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Authorized Amsoil Dealer

# OIL INFORMATION

## AMSOIL is the Cost Effective Choice

Quick Lube Customers and Do-It-Yourselfers Save Money with AMSOIL Synthetic Motor Oils

Although it has seen some signs of recovery, the economy still has a long way to go before experiencing a full turnaround. People are not spending money the way they were a few years ago, unnecessary purchases have been cut to a minimum and customers are demanding maximum value from the products they buy.

AMSOIL synthetic motor oils provide customers with the best of both worlds. Their premium quality provides superior protection and performance for their expensive vehicle investments, while their extended drain capabilities provide cost effectiveness that translates into immediate savings.

Although a 3,000-mile oil change using conventional motor oil is initially less expensive than an AMSOIL oil change, AMSOIL synthetic motor oils save customers money in the long run. As customers struggle with high vehicle expenses and gasoline prices, they can effectively cut the expense of 3,000-mile standard oil changes from their budgets by extending their drain intervals with AMSOIL synthetic motor oils.

### Saving Money at the Quick Lube

The following examples illustrate how quick lube customers save money by using AMSOIL products:

#### Quick Lube Example 1

A quick lube customer who drives 15,000 miles per year and purchases 3,000-mile oil changes must visit the quick lube five times per year:

Conventional Oil Change Price:  $\$32.49 \times 5 = \$162.45$

The quick lube customer pays \$32.49 per 3,000 miles.

A quick lube customer who drives 15,000 miles per year and purchases 7,500-mile AMSOIL XL Synthetic Motor Oil

changes must visit the quick lube twice per year:

AMSOIL XL Oil Change Price:  $\$64.95 \times 2 = \$129.90$

The quick lube customer pays \$25.98 per 3,000 miles and saves \$32.55 per year by purchasing AMSOIL XL Synthetic Motor Oil changes, while also saving the time associated with visiting the quick lube an additional three times per year.

#### Quick Lube Example 2

A quick lube customer who drives 30,000 miles per year and purchases 3,000-mile oil changes must visit the quick lube 10 times per year:

Conventional Oil Change Price:  $\$32.49 \times 10 = \$324.90$

The quick lube customer pays \$32.49 per 3,000 miles.

A quick lube customer who drives 30,000 miles per year and purchases 7,500-mile AMSOIL XL Synthetic Motor Oil changes must visit the quick lube four times per year:

AMSOIL XL Oil Change Price:  $\$64.95 \times 4 = \$259.80$

The quick lube customer pays \$25.98 per 3,000 miles and saves \$65.10 per year by purchasing AMSOIL XL Synthetic Motor Oil changes, while also saving the time associated with visiting the quick lube an additional six times per year.

#### Saving Money as a Do-It-Yourselfer

Further demonstrating customers' desires to save money and cut expenses, recent statistics indicate the do-it-yourself (DIY) market is healthy and growing. In fact, despite perceptions to the contrary, it's been healthy and growing for the past decade. The compounded annual growth rate for the DIY market over the past decade was 3.9 percent, while the growth rate for the do-it-for-me (DIFM) market was also 3.9 percent over the same time period. If the economy continues to worsen, experts predict growth of the DIY market will begin to outpace the growth of the DIFM market as an increasing number of people decide to either perform their own automotive maintenance or have someone other than a professional technician work on their vehicles.

The following examples illustrate how do-it-yourself customers save money by using AMSOIL products:

#### Do-It-Yourself Example 1

A do-it-yourself customer who drives 25,000 miles per year and uses conventional motor oil and filters for 3,000-mile drain intervals must change his or her oil eight times per year (\*comparisons based on a five-quart oil capacity):

Conventional 5W-30 Motor Oil

40 quarts needed for 25,000 miles\* @ \$3/qt. x 40 = \$120

8 Standard Oil Filters @ \$6 per filter x 8 = \$48

TOTAL = \$168

The do-it-yourself customer pays \$21 per 3,000 miles.

A do-it-yourself customer who drives 25,000 miles per year and uses AMSOIL synthetic motor oil and high-performance Ea Oil Filters for 25,000-mile drain intervals must only change his or her oil once per year (Note: AMSOIL synthetic motor oils may be used for 25,000 miles with conventional oil filters, but filters must be changed at filter manufacturer's recommended change interval):

AMSOIL 5W-30 Synthetic Motor Oil - Suggested Retail  
5 quarts needed for 25,000 miles\* @ \$8.75/qt. x 5 = \$43.75  
1 AMSOIL Ea Oil Filter @ \$18.30  
TOTAL = \$62.05

The do-it-yourself customer pays \$7.45 per 3,000 miles and  
AMSOIL is the Cost Effective Choice

Quick Lube Customers and Do-It-Yourselfers Save  
Money with AMSOIL Synthetic Motor Oils  
saves \$105.95 per year using AMSOIL synthetic motor oil  
and Ea Filters, while also saving the time and work associated  
with changing oil an additional seven times per year.  
Dealers and Preferred Customers Save Even  
More

The savings don't have to stop there. By registering as an  
AMSOIL Dealer or Preferred Customer and taking advantage  
of wholesale pricing, a customer can realize even greater  
savings:

AMSOIL 5W-30 Synthetic Motor Oil - Wholesale  
5 quarts needed for 25,000 miles\* @ \$6.75/qt. x 5 = \$33.75  
1 AMSOIL Ea Oil Filter @ \$13.90  
TOTAL = \$47.65

The do-it-yourself Dealer or Preferred Customer pays \$5.72  
per 3,000 miles and saves \$120.35 per year using AMSOIL  
synthetic motor oil and Ea Filters, while also saving the time  
and work associated with changing oil an additional seven  
times per year.

#### Do-It-Yourself Example 2

Even if a do-it-yourself customer drives only 15,000 miles  
per year, he or she will still save money by using AMSOIL  
synthetic motor oil and Ea Oil Filters (\*comparisons based  
on a five-quart oil capacity):

Conventional 5W-30 Motor Oil  
25 quarts needed for 15,000 miles\* @ \$3/qt. x 25 = \$75  
5 Standard Oil Filters @ \$6 per filter x 5 = \$30  
TOTAL = \$105

The do-it-yourself customer pays \$21 per 3,000 miles.

AMSOIL 5W-30 Synthetic Motor Oil - Suggested Retail  
5 quarts needed for 15,000 miles\* @ \$8.75/qt. x 5 = \$43.75  
1 AMSOIL Ea Oil Filter @ \$18.30  
TOTAL = \$62.05

The do-it-yourself customer pays \$12.41 per 3,000 miles and  
saves \$42.95 per year using AMSOIL synthetic motor oil and  
Ea Filters, while also saving the time and work associated  
with changing oil an additional four times per year.

Dealers and Preferred Customers Save Even  
More

Again, a customer can save even more by registering as an  
AMSOIL Dealer or Preferred Customer and taking advantage  
of wholesale pricing:

AMSOIL 5W-30 Synthetic Motor Oil - Wholesale  
5 quarts needed for 15,000 miles\* @ \$6.75/qt. x 5 = \$33.75  
1 AMSOIL Ea Oil Filter @ \$13.90  
TOTAL = \$47.65

The do-it-yourself Dealer or Preferred Customer pays \$9.53 per 3,000 miles and saves \$57.35 per year using AMSOIL synthetic motor oil and Ea Filters, while also saving the time and work associated with changing oil an additional four times per year.

In addition to the money-saving benefits of extended drain intervals, AMSOIL synthetic lubricants effectively improve fuel economy by allowing moving parts to move more freely, using less energy and creating less friction than when conventional lubricants are used. In fact, customers can achieve a 2 to 5 percent increase in fuel economy by switching to synthetic lubricants, while many AMSOIL customers report even larger gains.

## ***AMSOIL Adds to Synthetic Polymeric Grease Line***

New AMSOIL Synthetic Polymeric Truck, Chassis and Equipment Grease (GPTR1, GPTR2) delivers excellent wear protection and extreme-pressure performance over extended service intervals in medium- and heavy-duty applications. It combines select base oils, proprietary synthetic polymeric chemistry, an advanced additive package and a lithium-complex thickener for excellent impact resistance, reliable contaminant control and maximum longevity. Extreme Impact Resistance Greasable components on heavy-duty trucks and equipment regularly operate in severe-service, extreme-pressure environments. Frequent high-load operation increases the potential for grease to pound out, which can leave greased components vulnerable to increased wear and corrosion. AMSOIL Truck, Chassis and Equipment Grease is formulated to deliver maximum pound-out resistance. Its exceptional adhesion and cohesion properties help it stay in place to seal out water and contaminants and provide a protective barrier between metal components.

### **Long Service Life**

Most trucking companies work to maximize the length of time tractors are on the road. Inferior greases are not engineered to perform over extended service intervals, squeezing out of place and leaving components unprotected. AMSOIL Truck, Chassis and Equipment Grease is engineered to remain intact for maximum protection over extended service intervals. Owners/operators can be assured their equipment is protected when the job demands additional time on the road between maintenance checks.

### **Superior Rust and Corrosion Protection**

Over-the-road trucks and commercial equipment operate in all types of weather. Water, snow and ice are encountered regularly, and they combine with salt and other road-deicing chemicals to promote accelerated rust and corrosion on chassis and fifth-wheel components. AMSOIL Truck, Chassis and Equipment Grease clings tenaciously to metal surfaces, helping to keep rain, snow and other corrosive contaminants from penetrating greasable components. It is formulated with an advanced additive package designed to combat the harmful effects of roadway contaminants, helping components last longer and saving money.

## Maximum Extreme-Pressure Protection

AMSOIL Synthetic Polymeric Truck, Chassis and Equipment Grease is engineered for maximum protection in extreme-pressure applications. It features a sophisticated additive package and exclusive synthetic polymeric technology designed to provide long-term protection for heavily loaded components.

## Cost-Effective Choice

AMSOIL Synthetic Polymeric Grease offers enhanced protection for extended component life, reducing reapplication (or requires less grease at each servicing), reducing maintenance costs.

## APPLICATIONS

AMSOIL Synthetic Polymeric Truck, Chassis and Equipment Grease is recommended for heavy-duty over-the-road tractors and trailers, delivery fleets, dumptrucks, refuse haulers, utility fleets, emergency service vehicles, sewer and septic trucks, snow removal vehicles, wreckers, municipal service vehicles, equipment haulers, cement mixer trucks, airport support vehicles and more.

AMSOIL Synthetic Polymeric Grease provides exceptional performance in heavily loaded chassis grease points, wheel bearings, axle assemblies, universal joints, pivot pins, fifth-wheel hitch plates, steering linkages, spring pins, king pins, ball joints, water pump bearings and other greased heavy-duty components.

## Compatibility

AMSOIL Synthetic Polymeric Truck, Chassis and Equipment Grease is compatible with many other types of grease. However, for best results, the equipment should be cleaned of the old grease or flushed with a liberal amount of AMSOIL Synthetic Polymeric Grease while the mechanism is in operation. Closely monitor the system for any inconsistencies.

NLGI #1



NLGI #2



# AMSOIL Introduces Signature Series Synthetic 0W-30 Motor Oil

AMSOIL INC. of Superior, Wisc. has introduced a premier motor oil with a new, personal image. Supplemented with a proprietary ashless antiwear system for improved heat and viscosity control and boasting a 10 percent increase in TBN (13.2), new Signature Series 0W-30 sets the standard for protection and performance. Personally endorsed by AMSOIL founder and president Al Amatzio, each bottle bears his signature and describes how he developed the first API qualified synthetic motor oil, thereby launching the synthetic motor oil industry.

Engineered with the world's finest synthetic base oils and high performance additives, the exclusive extended drain formulation delivers superior engine protection and maximum fuel economy. AMSOIL Signature Series 0W-30 is a premium grade synthetic motor oil that exceeds the requirements of modern, high-performance engines and older engines, replacing other 0W-30, 5W-30 and 10W-30 motor oils.

## *Extends Service Life*

AMSOIL Signature Series 0W-30 Synthetic Motor Oil lasts much longer in service than conventional oils. Its unique synthetic formulation and long drain additive system resist oxidation and neutralize the acids that shorten the service life of other oils. AMSOIL Signature Series 0W-30 delivers the best possible engine protection, cleanliness and performance over extended drain intervals, reducing vehicle maintenance and waste oil disposal costs.

## *Maximizes Fuel Efficiency*

The lightweight molecular structure of AMSOIL Signature Series 0W-30 Synthetic Motor Oil reduces energy loss from the "drag" common to high viscosity oils. It is fortified with additives that enhance its friction-reducing properties to help further improve fuel efficiency.

## *Reduces Wear*

AMSOIL Signature Series 0W-30 Synthetic Motor Oil contains specialized anti-wear technology so that engines last longer. Its durable, high temperature film strength effectively separates metal surfaces to reduce wear even under the most grueling conditions.

## *Resists Heat, Reduces Oil Consumption and Emissions*

AMSOIL Signature Series 0W-30 Synthetic Motor Oil is thermally stable with a strong resistance to high temperature volatility (burn-off). Heavily fortified with detergent and dispersant additives, AMSOIL Signature Series 0W-30 is designed to prevent sludge deposits and keep engines clean. Low volatility and clean operation reduce oil consumption and emissions.

## *Provides Outstanding Cold Flow Properties*

Unlike conventional oils, AMSOIL Signature Series 0W-30 contains no wax. Its exceptional -60°F cold flow properties ease starting and reduce bearing wear.

## **Applications**

AMSOIL Signature Series 0W-30 Synthetic Motor Oil is recommended for use in gasoline engines, diesel engines (API CF, ACEA B5) and other applications requiring SAE 0W-30, 5W-30 or 10W-30 with the following worldwide specifications:

- API SM/CF, SL, SJ ...
- ILSAC GF-4, 3 ...
- ACEA A5/B5-04
- GM 4718M, 6094M
- Ford WSS-M2C929-A
- Daimler Chrysler MS-6395N
- VW 503.00

### **Service Life**

AMSOIL Signature Series 0W-30 Synthetic Motor Oil is recommended for extended drain intervals in unmodified, mechanically sound, gasoline-fueled vehicles as follows:

- Normal Service -- Up to 35,000 miles or one year, whichever comes first.
- Severe Service -- Up to 17,500 miles or one year, whichever comes first.
- Replace AMSOIL Ea oil filter at the time of oil change up to 25,000 miles or one year, whichever comes first (other brands at standard OEM intervals).
- **In all non-gasoline fueled vehicle applications, extend the oil change interval according to oil analysis or follow the OEM drain interval.**

## **Fuel Dilution Surfaces as Issue in Some Modern Diesel Applications**

AMSOIL has documented two separate fuel dilution issues in modern diesel applications, one of which has forced the company to reduce its drain interval recommendations in a few applications using Premium CJ-4 Synthetic Diesel Oils (DEO, DME).

### **Fuel Dilution**

Fuel in the oil reduces the oil's life expectancy and effectiveness. Because diesel fuel is a natural solvent, fuel dilution in motor oil causes a decrease in viscosity which may lead to an increase in engine wear. The following can occur if fuel enters the crankcase and contaminates the oil:

- Reduced oil viscosity
- Reduced oil film strength
- Increased engine wear (particularly in the cylinder/ring area)
- Increased volatility
- **Weakened lubricant detergency**

- **Accelerated lubricant oxidation**
- **Varnish formation**
- **Acid formation/corrosion**
- **Low oil pressure**

The most notable concern with increased fuel contamination is reduced viscosity and the effect it has on oil performance.

Issue One: Mechanical Deficiencies

AMSOIL has documented increasing fuel dilution levels in 2007 and newer Caterpillar C13 and C15 on-highway engines. Caterpillar has recognized its fuel dilution problem as noted in a special instruction titled *Determining the Cause of Fuel Dilution of Engine Oil for On-Highway Engines (C13, C15)*. The document states that mechanical deficiencies (i.e. leaking seals on the body or sleeve of unit injector, cracked body of unit injector, leakage from the drive shaft seal on the fuel transfer pump, etc...) are probable causes for fuel dilution.

A tolerable level of fuel dilution was present in 2007 engines; however, newer engines exhibit excessively high fuel dilution. Caterpillar is aware of the relationship between fuel dilution and viscosity loss and has stated the following:

“Fuel dilution that is greater than 4 percent will usually cause viscosity that is less than the specified viscosity grade. For example, 15W-40 oil with 4 percent fuel dilution will have a viscosity of less than 12.5 cSt.”

Even though Caterpillar realizes that fuel dilution has an adverse effect on viscosity, the company has not corrected the mechanical deficiencies that are causing the high fuel dilution rates. Instead, Caterpillar revised its guidelines for used oil viscosity to “slightly less than the limits of the SAE viscosity grades” (See **Table 1**).

**Table 1 – Viscosity Guidelines at 100°C**

In addition to viscosity loss, high fuel dilution also causes accelerated oxidation. Oxidation, combined with a significant loss in viscosity, can shorten engine life.

Forced Drain Interval Adjustment

Although AMSOIL Premium Diesel Oils have shown the ability to maintain integrity in some fuel-dilution conditions, the unresolved mechanical issues have forced AMSOIL, as a precautionary measure, to adjust its drain interval recommendations for 2007-present Caterpillar C13 and C15 on highway engines.

In these applications, AMSOIL recommends changing AMSOIL Premium API CJ-4 Synthetic Diesel Oils (DEO, DME) at the manufacturer-recommended drain interval.

Drain intervals may be extended further through oil analysis. For all pre-2007 Caterpillar C13 and C15 on-highway engines, the drain interval has not been affected (3 times the original equipment manufacturer’s recommendations, not to exceed 50,000 miles/600 hours, or one year).

Issue Two: DPF Regeneration

AMSOIL has also documented increasing levels of diesel

fuel dilution in the engine oil of 2007-2009 light-duty diesel pickups from all major vehicle manufacturers. Research indicates that fuel dilution is increasing due to the use of post fuel injection during the diesel particulate filter (DPF) regeneration process. The issue, however, is not prevalent enough at this point to warrant an adjustment in the drain interval recommendation of AMSOIL Premium Diesel Oils.

#### Regeneration Process

Current emissions legislation set by the Environmental Protection Agency (EPA) mandates that all 2007 and newer on highway diesel-fueled vehicles come equipped with a DPF.

A DPF is generally a honeycomb-like filter positioned in the exhaust stream to collect particulate matter and soot to prevent it from exiting the vehicle. DPFs are highly efficient and can usually remove 80-90 percent of particulate matter from diesel exhaust. When the filter is near its capacity, soot trapped in the filter is burned, freeing the plugged media and enabling the filter to remain serviceable. The process of burning the residual matter is termed regeneration and can be either active or passive.

Active regeneration uses raw diesel fuel as a combustion source to burn the accumulated soot and clear the filter. Active regeneration is accomplished using either in-stream or in-cylinder injection. In-stream injection systems inject raw diesel fuel directly into the exhaust stream before it reaches the DPF. In-cylinder injection systems inject raw diesel fuel directly into the cylinder on the exhaust stroke. The unburned fuel evaporates and travels down to the DPF to burn out the soot built up in the filter.

#### **SAE Viscosity Revised Caterpillar**

#### **Viscosity Grade Guideline (cSt) Viscosity Guideline (cSt)**

SAE 40 12.5 cSt – 16.3 cSt Greater than 11.5 cSt

SAE 30 9.3 cSt – 12.5 cSt Greater than 8.5 cSt

Passive regeneration requires exhaust gas temperatures of approximately 600°C (1100°F). These relatively high exhaust gas temperatures occur naturally in trucks operating under heavy load and can be used to burn the soot out of DPFs. Passive regeneration does not increase fuel consumption the way active regeneration does because, by design, it does not require the injection of additional fuel to increase exhaust temperatures.

#### “Less-Costly” Alternative

All class 8 over-the-road tractors and medium-class applications use active regeneration via in-stream injection. In this method, diesel fuel used to burn soot in the DPF does not reach the crankcase, leaving the oil uncontaminated.

Light-duty diesel pickup manufacturers (Dodge, Ford, GM) have opted for a less-costly in-cylinder injection system. With in-cylinder injection systems, some raw diesel fuel injected on the exhaust stroke can wash directly past the rings and into the crankcase, mixing with the oil. Regular washing of cylinders is a source of fuel contamination in the crankcase and is not conducive to long-term engine protection. Used

oil analysis results from 2007-2009 light-duty diesel vehicles showed some elevated fuel dilution, but at tolerable levels.

#### 2010 NOx Requirements

EPA emission mandates taking effect in 2010 require the reduction of nitrogen oxides (NOx) to .2 grams per brake horsepower (g/bhp). To meet this limit, engine manufacturers will use either selective catalytic reduction (SCR), NOx adsorbers or advanced exhaust gas recirculation (EGR). Most over-the-road truck and tractor manufacturers will use SCR technology, with International the only major manufacturer to use advanced EGR technology. Neither system is expected to increase fuel dilution. Light-duty turbo-diesel pickup manufacturers appear to be moving forward with the relatively new NOx adsorber technology first used by Dodge in its 2007 diesels to meet 2010 NOx requirements. Ford and GM have not yet released vehicles that meet 2010 NOx limits.

Like DPFs, NOx adsorbers need to be regenerated. However, they require more fuel to regenerate than DPFs do, which may compound the fuel dilution problem.

#### Higher Fuel Dilution Levels

In Dodge light-duty turbo-diesel pickups, the combined regeneration requirements of the DPF and NOx adsorber technologies are causing fuel dilution of the engine oil. Model-years 2007-2009 Ford and GM applications also show higher levels of fuel dilution, which may increase in 2010 emission-compliant models if similar technology is adopted. Although model-year 2007-2009 light-duty diesels are experiencing higher fuel dilution than previous model years, regeneration cycles vary based on service (engines operating in severe service conditions do not actively regenerate as often as engines operating in normal service conditions), and some applications are affected more than others. While not all 2007-2009 light-duty diesel vehicles develop this problem, fuel contamination can reduce oil viscosity and decrease film thickness. Other concerns include significantly reduced fuel economy, accelerated engine oil oxidation, increased volatility and overfilling of the oil sump.

#### AMSOIL Maintains Drain Interval Recommendations for Premium Diesel Oils

AMSOIL Premium Diesel Oils have shown the ability to maintain integrity in the face of fuel dilution in 2007-2009 light-duty diesel applications and continue to be recommended for three times the vehicle manufacturer recommendation, not to exceed 50,000 miles/600 hours or one year. However, it is recommended that owners of 2007-2009 Dodge, Ford and GM light-duty diesel vehicles perform regular oil analysis as a precautionary measure. If oil analysis reveals greater than 5% fuel dilution, AMSOIL recommends changing the oil. The company will continue to closely monitor this situation, and if deemed necessary, will adjust recommended drain intervals in these applications.

#### New Simplified Diesel Oil Drain Recommendations

In order to simplify recommendations, AMSOIL Series 3000 Synthetic 5W-30 Heavy Duty Diesel Oil (HDD), Synthetic 15W-40 Heavy Duty Diesel and Marine Oil (AME) and Synthetic 10W-30/SAE 30 Heavy Duty Diesel Oil (ACD) now carry a three times the OEM recommendation similar to the recommendation for AMSOIL Premium Diesel Oils. The AMSOIL Product Recommendation and Drain Interval Guide (G1490) and all relevant data bulletins are being revised to reflect these changes.

2007-Present

2007-Present Heavy-duty On/Off-Road

All Personal Light Truck Applications, Fleet, Marine

Pre-2007 Vehicles with Diesel-Fueled and Motor Homes with

Applications Engines Diesel Engines

DEO 3X OEM recommendations, 3X OEM recommendations, 3X OEM recommendations, DME not to exceed 50,000 miles/ not to exceed 50,000 miles/ not to exceed 50,000 miles/ 600 hours or one year. 600 hours or one year. 600 hours or one year.\*

HDD 3X OEM recommendations, -- --

AME not to exceed 50,000 miles/ -- --

ACD 600 hours or one year. -- --

**\*Except in 2007-present Cat C13 and C15 applications. In those applications, follow OEM recommendations**

# FAQ: About Synthetics

by Ed Newman

AMSOIL Director of Advertising

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If you spend any amount of time on the internet you will sooner or later come across a page called FAQ, which is shorthand for Frequently Asked Questions. The purpose of the FAQ page is to relieve tech support people from having to answer the same questions over and over again, and to make it easy for customers to find answers on their own.

Here are some of the typical questions we've received over the years. If you still have more specific questions, I will be happy to answer anything you submit. My email address is listed at the end of this column.

Q: What is the difference between synthetic motor oil and conventional petroleum oil?

A: Synthetic lubricants are composed of select base stocks and special purpose additives chemically assembled with planned, predictable properties. Whereas petroleum oils are pumped from the earth and refined, synthetics are custom-designed in the laboratory, with each phase of their molecular construction programmed to produce, in effect, the ideal lubricant.

Q: What are some of the common misconceptions about synthetic motor oil?

A: It is interesting how some of these myths hang around for so many years. Some of the most common

were that synthetics are not compatible with seals (properly formulated synthetics actually extend seal life), that synthetics are too thin to stay in the engine, and that synthetics cause cars to use more oil. Of course there are misconceptions going the other direction, too. Some people think synthetic oil is a super oil that will last forever. It is true that synthetic oils are more impervious to oxidation, but the additives in synthetic formulations do get used up over time. A motor oil's formulation includes the performance of both the base stock and additive package.

Q: If a car is factory fill conventional petroleum, will switching to synthetic void the warranty?

A: No, it will not. Vehicle manufacturers recommend using motor oils that meet certain viscosity grades and American Petroleum Institute service requirements. Whether the motor oil is petroleum-based or synthetic will not affect warranty coverage. The manufacturer is required to cover all equipment failures it would normally cover as long as the oil was not the cause of the failure.

Q: Is there any truth to the notion that cars should be running petroleum oil during the break in period before switching to synthetic?

A: A premium synthetic motor oil can be used during break-in without any trouble. In fact, dozens of vehicle models come factory-filled with synthetic oil now. Rebuilt engines may still require break in oils that don't prevent wear as well and will allow rings to seat, but not factory supplied engines.

Since a majority of new vehicles come filled with petroleum oil, it only makes good sense to change to synthetic at the first scheduled oil change interval. New engine components generate high levels of wear metals and can contain contaminants from assembly. By allowing the engine to operate with the petroleum oil until the first oil/filter change interval, the wear metals and contaminants are removed prior to installing the premium product.

Q: Will switching from petroleum to synthetic result in a plugged oil filter when the sludge is cleaned out by the synthetic?

A: This is a common fear, however, switching from petroleum oil to premium synthetics in routinely maintained vehicles will not cause clogged oil filters or passageways, regardless of mileage. Sludge, which is caused by poor quality oil and neglected maintenance practices, would have to be present in significant amounts to plug oil filters and passageways. If there is an excessive amount of sludge present in an engine, it is just a matter of time before oil filters and passageways clog, regardless of the oil you choose.

Q: Will switching to synthetics cause my engine to leak oil?

A: In mechanically sound engines, there's no risk of synthetic motor oil leaking. In fact, premium synthetic oils are fully compatible with modern seal materials, keeping them pliable to prevent leakage. New engines are built to much tighter tolerances now than they were in the 70's and 80's when that notion was promulgated, and is not true anymore.

Q: Is there a recommended procedure for switching to synthetic motor oils?

A: As long as the vehicle has been properly maintained and the vehicle is mechanically sound, there are no special requirements. Some oil manufacturers, however, may indicate specific drain intervals that should be followed for vehicles that have over 100,000 miles and are first time users of their products.

Q: If someone switches to synthetic can they switch back to conventional oil?

A: Yes, they can, but why would anyone want to?

## AMSOIL Performance Test

## API Comparative Motor Oil Testing

Product Tested: 10W-30 Motor Oil (ATM)

### Overview

AMSOIL Synthetic 10W-30 Motor Oil (ATM) and 10 competing conventional, synthetic and synthetic blend 10W-30 motor oils were subjected to a series of motor oil tests. The competing oils included petroleum-based Castrol GTX, Chevron Supreme, Shell Formula, Valvoline SynPower, Mobil1 Extended Performance, Motorcraft Synthetic Blend, Kendall GT-1 High Performance, Pennzoil Platinum, Quaker State Horse Power and Trop Artic Synthetic Blend.

### AMSOIL Extends Oil Life

#### Thin Film Oxygen Uptake Test - ASTM D-4742

The Thin Film Oxygen Uptake Test (TFOUT) is used to evaluate engine oil's ability to resist heat and oxygen breakdown when contaminated with oxidized/nitrated fuel, water, and soluble metals such as lead, copper, iron, manganese and silicon. This test is designed to mimic the operating conditions of a gasoline engine.

AMSOIL 10W-30 Synthetic Motor Oil has superior heat and oxidation resistance to control sludge deposits and extend oil life. Engines stay clean for maximum protection and oil changes are reduced, saving time and money.

### Maximizes Fuel Economy, Reduces Oil Consumption and Emissions

#### NOACK Volatility Test - ASTM D-5800

The NOACK Volatility Test determines the evaporation loss of lubricants in high temperature service. The more motor oils vaporize, the thicker and heavier they become, contributing to poor circulation, reduced fuel economy and increased oil consumption, wear and emissions.

AMSOIL 10W-30 Synthetic Motor Oil resists high temperature volatilization (evaporation) better than other motor oils. AMSOIL Synthetic Motor Oil maintains peak fuel efficiency and reduces oil consumption and emissions.

### Improves Cold Temperature Startup

#### Pour Point - ASTM D-97

The Pour Point Test determines the lowest temperature at which a lubricant will flow. The lower a lubricant's pour point, the better protection it provides in low temperature service. Unlike conventional oils that solidify in cold temperatures, AMSOIL 10W-30 Synthetic Motor oil remains fluid down to -58° F. AMSOIL Synthetic Motor Oil helps engines turn over easier and flows quickly to engine parts for critical start-up protection. Engines start faster and wear is greatly reduced for extended engine life.

### Controls Acid Formation

#### Total Base Number - ASTM D-2896

Total Base Number (TBN) is the measurement of a lubricant's reserve alkalinity, which aids in the control of acids formed during the combustion process. The higher a motor oil's TBN, the more effective it is in suspending wear-causing contaminants and reducing the corrosive effects of acids over an extended period of time.

The high TBN of AMSOIL Synthetic 10W-30 Motor Oil allows it to effectively combat wear-causing contaminants and acids, providing superior protection and performance over extended drain intervals.

### Helps Engines Start Easier

#### Cold Cranking Viscosity - ASTM D-5293

The Cold Crank Simulator Test determines the apparent viscosity of lubricants at low temperatures and high shear rates. Viscosity of lubricants under these conditions is directly related to engine cranking and startability. The lower a lubricant's cold crank viscosity, the easier an engine will turn over in cold temperatures. The low cold crank viscosity of AMSOIL Synthetic 10W-30 Motor Oil reduces drag on moving engine parts and allows engines to achieve critical cranking speed in extremely frigid temperatures. Engines turn over quickly and dependably in the coldest winter temperatures.

### Protects Against Wear

#### Four-Ball Wear - ASTM D-4172

The Four-Ball Wear Test evaluates the protection provided by engine oil under conditions of pressure and sliding motion. The size of the scar left as a result of the test determines the amount of wear protection the lubricant provides. The smaller the wear scar, the better the protection. Tests show that AMSOIL 10W-30 Synthetic Motor Oil has better antiwear performance than all other oils tested. With AMSOIL Synthetic Motor Oil, engine life can be extended and major repairs are often reduced.

### Saves Money

#### Cost Per 25,000 Miles

By extending oil drain intervals through its premium formulation, AMSOIL Synthetic Motor Oil saves drivers money. A value comparison shows AMSOIL Synthetic Motor Oil costs less than competing motor oils over 25,000 miles.

While competing motor oils must be changed up to five times over 25,000 miles, AMSOIL Synthetic Motor Oil is only changed once, saving both time and money.

# Friction

by Ed Newman

**AMSOIL Director of Advertising**

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In February we experienced one of those dreaded ice storms which create so much havoc here in the Northland from time to time. What typically happens is this. A warm front from the south pushes north where pouring rain turns to ice on the already frozen terrain. In really bad storms, power lines get so coated with ice that they snap from the weight. In a really bad storm several years ago, a television tower on Signal Hill became so thickly crusted with ice that it snapped the cables that held it erect. The newspapers said that the ice was six inches thick, and with the high winds coming off the lake it is a wonder that more of those towers were not mangled.

As you can imagine, the roads become quite treacherous. The freezing rain adheres to road surfaces,

transforming your driving adventure into a white knuckle experience. Even our driveways and walkways become hazardous. In order to reduce the danger of slipping, falling and breaking an arm we keep sand and gravel to scatter across these icy surfaces. The purpose here is to generate friction so the soles of our shoes, and our feet, don't slide out from under us. Friction has a very positive benefit.

In other words, friction is not always a bad thing. In cars, friction is good when it comes to tires gripping pavement. Friction is also useful in your brake pads. When you press down on the brake pedal you want resistance there.

But, friction in an engine has two consequences that are not so good for your vehicle. The first is wear. The second is heat. For the purposes of this article we'll primarily be focusing on the issue of heat.

### **Synthetics and Heat**

Engines get hot for a variety of reasons, of course, and not just from friction. The continuous combustion of gasoline is generating a lot of heat. Electrical systems also generate heat. In the summer there's quite a bit of heat being transferred through the hood via sunlight, as well as radiation coming up from road surfaces.

The foremost function of a lubricant is to minimize or, if possible, eliminate friction. Lubricants reduce friction by creating a film between two surfaces. Many parts don't need much separation, but that separation counts. Even the thinnest film cuts down contact. In most cases it eliminates it.

Another function of motor oil is to absorb the heat that is generated from the engine combustion process. The flowing oil then carries the heat back to the oil sump where it releases this heat and cools off. From there, it is circulated back through the engine. This process, in addition to the radiator cooling system, helps keep the engine in the correct operating zone.

Premium synthetic oils much more readily absorb and yield up heat due to the uniform molecular structure. Just like synthetic oils flow much more readily to critical engine parts, true synthetic oils also absorb and carry away heat to the oil sump where it can be dissipated. Once in the sump, the oil also gives up heat more quickly which allows engines or gearboxes to operate more effectively, and efficiently, at cooler temperatures.

### **Viscosity and Heat**

Oil viscosity is a very important factor when determining oil's ability to absorb and transfer heat away from critical engine components. First, given two different viscosity levels, it takes more energy to pump the oil around the lubrication system with a thicker oil because it provides more resistance to flow and will build up heat faster than a thin oil being pumped through a restricted area.

If oil is too viscous and difficult to pump through the system, the ability for the oil to get to the critical engine components may be compromised creating more friction and heat build-up. The opposite can also take place if the oil is too thin for the application. In this case there may be an insufficient layer of lubricant to protect the metal components and the result is more friction and heat build-up. The bottom line is to make sure to use the correct viscosity for the application. We recommend a premium synthetic motor oil due to its high film strength and resistance to breakdown.

### **Conclusions**

Synthetics outperform refined lubricants because they reduce friction. Less friction means less engine wear, better heat control and *fuel efficiency*. With premium synthetics, due to less drag in the engine (reduced friction), you get more power from the same discharge of energy.

At the end of the day, it should be self-evident that a properly priced synthetic oil change is

the ideal solution for optimal performance and longer lasting vehicles, at a time when motorists care about these benefits more than ever.

## AMSOIL Performance Test

### API Sequence IIIF Test

Product Tested: 10W-30 Motor Oil (ATM)

### Overview

The Sequence IIIF test is a stringent API SL, ILSAC GF-3 test designed to measure oil thickening and piston deposits in high temperature service, as well as provide information on valve train wear. The test is designed to emulate high-speed service under high ambient conditions.

### Objective

Subject AMSOIL 10W-30 Synthetic Motor Oil (ATM) to an independent API Sequence IIIF Test to determine its effectiveness in preventing deposit formation and providing wear protection in high temperature conditions.

### Special Conditions

Because AMSOIL is formulated to provide superior performance over extended drain intervals, testing was allowed to continue for 240 straight hours, three times the length of the standard Sequence IIIF test.

### Test Procedure

Testing is conducted with a 1996 model Buick 3800 Series II, water-cooled, four-cycle, V-6 engine. The test engine is an overhead valve design (OHV) with a single camshaft operating the intake and exhaust valves through pushrods and hydraulic valve lifters in a slider-follower arrangement, and it has one intake and one exhaust valve per cylinder. Induction is performed through a modified GM port fuel injection system with the air-to-fuel ratio set to 15:1.

Running unleaded gasoline, testing begins with a 10-minute initial oil leveling procedure before slowly working its way up to test speed, temperature and load conditions. Testing continues at 100 bhp, 3600 rpm and 155 C oil temperature for 80 hours with oil checks performed every 10 hours. Kinematic viscosity increase and wear metals (Cu, Pb and Fe) are evaluated at every 10-hour interval.

At the end of 80 hours, all six pistons are inspected for deposits and varnish, camshaft and lifters are measured for wear and oil screen plugging is evaluated.

### Test Results

Even at three times the standard test length, AMSOIL 10W-30 performed three times better than the test limit in the area of kinematic viscosity increase, and it excelled in all areas of the test. AMSOIL 10W-30 Motor Oil kept viscosity increase, wear, deposits and varnish to a minimum. The pictures below demonstrate the superior protection provided by AMSOIL Motor Oil throughout 240 straight hours of Sequence IIIF testing.

While conventional motor oils tend to thicken and lose their lubricating effectiveness, AMSOIL

Motor Oils are formulated to maintain their viscosities over extended drain intervals. The results of the Sequence IIF test clearly demonstrate the long drain capability of AMSOIL 10W-30 Motor Oil. Even after being subjected to a triple length Sequence IIF test, AMSOIL 10W-30 performed three times better than the standard test limits. The competitor's motor oil shows dramatic viscosity increase in less than half the time.

# WHAT IS A MOTOR OIL?

Motor oil is the primary determinant in the durability of an engine. It contains two basic components: **base stocks** and **additives**.

## Base Stocks

The base stock is the bulk of the oil. The base stock lubricates internal moving parts, removes heat and seals piston rings.

Motor oil base stocks can be made from: 1) petroleum, 2) chemically synthesized materials, 3) a combination of synthetics and petroleum (called para-synthetic, semisynthetic or synthetic blend.)

A petroleum base stock consists of many different oil fractions that form the final product. Generally, molecules of a petroleum base stock are long carbon chains that can be sensitive to the stress of heat and "boil off" at relatively low temperatures.

Engine temperatures break down these molecular chains, changing the physical properties (such as viscosity) of the motor oil. The difference with synthetic base stocks is that molecules are uniformly shaped, which makes them more resistant to the stress of heat. Because AMSOIL synthetic motor oils possess these uniformly-shaped molecules, they have a low "boil off" rate. Thus, their physical properties (such as viscosity) do not change.

## Additives

The various chemicals that comprise the additive system in motor oils function to provide anti-wear, antifoam, corrosion protection, acid neutralization, maintenance of viscosity, detergency and dispersancy properties.

These are the chemicals that help modern motor oils meet the increasing demands of today's hightech engines. Their quality varies widely throughout the lubrication industry, ranging from a bare minimum in some oils (to comply with certain requirements) to exceptionally high quality, as in all AMSOIL motor oils.

### **What a Motor Oil Must Do**

Modern motor oil is a highly specialized product carefully developed by engineers and chemists to perform many essential functions. A motor oil must:

- Permit easy starting
- Lubricate engine parts and prevent wear
- Reduce friction
- Protect against rust and corrosion
- Keep engine parts clean
- Minimize combustion chamber deposits
- Cool engine parts
- Seal combustion pressures
- Be non-foaming
- Aid fuel economy.

### **Improvements in Oil**

The quality of motor oil has changed dramatically in the past 30 years, and new demands on lubricants in modern engine design call for oils that meet stringent requirements.

Variations in an oil's ability to meet the requirements determine which service classification rating and viscosity grade it receives.

Service classifications are determined by the American Petroleum Institute. Viscosity grades of oils are determined by the Society of Automotive Engineers. These two organizations have set industry standards for motor oils for more than 75 years.

### **Viscosity**

Viscosity, the most important property of an oil, refers to the oil's resistance to flow. The viscosity of oil varies with changes in temperature – thinner when hot, thicker when cold. An oil

must be able to flow at cold temperatures to lubricate internal moving parts upon starting the engine. It must also remain viscous or “thick” enough to protect an engine at high operating temperatures. When an oil is used at a variety of temperatures, as it is in most engines, the change of viscosity with temperature variation should be as small as possible. The measure of an oil's viscosity change is called the **Viscosity Index number (VI)**; the higher the number, the smaller the viscosity change which means the better the oil protects the engine. The number does not indicate the actual viscosity in high and low temperature extremes of the oil. It represents the rate of viscosity change with temperature change.

**Viscosity improvers** are viscous chemical compounds called polymers or polymeric compounds that decrease the rate at which oils change viscosity with temperature. These viscosity modifiers extend a motor oil's operating temperature range and make multi-grade or allseason oils possible. However, lowquality viscosity improvers lend themselves to shearing.

The VI is measured by comparing the viscosity of the oil at 40°C (104°F) with its viscosity at 100°C (212°F). VI can provide insight into an oil's ability to perform at high and low temperatures.

Petroleum-based motor oils require the use of viscosity improvers to meet the low-temperature requirements of SAE 0W, 5W or 10W and the high-temperature requirements of SAE 30 or heavier oil.

Synthetic-based motor oils have a naturally-high viscosity index and require less viscosity improver additive than petroleum oils.

## What Is a Motor Oil?

20W-50

15W-40

10W-30

5W-30

-30° -20° -10° 0° 10° 20° 30° 40° 50° 60° 70° 80° 90° 100°

°Fahrenheit

0W-30

**SAE Viscosity Grade and**

**Outdoor Temperature**

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### **Cold-Temperature Protection**

Motor oil must begin to circulate as soon as the engine is started. If oil gets cold enough and begins to solidify, it fails to flow through the oil screen to the pump at engine start and causes bearings and other critical parts to fail almost immediately.

**Pour point** is an indicator of the ability of an oil to flow at cold operating temperatures. It is the lowest temperature at which the fluid will flow.

Modern refining techniques remove most of the wax from petroleum oil, but some wax-like molecules remain. These wax-like molecules are soluble at ambient temperatures above freezing, but crystallize into a honeycomblike structure at lower temperatures and cause oil circulation problems.

**Pour point depressants** keep wax crystals in the oil microscopically small and prevent them from joining together to form the honeycomb-like structure. They lower the temperature at which oil will pour or flow and are found in most motor oils designed for cold-weather use. As synthetic motor oils do not contain those wax crystals, they do not require pour point depressant additives.

### **Wear Protection**

Since one of an oil's main functions is to prevent friction and wear, **anti-wear additives** are part of the chemical composition of an oil. These additives protect engines by bonding to metal surfaces and forming a protective film

vulnerable to friction and wear when an engine is first started and before the oil begins to circulate completely. While this protective film doesn't entirely eliminate metal-to-metal contact of moving parts at start-up, it minimizes the effects of contact.

### **Oxidation**

Because excessive engine heat causes chemical breakdown of oil, which in turn results in permanent thickening of the oil, **oxidation inhibitors** work to limit the impact of oxidation. Oil oxidation produces acidic gases and sludge in the crankcase. These gases combine with water in the crankcase to corrode and rust the engine. Corrosion prevention is especially critical in diesel engines.

### **TBN**

An oil's ability to neutralize acids is expressed by its **Total Base Number (TBN)**. The greater the number, the greater the amount of acidic by-products the oil can neutralize. A high TBN is particularly important in extended drain interval oils, such as AMSOIL motor oils, because they neutralize acids, and more of them, for a longer period of time.

Most oils for diesel engines in North America have a TBN between 8 and 12. AMSOIL manufactures several diesel oils with a TBN of 12.

### **Detergents**

In the same way that some chemical compounds are used to prevent engine rust and corrosion, other chemicals are added to motor oil to help prevent combustion by-products from forming harmful sludge or varnish deposits. **Detergents** are added to motor oil because combustion causes carbon build-up and deposit formation on the pistons, rings, valves and cylinder walls. Carbon and deposits affect engine temperature, oil circulation, engine performance and fuel efficiency. Detergent additives clean these by-products from the oil. Some combustion

by-products slip past the piston rings and end up in the motor oil, which can clog the engine's oil channels.

### **Dispersants**

While detergents help minimize the amount of combustion by-products, **dispersant** additives keep those byproducts suspended in a form so fine they minimize deposits. They keep the oil in the engine clean while they prevent the build-up of carbon or deposits from burned and unburned fuel and even from the oil itself. Eventually, these suspended particles are removed by the oil filter.

### **Anti-Foam**

The addition of **silicone** or other compounds in very small amounts makes most oils adequately foam-resistant. It's important to minimize foaming in motor oil because tiny air bubbles are whipped into motor oil by the action of many rapidly moving parts, resulting in a mass of oily froth that has very little ability to lubricate or aid in the cooling of the engine. These compounds weaken the air bubbles, causing them to collapse almost immediately upon forming, allowing the oil to continue to protect the engine.

### **Seal Swell**

All motor oils must be compatible with the various seal materials used in engines. Oil must not cause seals to shrink, crack, degrade or dissolve. Ideally, oils should cause seals to expand or "swell" slightly to ensure continued proper sealing.

### **Heat Dispersal**

Another function of motor oil is to cool the engine. The radiator/antifreeze system is responsible for about 60 percent of the engine cooling that takes place. This cools only the upper portion of the engine, including the cylinder heads, cylinder walls and valves.

The other 40 percent is cooled by the oil. The oil is directed onto hot surfaces, such as the crankshaft, main and connecting rod bearings,

the camshaft and its bearings, the timing gears, the pistons and many other components in the lower portion of the engine that directly depend on the motor oil for cooling. Engine heat is created from friction of moving parts and the ignition of fuel inside the cylinder. Oil carries heat away from these hot surfaces as it flows downward and dissipates heat to the surrounding air when it reaches the crankcase. Lubricating an engine actually requires a very small amount of motor oil compared to the amount needed to ensure proper cooling of these internal parts.

The oil pump constantly circulates the oil to all vital areas of the engine.

### **Classification Systems**

Oil is classified by two systems. One system determines the oil's viscosity (the SAE grade), and one determines its performance level, which oil to use in what type of engine (the API class).

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### **SAE Grade**

The Society of Automotive Engineers (SAE) Viscosity Grade is a system based on viscosity measures taken from a variety of tests. It developed 11 distinct motor oil viscosity classifications or grades: SAE 0W, SAE 5W, SAE 10W, SAE 15W, SAE 20W, SAE 25W, SAE 30, SAE 40, SAE 50 and SAE 60. These are single-grade or single-viscosity oils. These grades designate the specific ranges that the particular oil falls into. The "W" indicates the grade is suitable for use in cold temperatures. (indicating the difference between them and what the difference means. Simply put, the lower the number, the lower the temperature at which the oil can be used for safe and effective protection. The higher numbers reflect better protection for high-heat and high-load situations. Single-grade oils have a limited range of protection and, therefore, a

limited number of uses.

With today's well-refined, high viscosity index oils, however, an SAE 20 oil usually will meet the viscosity requirements of SAE 20W and vice versa. Those that do are classified SAE 20W-20.

This multi-grade or multi-viscosity ability increases an oil's usefulness, because it meets the requirements of two or more classifications.

Examples of multi-viscosity oils are SAE 5W-30, SAE 10W-30, SAE 15W-40 and SAE 20W-50. The number with the "W" designates the oil's properties at low temperatures. The other number characterizes properties at high temperatures. For instance, a multi-viscosity or multigrade oil such as 10W-30 meets the 10W criteria when cold and the 30 criteria once hot. SAE 10W-30 and SAE 5W-30 are widely used because under all but extremely hot or cold conditions, they are light enough for easy engine cranking at low temperatures and heavy enough to protect at high temperatures.

### API Class

The American Petroleum Institute (API) developed a classification system to identify oils formulated to meet the operating requirements of various engines. The API system has two general categories: S-series and C-series.

#### The S-series service classification

emphasizes oil properties critical to gasoline- or propane-fueled engines. If an oil passes a series of tests in specific engines (API Sequence tests), the oil can be sold bearing the applicable API service classification. The classifications progress alphabetically as the level of lubricant performance increases. Each classification replaces those before it. SM oil may be used in any engine, unless the engine manufacturer specifies a "non-detergent" oil.

SA and SB are non-detergent oils

and are not recommended for use unless specified.

Cars from model-years 1980 to 1989 require SF oils, while cars from model-years 1990 to 1993 require SG oils.

New cars beginning with the 1994 model year require oils with an API SH performance rating. Beginning with model-year 1997, new cars require an API SJ oil. The year 2001 brought the introduction of SL oils.

SM category is the most recent classification. It was introduced Nov. 30, 2004. SM oils are designed to provide improved oxidation resistance, improved deposit protection, better wear protection and better low-temperature performance over the life of the oil.

SJ, SL and SM are the current API classes. SJ, SL and SM oils are widely available and ensure the best engine protection available.

**C-series classifications** pertain to diesel engines. They are: CA, CB, CC, CD, CD-II, CE, CF, CF-2, CF-4, CG-4, CH-4, CI-4, CI-4 PLUS and CJ-4. All are obsolete except CF, CF-2, CH-4, CI-4, CI-4 PLUS and CJ-4 performance rated oils.

Not all C-series classifications supersede one another. The current classifications, CF and CF-2 are specified for different applications.

#### **CF for Indirect-Injected Diesel**

**Engine Service.** Service category CF denotes service typical of indirectinjected diesel engines and other diesel engines that use a broad range of diesel fuels in off-road applications, including diesel fuel with greater than 0.5 percent sulfur by weight. CF oils may be used in place of CD oils.

#### **CF-2 for Two-Stroke Diesel**

**Engine Service.** This service category is typical of two-stroke engines requiring highly effective control over cylinder and ring-face scuffing and deposits. CF-2 oils may be used

in engines for which CD-II oils are recommended.

#### **CH-4 for Four-Stroke Diesel**

**Engine Service.** CH-4 is required for high-speed, four-stroke engines designed to meet 1998 exhaust emission standards. CH-4 oils are specifically compounded for use with diesel fuels ranging in sulfur content up to 0.5% weight. Can be used in place of CD, CE, CF-4 and CG-4 oils.

#### **CI-4 PLUS for Severe-Duty**

**Diesel Engine Service.** CI-4 PLUS typically is required in high-speed four-stroke diesel engines used in heavy-duty on- and off-highway applications. CI-4 PLUS oils are especially effective in engines designed to meet 2002 exhaust emission standards. CI-4 PLUS oils may be used in place of CD, CE, CF, CF-4, CG-4, CH-4 and CI-4 oils.

#### **CJ-4 for 2007 and newer diesel**

**Engines.** CJ-4 was developed to address special concerns about emission control engines and their operation on ultra-low-sulfur diesel fuel (ULSD).

These classification systems aim to help motorists choose the right oil for their needs. The choice depends on the engine, the outdoor temperature and the type of driving the engine must withstand.

**Think of the “W” in a motor oil’s classification as meaning “Winter.”**

## 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 often-times 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 is very different 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, they both must lubricate, cool and protect components, but gear oils are placed under extreme amounts of pressure, creating a propensity for boundary lubrication. 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 treat 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 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 stocks either enhance existing properties or impart new ones. Some of the additives that may be found in a drivetrain fluid include:

- 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 which will increase the lubricant's service life.
- Viscosity index improvers - These allow a lubricant to operate over a broader temperature range.
- Anti-foam agents - The churning effects of gears running in oil causes a foaming effect in the oil. To reduce the harmful effects of air trapped in a lubricant, anti-foam additives speed the separation process.
- 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:

#### **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 for 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 they offer 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 gears, 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 for 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, gears normally seen in automotive differentials are hypoid gears and require GL-5 concentration and performance of extreme pressure additives.

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

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 of the extreme pressure additives of GL-5 lubes

## **AMSOIL Performance Test**

Severe Gear® Synthetic Gear Lubes Demonstrate Superior Shear Stability

Product Tested: Severe Gear 75W-140 (SVO)

### **Overview**

The extreme pressures and temperatures generated by modern vehicles increase stress on gear lubricants and can lead to a serious condition known as thermal runaway. As temperatures in the differential climb upward, gear lubricants lose viscosity and load carrying capacity. When extreme loads break the lubricant film, metal-to-metal contact occurs, increasing friction and heat. This increased friction and heat, in turn, results in further viscosity loss, which further increases friction and heat. As heat continues to spiral upward, viscosity continues to spiral downward. Thermal runaway is a vicious cycle that leads to irreparable equipment damage from extreme wear, and

ultimately catastrophic gear and bearing failure.

In order to ensure continued viscosity protection in high-shear conditions, it is required that SAE 75W-140 automotive gear lubes stay in grade throughout the CEC L-45-A-99 (KRL) 20-Hour Shear Test. AMSOIL recently subjected Severe Gear 75W-140 Synthetic Gear Lube (SVO) and four competing 75W-140 gear lubes to KRL shear stability testing.

#### Testing

SAE J306 standards dictate SAE 140 gear lubes maintain a minimum 24.0 cSt viscosity. Although each of the test oils met this standard before testing began, each competitor failed to stay in grade following the test. In fact, two experienced viscosity losses so dramatic that they dropped well below SAE 140 requirements and all the way down to an SAE 85 viscosity. AMSOIL Severe Gear, on the other hand, easily retained its viscosity within SAE J306 requirements, indicating its superior ability to protect against thermal runaway by maintaining its protection qualities in severe, high shear operating conditions.

Brand	cSt Before	cSt After	Viscosity Loss(%)
AMSOIL SVO 75W-140	24.90	24.56	1.37
Redline 75W-140	26.27	Failed	21.59 17.81
Royal Purple 75W-140	33.70	Failed	21.06 37.51
Lucas 75W-140	27.39	Failed	8.94 67.36
Torco 75W-140	29.33	Failed	8.75 70.17

AMSOIL also took the opportunity to subject Severe Gear 75W-110 Synthetic Gear Lube (SVT) to KRL testing. SAE J306 standards dictate SAE 110 gear lubes maintain a minimum 18.5 cSt viscosity. Like Severe Gear 75W-140, SVT demonstrated its superior protection qualities by easily retaining its viscosity and staying in grade.

Brand	cSt Before	cSt After	Viscosity Loss (%)
AMSOIL SVT 75W-110	19.92	19.73	0.95

**The superior viscosity protection, viscosity index and shear stability properties of AMSOIL Severe Gear Synthetic Gear Lubes effectively protect equipment from the devastating effects of thermal runaway. Severe Gear Synthetic 75W-90, 75W-110 and 75W-140 Gear Lubes are ideal for severe-duty applications, including towing, hauling, steep hill driving, commercial use, plowing, racing, off-road use, rapid acceleration, frequent stop-and-go operation and high ambient temperatures**

#### Does Your Differential Feel Neglected ?

Many truck and SUV owners personalize their vehicles with aftermarket products such as lift kits, tires and rims, custom grills, paint, wheel well flairs and engine upgrades. While these upgrades and accessories can increase engine performance and add plenty of visual appeal, they do nothing for extending drivetrain life. Most people perform proper engine maintenance and change their engine oil on a regular basis, but according to one quick lube business, only about two percent of its customers purchase differential

gear lube changes. Sometimes this out of sight, out of mind differential neglect results in costly gear failure, leaving the motorist stranded on the highway.

There are two basic ways to change differential gear lube. The old fluid may be drained or suctioned out and the differential refilled with new gear lube, or the differential cover may be removed to allow more of the old gear lube to drain out and allow access to the magnet inside the differential. Unlike engines, differentials are not equipped with filters. Instead, magnets that are open to the entire gear lube sump are used to catch some of the metal wear particles. When changing differential fluid, the magnet should be cleaned to ensure the new gear lube does not become contaminated.

After draining the old fluid and cleaning the magnet, the differential cover should be re-installed and the differential filled with the correct viscosity grade of AMSOIL SEVERE GEAR® Synthetic Gear Lube. The use of cleaning solvents is not recommended. Initial differential oil changes are recommended by some manufacturers after the first 500 to 3,000 miles.

Even when vehicle manufacturers do not specify to change the factory-fill gear lube to remove wear particles, it is a good practice to do so. For optimum gear and bearing life, AMSOIL recommends the factory-fill differential gear lube be changed no later than the first 5,000 miles with new or rebuilt gears, followed by 50,000 mile drain intervals in severe service or 100,000 mile drain intervals in normal service when using AMSOIL synthetic gear lubes.

AMSOIL recommends any one of three SEVERE GEAR viscosity grades, 75W-90, 75W-110 or 75W-140, for turbo diesel or 4x4 trucks, SUV's and automobiles. SEVERE GEAR 75W-90 (SVG) replaces competitive 75W-90 and 80W-90 gear lubricants and delivers the optimum fuel efficiency and cold temperature performance of all the **SEVERE GEAR gear lubes. SEVERE GEAR 75W-110**

(SVT) replaces competitive 75W-110, 75W-90 and 80W-90 gear lubricants and delivers increased fluid film wear protection over lighter viscosity fluids and better fuel efficiency than 75W-140 gear lubes. SEVERE GEAR 75W-140 (SVO) replaces competitive 75W-140, 80W-140 and 85W-140 gear lubes in applications where these viscosities are recommended by equipment manufacturers. Does Your Differential Feel Neglected?

Differential gear lube sumps are equipped with magnets that attract **metal wear particles.**



# The Use of Synthetic Motor Oil in Automobiles

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Tom's Corner:

By Tom Torbjornsen

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*I have been getting a lot of mail regarding using synthetic motor oil in vehicles. Should I use synthetic oil? Does it work better in some cars than others? Does it cost more? Do I have to change the oil more frequently? Less frequently? Does it make my engine last longer?*

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First of all, let's take a brief look at the history of synthetic motor oil and its introduction to the marketplace.

[AMSOIL INC.](#) developed the first synthetic motor oil to meet API service requirements. Lieutenant Colonel Albert J. Amatuzio, president and CEO of AMSOIL INC. witnessed synthetic lubricants in action as a jet fighter squadron commander. Synthetic oils were developed for (and still are used exclusively in) aircraft jet engines because of their extraordinary capacity to reduce friction and wear on engine parts. Synthetic oil has an incredible ability to function dependably at severe hot and cold temperatures as well as to withstand rigorous and lengthy engine operation without chemical breakdown.

This is critical in aircraft engine operation because, if oil breaks down at 30,000 feet, aircraft engines can fail and - well, you get the picture.

Amatuzio decided that he would develop synthetic motor oil to be used in automobiles for the same benefits. In 1972 AMSOIL introduced the first motor oil for automotive applications.

In the early '70s, another company was also working on synthetic oil development for the automobile - Mobil Oil Company. They came to market with synthetic motor oil in 1975.

By the 1990's the other major oil companies added their synthetic oils to the marketplace, in addition to their petroleum-based products.

To understand synthetic motor oil, let's look first at the origins of all motor oil. Conventional oils come from crude oil that is pumped from the ground. In an oil refinery, crude oil is separated into various fractions. These fractions become the bases for lubricating oils and fuels.

The part of crude oil that forms thick tangled masses of carbon chains are used in roofing tar and roadwork. Very short chains and ring compounds of carbon are volatile and can be refined to produce gasoline and other products.

All motor oils are made up of base oils and additives. In general, fully synthetic motor oils contain non-conventional, high-performance fluids. Synthetic blends usually use some non-conventional, high-performance fluids in combination with conventional oil. It is the unique chemical formulation of synthetic oil that causes it to be highly resistant to viscosity breakdown from high temperature, friction, and chemical contaminants.

### ***Should I use synthetic oil in my car?***

That depends on the vehicle's age, mileage, and the carmaker's recommendations for engine lubricants. Older vehicles with high mileage tend to have excessive mechanical wear in the engine, allowing for internal oil leakage. On vehicles with high mileage, it is not recommended to use full synthetic oil because it is thin and very free flowing, and use of it does (more often than not) result in internal oil combustion. I used full synthetic oil in a Plymouth Neon. After logging 120,000 miles the car started to consume oil at an alarming rate. Concerned, I switched to a semi-synthetic oil that was more full-bodied and the consumption stopped. I logged another 30,000 miles and sold it. It's still running with over 200,000 miles today and it doesn't burn oil.

Carmakers use full synthetics and semi synthetics in some of their engines today. In most cases, you will find that a synthetic lubricant is used when there's a high performance engine with tight engine tolerances, high compression, and high operating temperatures.

Follow your owner's manual for motor oil recommendations. If you want to use synthetic oil and your car is still under warranty, check with your local dealer before switching to synthetic oil (just to make sure you're covered with the switch).

### ***Does it work better in some cars than others?***

As I stated earlier, some carmakers recommend only using synthetic oil in their engines. For instance, Chevy recommends the use of Mobil One full synthetic oil in its new generation Chevy Corvette engine.

I have used synthetic oil in all of my vehicles for the last six years with great results, with one exception. I didn't use a full synthetic in my Ford Taurus 3.0 DOHC V-6. Ford specifies using a 5W20 semi synthetic due to engine design, so I followed the manufacturer's specification.

Remember, before changing to synthetic oil, check with your dealer on carmaker's recommendations. As stated earlier, you could void the warranty.

## ***What are the pros and cons of using synthetic oil in my car?***

### **Pros:**

- It flows easier in cold weather, therefore no loss of prime when the oil is cold. Also, it is highly resistant to viscosity breakdown (the ability of the oil to flow easily in all temps) from heat, friction, and chemical contaminants.
- Longer change intervals: 5,000 to 7,000 miles between oil changes (compared to 3,000 for regular oil). Some folks have documented up to 25,000 miles between changes. However, I would not advice going that long!

### **Cons:**

- Cost is twice as much as conventional oil per quart. However it lasts longer, so the actual Cost increase is closer to 50 to 60 percent.
- Flows easily, therefore, not recommended for use on high mileage engines; nor do I recommend using it in new engines during the break-in period because it is so slippery and dramatically limits the wearing of new mating parts within the engine. This initial wearing of parts is what makes for proper engine break-in, sealing of piston rings, mating of camshafts and lifters, etc.  
Does it make my engine last longer? Yes, because it's so slippery, synthetic makes for less engine wear and thus greater engine longevity.

### **'Til next time - keep rollin'**

AMSOIL carries drivetrain lubricants to meet nearly any 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, differentials, heavy-duty and racing applications.

## **Why after 35 years are so many Americans still using conventional petroleum?**

### **Mysteries**

**by Ed Newman**

**AMSOIL Director of Advertising**

*This article appeared in National Oil & Lube News, December 2008*

One of the most popular shows on television today is CSI, a.k.a. Crime Scene Investigation. Essentially, it's about the processes involved in solving murders. The show is so popular it's on nearly every night of the week now.

CSI is, of course, only the latest in a long line of mystery, whodunit types of stories stretching back who knows how far. I remember conversations with my grandmother about the mysteries of the Great Pyramid and all the questions it raised. The Greek historian Herodotus wrote about it 2500 years ago and it is still unearthing unresolved questions to this day.

What is it about mysteries and puzzles that gets us so engaged? In the realm of literature Edgar Allen Poe made his mark with mysteries such as *The Gold Bug* and *Murders in the Rue Morgue*. Suddenly, a genre was born. Sir Arthur Conan Doyle's Sherlock Holmes was all about solving imponderables with a searing brilliance. G.K. Chesterton's Father Brown was a contemporary to Holmes with an equally rabid following. Agatha Christie's Hercule Poirot became a household name through the murder mystery genre as well.

When television culture emerged, the short mystery tale became a staple in the nation's diet for diversion. The Rockford Files, Perry Mason, Columbo, Murder She Wrote... The shows made for good fun as audiences attempted to solve the crimes faster than their heroes.

One of the great mysteries for me personally has been this one: with all the self-evident benefits of synthetic motor oils, why after 35 years are so many Americans still using conventional petroleum? Here are a few points of light which we can try to connect like dots and make a picture.

1. Motor oil companies historically treated oil like a commodity. Like milk or gasoline, the average consumer was led to believe all oil is pretty much the same, just different color labels. As a result, there was a perception that oil had little value. The oil companies perpetuated this idea by selling on price. I frequently recall how when I was young I could buy a case of oil for six dollars and send in a coupon for a six dollar rebate.

2. The oil companies had a lack of interest in educating the public. The only educational message was this one: "Change your oil. Change it often. What else is there to know?"

3. Change raises questions and creates insecurity. If I change to synthetic oil will it be compatible with what was in there before? What if it leaks out? Is it too slippery to stay in the engine? If something goes wrong, can I change it back to regular petroleum? (Answers: yes; it won't; no; and yes.)

4. Initial cost can be a stumbling block. I can concede that people who do not know the benefits of premium extended drain synthetic oils will sometimes experience a twinge of sticker shock. This is only because they do not understand the value equation. In point of fact, the annual cost with a premium synthetic and extended drain intervals is a better deal, not to mention the savings in fuel economy. Properly priced the installer makes a fair profit, too.

At the other end of the spectrum, I find it puzzling when we don't promote premium synthetic oils to those car owners for whom money is no object. The guy drives a Mercedes, is dressed to the nines and we try to go to the bottom with our product offering? This approach doesn't make much sense to me.

In spite of these barriers to the adoption of synthetics, there are more vehicles on the road every year switching to synthetic motor oils and drive train fluids. One reason might be the ease with which people can obtain information on the Internet these days. In the past, information was limited to a few specific channels. Today, consumers can Google anything and find answers to nearly any technical question on nearly any topic. For this and other reasons, the superior performance capabilities of synthetic lubricants are no longer a mystery for most motorists. The only real mystery is why we don't recommend them more often.

## AMSOIL Performance Test

ATF Excels in MERCON® V Aluminum Beaker Oxidation Test

Product Tested: AMSOIL Synthetic Automatic Transmission Fluid (ATF)

### Overview

Automatic transmission technology has quickly evolved in recent years, and automakers are demanding higher quality, longer lasting transmission fluids to protect these transmissions in extreme conditions. In fact, Ford Motor Company recently retired its MERCON® automatic transmission

fluid specification. Its current MERCON V specification requires significantly improved anti-oxidation, antiwear and anti-shudder properties over previous specifications.

The MERCON V Aluminum Beaker Oxidation Test (ABOT) is a 300-hour oxidation test in which a gear pump circulates and shears the test lubricant in an aluminum beaker. Fluid temperature is maintained at 155° C (311° F), and samples are drawn and analyzed at intervals throughout the test. In addition, metal catalysts are submerged in the lubricant to evaluate its tendency to attack metal materials commonly found inside transmissions.

To show the superior performance of AMSOIL Synthetic Automatic Transmission Fluid (ATF) in extreme operating conditions and over extended drain intervals, an independent laboratory subjected both AMSOIL Synthetic ATF and Texaco Havoline petroleum ATF, a MERCON V product, to extended ABOT testing, which includes tests for viscosity increase and total acid number (TAN). A Brookfield Viscosity Test, as stipulated by MERCON V, was also performed to determine the cold temperature performance of the lubricants.

#### Viscosity Increase Test

In order to pass the requirements of MERCON V, automatic transmission fluids must not exceed a 25 percent viscosity increase following 300 hours of testing. AMSOIL Synthetic ATF easily passed the 300-hour ABOT test, exhibiting no viscosity increase. The test was allowed to continue for 1,106 hours, over three times the standard test length. Even after 1,106 hours, AMSOIL Synthetic ATF exhibited a minimal 6.45 percent viscosity increase, still easily passing MERCON V requirements for 300 hours.

Texaco Havoline ATF did not fare as well. Although it passed the 300-hour test requirements with a 10.66 percent viscosity increase, viscosity increased significantly as the test was allowed to continue. It exceeded the 25 percent viscosity increase mark after 500 hours, then soared to a 3,539.04 percent viscosity increase after 1,012 hours.

#### Total Acid Number (TAN) Test

MERCON V requirements do not allow a total acid number exceeding 3.5 mg following 300 hours of testing. Measured at 0.4 mg following 300 hours of testing, AMSOIL Synthetic ATF easily passed this portion of the test. Even after 1,106 hours of extended testing, AMSOIL Synthetic ATF easily passed MERCON V test requirements for 300 hours. In fact, its TAN of 2.7 mg after 1,106 hours was lower than the 3.2 mg TAN of Texaco Havoline ATF after 300 hours. Although Texaco Havoline ATF passed 300-hour ABOT test requirements, it again showed its inability to provide protection over extended intervals, climbing to a TAN of 7.50 mg after 1,012 hours of testing.

#### Brookfield Viscosity Test

The Brookfield Viscosity Test involves preheating the test lubricant and allowing it to stabilize at room temperature before transferring it to a glass cell with a special spindle. The glass cell is placed into a cold cabinet for 16 hours at a predetermined temperature of between 5 and -40° C. A viscometer rotates the spindle within the lubricant at the speed giving a maximum torque reading on the viscometer, and the reading is used to calculate the viscosity of the lubricant. The lower the cold temperature viscosity (measured in cP), the better the cold temperature protection. The MERCON V specification requires a maximum Brookfield viscosity of 13,000 cP.

The Brookfield viscosity of the automatic transmission fluids was measured before the test began and again at the conclusion of the test. The Brookfield viscosity of the AMSOIL Synthetic ATF measured 8,770 cP at the beginning of the test, easily meeting MERCON V requirements of 13,000 cP. Following 1,106 hours of extended testing, the Brookfield viscosity of the AMSOIL Synthetic ATF was 9,570 cP, still easily passing MERCON V requirements.

Texaco Havoline, on the other hand, exhibited a Brookfield viscosity of 14,400 cP at the beginning of the test, failing to fulfill the requirements of MERCON V. Following 1,012 hours of testing, its Brookfield viscosity exceeded 1,000,000 cP.

### Conclusions

Oxidation and shearing forces seriously affect transmission and lubricant performance and life. The ability of AMSOIL Synthetic ATF to resist oxidation and shearing forces and maintain its protective qualities throughout the extended ABOT test clearly demonstrates the superior transmission protection and performance it provides over extended drain intervals.

AMSOIL Synthetic Automatic Transmission Fluid (ATF) exceeds the performance requirements for domestic and foreign automatic transmission fluid applications, providing automatic transmissions, power steering units and hydraulic equipment with excellent lubricating protection and better performance over a wider temperature range than conventional automatic transmission fluids.

1. Resists thermal and oxidative degradation
2. Ensures cool transmission operation
3. Provides outstanding low temperature protection
4. Improves fuel economy
5. Provides smooth shifting
6. Maximizes transmission performance and service life
7. Reduces maintenance costs
8. Offers extended drain intervals

## AMSOIL Performance Test

Jeff Foster Trucking Road Testing

Product Tested: Series 3000 Synthetic 5W-30 Heavy Duty Diesel Oil (HDD)

### Overview

With the help of Jeff Foster Trucking Inc. of Superior, WI, AMSOIL put its Series 3000 Synthetic 5W-30 Heavy Duty Diesel Oil (HDD), as well as its Dual-Gard filtration system, to the test.

Ten 1996 Kenworth Class 8 tractors used as interstate freight hauling vehicles and equipped with Cummins N-14 ESP3 diesel engines participated in the demonstration. Five trucks equipped with AMSOIL Series 3000 Synthetic 5W-30 Heavy Duty Diesel Oil, AMSOIL BMK-12 Filter mounts and BE-110 By-Pass filtration elements utilized 120,000-mile oil drain intervals, 20,000-mile full-flow oil filter change intervals and 40,000-mile By-Pass filter change intervals, while the other five trucks continued using petroleum motor oil, utilizing 20,000-mile oil and filter drain intervals.

The 10 Jeff Foster Trucking vehicles were identical in the following areas:

1. Vehicle manufacturer, model and model year
2. Engine model, displacement and year
3. Transmission and differential manufacturer and model
4. Tires, brand and design

5. Mileage, 10,000-mile minimum; 25,000-mile maximum

#### Objective

The objective of the field demonstration was to prove that using AMSOIL Series 3000 Synthetic 5W-30 Heavy Duty Diesel Oil, together with the AMSOIL Dual-Gard filtration system, would result in a reduction in operating expenses when compared to the use of conventional petroleum lubricants and filtration methods. Verification will be demonstrated through increased fuel economy, extended drain intervals, reduced oil consumption and reduced maintenance.

#### Lubricant Cost Savings

Both the AMSOIL motor oil and the petroleum product were sampled and tested at 20,000-mile intervals in the areas of elemental analysis (including wear metals, contaminants and additives), physical properties (including viscosity, total acid number and total base number) and contamination (including water, solids, glycol, oxidation, fuel soot and fuel dilution). Oil condemnation limits vary due to individual engine idiosyncrasies, operating conditions and time the fluid has been in service.

The total mileage in this demonstration exceeded 2,548,580 miles, with the average over-the-road mileage for each demonstration vehicle exceeding 217,527 miles. Even while making use of extended drain intervals, the protection and fuel economy advantages of AMSOIL Series 3000 Synthetic 5W-30 Heavy Duty Diesel Oil met or exceeded that offered by the petroleum products utilizing conventional 20,000-mile fluid and filter change intervals. Furthermore, Jeff Foster Trucking saves \$61.90 in lubrication costs per vehicle by using AMSOIL products. Calculated to cover the entire Jeff Foster fleet of 200 vehicles, that is a savings of \$12,380.

#### Fuel Economy Savings

The chart below demonstrates the fuel economy benefits of the AMSOIL products. Overall, AMSOIL provided a 3.065 percent increase in fuel economy. For every 240,000 miles a single Jeff Foster truck travels, it saves \$1443 in fuel costs by using AMSOIL products. Calculated to cover the entire fleet, that is a savings of \$288,600 at an average diesel fuel cost of \$1.30/gal. Jeff Foster Trucking currently uses AMSOIL Diesel Oil in its entire fleet of 200 trucks.

#### Fuel Economy Results for Jeff Foster Trucking Inc. / AMSOIL Inc.

Control Group Monthly Average

(Petroleum) Test Group Monthly Average

(AMSOIL)

September 6.595 mpg September 7.175 mpg

October 6.708 October 6.7975

November 6.63 November 6.9446

December 6.3633 December 6.2

January 6.23 January 6.245

February 6.034 February 6.378

Average for the six month period:

Petroleum: 6.4267 mpg AMSOIL: 6.6237 mpg

TO BE CONTINUED



