion, two carrier and two axle) and sometimes include a clutch setup for limited slip performance. All of these parts require high quality, clean gear oil in order to perform at an optimal level.

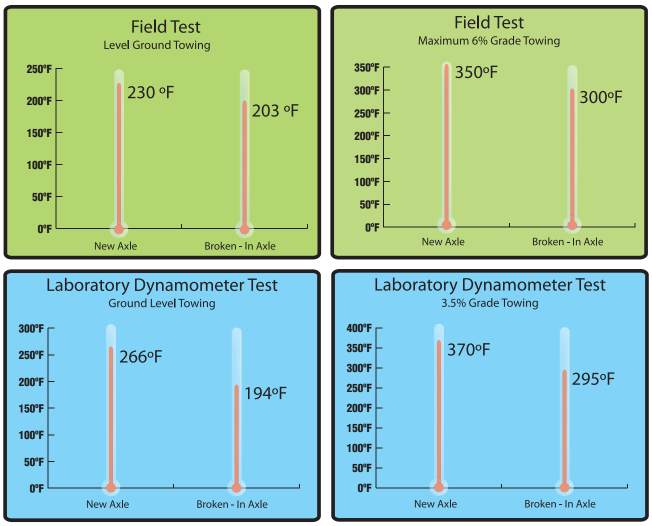


Most pickup trucks, SUVs and vans operate in severe service conditions, including towing, hauling, steep hill driving, commercial use, plowing, racing, off-road use, rapid acceleration, frequent stop-and-go operation and high ambient temperatures. These severe service operating conditions subject the differential to extreme pressures and operating temperatures.

New vehicles such as turbo diesel trucks and vehicles with V-10 engines boast more horsepower and torque than their predecessors, but differential designs have remained virtually unchanged. Differentials today are subjected to severe duty service and encounter more stress and heat than was seen only a few years ago. Modern gear oils are faced with the challenge of providing adequate wear protection during severe service operating conditions, while also providing maximum fuel efficiency.

In fact, according to a 2005 SAE paper entitled *Breaking the Viscosity Paradigm: Formulating Approaches for Optimizing Efficiency and Vehicle Life,* "Concurrent with the strong drive toward better fuel economy, consumers have been demanding increased performance, which has required axle lubricants with enhanced durability protection and lower operating temperatures. There has been a 34% increase in engine horsepower over the last decade, while axle gear sizes have remained constant, sump capacities have been lowered, and drain intervals extended. In the light truck segment there has been a 93% horsepower increase since 1981."

Further evidence of stress and increased temperatures during the differential break-in period is documented in a 2005 SAE paper entitled *The Effect of Heavy Loads on Light Duty Vehicle Axle Operating Temperature.* A light duty GM truck towing 14,000 pounds was driven from Orange County, Calif. to the Nevada state line. The test was conducted with both a new axle and a broken-in axle. Over level ground towing, oil temperature was measured at 230 degrees F in the new axle and 203 degrees F in the broken-in axle. Oil temperature over the most grueling portion of the trip, during which a maximum 6% grade was encountered, revealed the new axle was operating at 350 degrees F and the broken-in axle was operating at 300 degrees F. Laboratory dynamometer test results simulating a truck hauling a trailer provided similar results, with level ground towing temperatures recorded at 266 degrees F with the new axle and 194 degrees F with the broken-in axle and towing temperatures (at a 3.5% grade) recorded at 370 degrees F with the new axle and 295 degrees F with the broken-in axle.




AMSOIL SEVERE GEAR™ 75W-90 and 75W-140 Synthetic Gear Lubes are formulated for severe service applications, protecting differential gears for extended drain intervals of up to 50,000 miles in severe service and 100,000 miles in normal service, or longer where specified by the vehicle manufacturer. Formulated with shear stable synthetic base stocks and an extra treatment of additives, SEVERE GEAR™ Gear Lubes provide unsurpassed wear protection and friction reduction, while their excellent thermal stability prevents thermal runaway, a phenomenon caused by a lubricant's inability to control friction and increased heat under high stress conditions.

AMSOIL SEVERE GEAR™ Synthetic Gear Lubes are recommended for turbo diesel pick-ups, SUVs, vans, delivery/utility vehicles, light, medium and heavy-duty trucks, buses, heavy equipment, 4x4s, tow trucks, race cars, tractors and motor homes.

AMSOIL Synthetic Gear Lubes save motorists money through extended drain intervals, and they also cost less per quart compared to many competing OEM gear lubes:

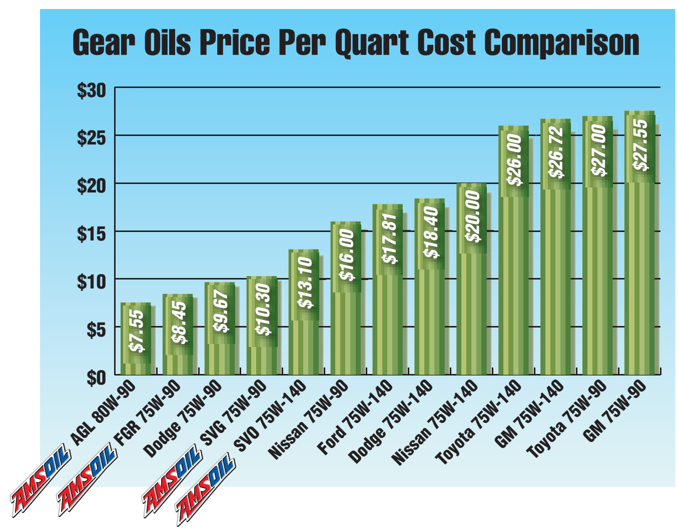



**Chart 1**

### Manufacturer drain interval source; Motor Check Chart, Quick Lubrication Guide, 2005 Edition.

| MFG & Model (Trucks, Vans & SUV's) | | Model Year | Drain Interval (Miles) 500 | 3000 | 5000 | 12000 | 15000 | 30000 |
|---|---|---|---|---|---|---|---|---|
| All Dodge full size pickups and Ramcharger Front & Rear Differential | | 2003-2005 | | | | | S | |
| All Dodge full size pickups and Ramcharger Front & Rear Differential | | 1995-2002 | | | | S | | |
| Dodge Full Size Vans | | 1995-2003 | | | | S | | |
| Ford E-Series, Excursion, Expedition, F-Series & F-Super Duty, Lincoln Blackwood, Navigator & Aviator | | 1997-2005 | | S (petroleum gear lube) | | | | |
| Chevrolet Silverado, GMC Sierra, Suburban, Tahoe, GMC Yukon, Yukon XL, Denali & Cadillac Escalade | | 1999-2002 | First 500 miles (break in period) trailer towing | | | | | |
| Chevrolet C and K models 1500, 2500 & 3500 | | 2001 | | N Initial oil change only (break-in) | | | S | |
| Chevrolet Avalanche | | 2002-2005 | First 500 miles (break in period) trailer towing | | | | | |
| Chevrolet SSR: | Locking diff | 2003-2005 | | N Initial oil change only (break-in) | | | S | |
| | Standard diff | 2003-2005 | | | | | S | |
| Nissan: | Standard diff | All | | | | | | S |
| | Limited Slip diff | All | | | | | S | N |
| Toyota: | Sequoia | 2001-2002 | | | N | | | |
| | Sequoia | 2003-2005 | | | | | | S |
| | Tundra | 2004-2005 | | | | | | S |
| | Tacoma Limited Slip | 2004-2005 | | | | | S | N |

**S = Severe Service, N = Normal Service**

A test on four separate vehicles further demonstrated the importance of changing the factory-fill gear lube within the first few thousand miles. Oil analysis results revealed most of the wear in vehicle one occurred within the first 6,869 miles. Despite higher mileages, vehicles two and three only showed slightly higher iron wear than vehicle one. Vehicle four was the only vehicle which had the factory-fill oil changed to AMSOIL synthetic gear lube, and despite significantly higher mileage than the first three vehicles, it showed a significantly lower level of wear. The chart and photos below provide visual evidence of the wear materials present in the differentials of each vehicle. The photos clearly show that the heaviest amount of wear occurs early in the break-in period. *Wear is significantly reduced when the gear lube is changed to AMSOIL synthetic gear lube following the break-in period.*

**Most customers are unaware of the importance of changing the factory-fill gear oil within the first few thousand miles. AMSOIL Synthetic Gear Lubes are ideal for owners of new vehicles. Presenting customers with this information and referring them to a retail-on-the-shelf account that performs gear lube changes is an excellent way to increase sales.**

| Vehicle | Miles on Vehicle | Miles on Oil | Viscosity | Iron Wear PPM | Oil Brand |
|---|---|---|---|---|---|
| 1 | 6,869 | 6,869 | 14.55 | 493 | GM Factory Fill |
| 2 | 16,766 | 16,766 | 14.57 | 542 | GM Factory Fill |
| 3 | 50,994 | 50,994 | 14.58 | 608 | GM Factory Fill |
| 4 | 146,764 | 18,101 | 14.97 | 83 | AMSOIL SVG |

**Vehicle 1 Differential Cover**

6,869 miles on vehicle and oil **493 PPM Iron**


**Vehicle 2 Differential Cover**

16,766 miles on vehicle and oil **542 PPM Iron**


**Vehicle 3 Differential Cover**

50,994 miles on vehicle and oil **608 PPM Iron**


**Vehicle 4 Differential Cover**

146,764 miles on vehicle 18,101 miles on AMSOIL SVG **83 PPM Iron**