Motor Oil & Filtration Guide

SYNTHETIC MOTOR OILS

FILTERS

Premium quality oil and filtration products

What is a motor oil?

Motor oil is one of the most important determinants in the durability of an engine. It contains two basic components: **base stocks** and **additives**.

Base Stocks

The base stock comprises the largest portion of the oil. It lubricates internal moving parts, removes heat and seals piston rings.

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

A petroleum base stock consists of many different oil factions that form the final product. Generally, petroleum base stock molecules 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.

Synthetic base stock molecules are uniformly shaped, helping them resist the stress of heat. Because AMSOIL synthetic motor oils are constructed of these uniformly shaped molecules, they have a low "boil off" rate and their physical properties (such as viscosity) resist change.

Additives

The various chemicals that comprise a motor oil's additive system provide anti-wear, anti-foam, corrosion protection, acid neutralization, viscosity maintenance, detergency and dispersancy properties. Additives help modern motor oils meet the increasing demands of today's high-tech engines. Their quality varies widely throughout the lubrication industry, ranging from a bare minimum with some oils (to comply with certain requirements) to exceptionally high quality, as with AMSOIL synthetic 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:

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

Improvements in Oil

Motor oil quality has changed dramatically in the past 30 years, and new demands on lubricants in modern engine designs 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 (API), while oil viscosity grades are determined by the Society of Automotive Engineers (SAE). These two organizations have set industry standards for motor oils for more than 75 years.

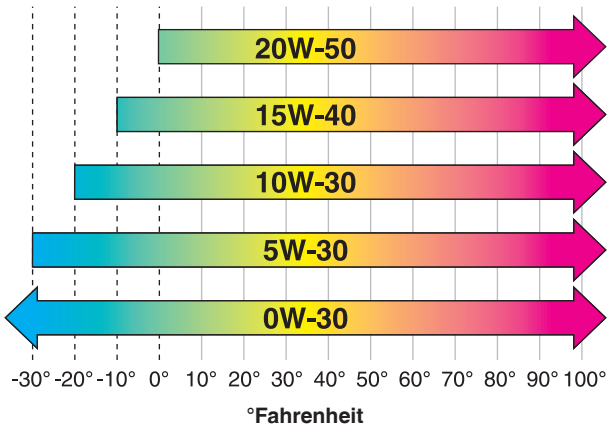
Viscosity

Viscosity refers to the oil's resistance to flow and is the most important property of an oil. The viscosity of oil varies with changes in temperature – thinner when hot, thicker when cold. An oil must flow at cold temperatures to lubricate internal moving parts upon starting the engine, but it must also remain viscous or "thick" enough to protect the engine at high operating temperatures. When an oil is used at a variety of temperatures, as it is in most engines, the change in viscosity should be as minimal as possible.

The measure of an oil's viscosity change is called the **Viscosity Index (VI) number**; the higher the number, the smaller the viscosity change and the better the oil protects the engine. The number does not indicate the actual viscosity of the oil in high- and-low temperature extremes; it represents the rate of viscosity change with temperature change.

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

SAE Viscosity Grade and Outdoor Temperature



Viscosity improvers are viscous chemical compounds called polymers or polymeric compounds that decrease the rate at which oils change viscosity with temperature. Viscosity improvers extend a motor oil's operating temperature range and allow the manufacture of multi-grade or all-season oils. Low-quality viscosity improvers, however, lend themselves to shearing.

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

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 startup, causing bearings and other critical parts to fail almost immediately.

Pour point is the lowest temperature at which an oil will flow, providing an indicator of its ability to flow at cold operating temperatures.

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

Pour point depressants keep wax crystals microscopically small and prevent them from joining together to form the honeycomb-like structure. Found in most motor oils designed for cold-weather use, they lower the temperature at which oil will pour or flow.

Wear Protection

Anti-wear additives bond to metal surfaces and form a protective film layer between the moving parts that are vulnerable to friction and wear when the engine is first started. While this protective film doesn't entirely eliminate metal-to-metal contact, it minimizes the effects.

Oxidation

Oxidation inhibitors limit the impact of oxidation. Oil oxidation produces acidic gases and sludge in the crankcase, and when combined with water, leads to corrosion.

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 synthetic motor oils, because it neutralizes increased levels of acids for a longer period of time.

Detergents

Combustion causes carbon build-up and deposit formation on the pistons, rings, valves and cylinder walls, negatively affecting engine temperature and performance, oil circulation and fuel efficiency. **Detergent** additives clean these by-products from the oil. Some combustion by-products slip past the piston rings and into 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 by-products suspended in the oil, helping prevent build-up of carbon and deposits. Larger suspended particles are removed by the oil filter.

Anti-Foam

When tiny air bubbles are whipped into motor oil by the action of the many rapidly moving parts, it results in a mass of oily froth that has very little ability to lubricate or cool the engine. **Anti-foam** additives weaken the air bubbles, causing them to collapse almost immediately upon forming and allowing the oil to continue protecting the engine.

Seal Swell

Motor oil must be compatible with the various seal materials used in engines. It 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 engine cooling. The radiator/antifreeze system is responsible for cooling about 60 percent of the engine, covering only the upper portion, including the cylinder heads, cylinder walls and valves.

The other 40 percent is cooled by the oil, which is directed onto hot surfaces in the lower portion of the engine, including the crankshaft, main and connecting rod bearings, the camshaft and its bearings, the timing gears, the pistons and many other components.

Engine heat is created from friction of moving parts and fuel ignition inside the cylinder. Oil carries heat away from these hot surfaces as it flows downward and dissipates the heat to the surrounding air when it reaches the crankcase.

Lubricating an engine requires a very small amount of motor oil compared to the amount needed to ensure proper cooling of these internal parts.

Classification Systems

Oil is classified by two systems. The SAE grade determines the oil's viscosity, while the API class determines its performance level and appropriate applications.

SAE Grade

The Society of Automotive Engineers (SAE) developed 11 distinct single-grade motor oil viscosity classifications or grades: SAE 0W, SAE 5W, SAE 10W, SAE 15W, SAE 20W, SAE 25W, SAE 20, SAE 30, SAE 40, SAE 50 and SAE 60.

These viscosity grades designate the specific ranges into which the particular oil falls. The "W" indicates it is suitable for use in cold temperatures. (Think of the "W" as meaning "Winter.") The classifications increase numerically; the lower the number, the lower the temperature at which the oil can be used for safe and effective engine protection. 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 will usually 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-20, 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, while the second number characterizes its properties at high temperatures. For instance, a multi-viscosity 10W-30 oil 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.

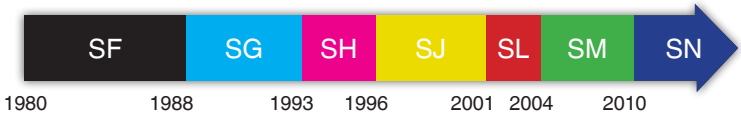
API Class

The American Petroleum Institute (API) developed a classification system to identify oils formulated to meet the different operating requirements of gasoline and diesel 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. When an oil passes a series of tests in specific engines (API Sequence tests), it 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. Oils meeting the latest API classification, API SN, 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.

API S-Series Service Classification for Passenger Car Engine Oil



The API SN category is the most recent classification, replacing those before it. SN oils are designed to provide improved oxidation resistance, deposit protection, fuel economy and emission system performance over the life of the oil.

SL, SM and SN are the currently recognized API classes; previous classifications are obsolete.

C-series classifications pertain to diesel engines; they include CA, CB, CC, CD, CD-II, CE, CF, CF-2, CF-4, CG-4, CH-4, CI-4, CI-4 PLUS and CJ-4. The currently recognized classes are CH-4, CI-4, CI-4 PLUS and CJ-4.

Not all C-series classifications supersede one another.

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

API C-Series Service Classification for Diesel Engine Oil

CATEGORY	STATUS	SERVICE
CJ-4	Current	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) (less than 0.05 percent sulfur). CJ-4 oils exceed CI-4 PLUS, CI-4, CH-4, CG-4 and CF-4 oils.
CI-4 PLUS	Current	For severe-duty diesel engine service. CI-4 PLUS was typically required in high-speed four-stroke diesel engines used in heavy-duty on- and off-highway applications. CI-4 PLUS oils were 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.
CI-4	Current	For high-speed four-stroke engines designed to meet 2004 exhaust emissions standards implemented in 2002. CI-4 oils are formulated to sustain engine durability where exhaust gas recirculation (EGR) is used and are intended for use with diesel fuels ranging in sulfur content up to 0.5 percent weight. Can be used in place of CD, CE, CF-4, CG-4 and CH-4 oils. Some CI-4 oils may also qualify for the CI-4 PLUS designation.
CH-4	Current	For four-stroke diesel engine service. CH-4 was 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 percent weight, and they can be used in place of CD, CE, CF-4 and CG-4 oils.
CG-4, CF-4, CF-2, CF, CE, CD-II, CD, CC, CB, CA	Obsolete	

How does motor oil become contaminated?

Motor oil deteriorates and becomes unfit for service due to accumulation of contaminants in the oil and chemical changes (additive depletion and oxidation) in the oil itself.

Abrasives

Dust and Dirt

The design limitations of air cleaners, some oil fill caps and crankcase ventilation systems allow a certain level of dust and dirt into the engine, while leaks in the intake system can permit unfiltered air to enter the engine. Proper maintenance of the engine and its accessories can minimize the amount of contaminants entering the lubrication system and extend engine life.

Metal Particles

Normal wear of engine parts produces very small metal particles that are picked up and circulated by the oil. Particles of road dust and dirt increase wear rates and generate larger, even more abrasive metal particles that are circulated through the engine by the oil. While oil filters help keep these particles at a minimum, they can't remove them entirely.

Combustion By-Products

Water

Combustion produces water vapor, or steam. When engine temperatures are high, most of the water remains in vapor form and exits through the exhaust. However, when engine temperatures are low, such as at start-up, warm-up and during short-trip operation in low ambient temperatures, the water vapor condenses (turns into a liquid) on cylinder walls and enters the crankcase oil, where it leads to sludge and corrosion.

Acids

The combustion process produces acidic gases which, like water vapor, condense on cylinder walls at cold engine temperatures and find their way into the crankcase oil. The gases combine with water to cause corrosion.

Soot and Carbon

Incomplete combustion produces soot, carbon and other deposit-forming materials. An engine running too "rich," or with too much fuel, increases contaminant levels. Light-load, low-speed gasoline engine operation and high-load, low-speed diesel engine operation increase levels of these combustion by-products.

Dilution

When an engine is started or running abnormally, some unburned fuel is deposited on cylinder walls, leaking past the rings and into the crankcase, where it reduces oil viscosity. Fuel dilution decreases oil film strength and increases oil consumption. Although this is only a minor problem when engine operation is at high-speed or high-temperatures, it can be a significant problem in vehicles consistently used for short-trips.

What causes engine wear?

Automotive experts agree dirt is the number-one cause of engine wear. In fact, analysis by Federal-Mogul Corporation reveals that 43.4 percent of all engine bearing distress is caused by dirt.

Dirt particles are extremely abrasive, consisting of razor-like flakes of road dust and airborne grit drawn into the engine through the intake manifold. Along with residual manufacturing dust and wear-metal particles generated inside the engine, these contaminants are carried by the oil into the precision clearances between bearings and other moving parts, where they grind and gouge surfaces, alter clearances and generate more abrasive debris. As this wear cycle continues, precision components become sloppy and fatigued until they fail altogether.

Filtration is the key to preventing costly engine repairs caused by dirt, removing contaminants by trapping and holding them outside the system of oil circulation. Truly effective filters must capture contaminants of all types and sizes. AMSOIL offers a complete line of sophisticated filtration products designed to offer the best protection available against virtually all harmful engine contaminants.

How do you stop engine wear?

Air Filtration

An engine “breathes” air to mix with fuel for combustion – about 9,000 gallons of air for every gallon of gas. The air within one cubic mile over a typical city contains more than 400 tons of suspended dirt, and the concentration is much higher in rural areas where travel frequently takes place over unpaved roads.

The air filter is the engine’s first line of defense against abrasive airborne grit. It must effectively filter the dangerous particles without obstructing the vital flow of air that sustains the engine.

Conventional air filters quickly become obstructed with dirt, reducing vital engine air intake and leading to poor engine performance and low fuel efficiency. They require frequent replacement.

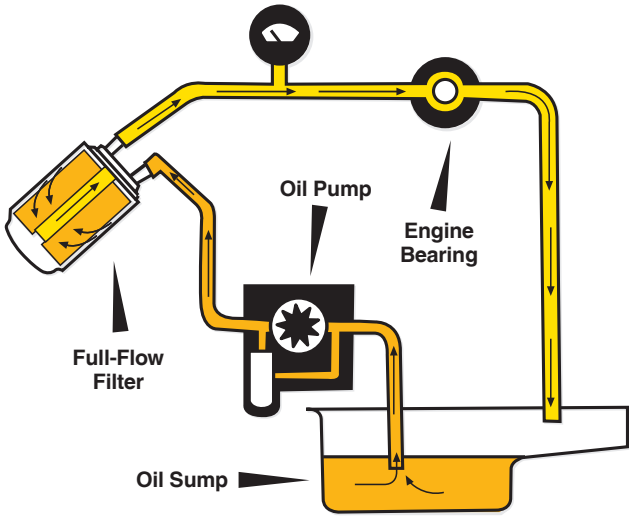
Oil Filtration

Full-flow oil filters install directly into the line of oil circulation; the oil passes through the filter as it travels between the oil pump and the engine. A full-flow oil filter must remove and hold contaminants without obstructing oil flow to the engine.

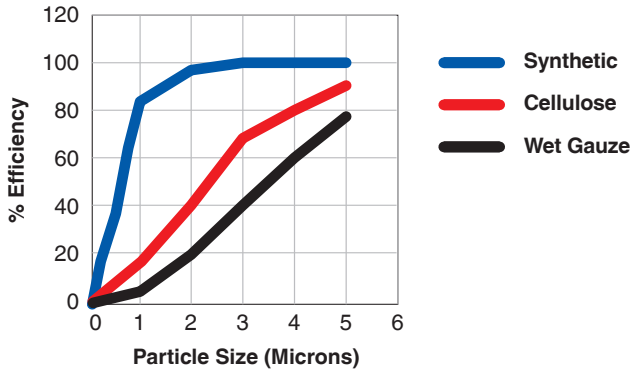
Because they use a thin layer of porous filter paper, most oil filters on the market compromise the filtration of finer materials. Such filters have almost no extended cleaning ability because they have a low capacity for storing dirt.

These “surface-type” paper filters quickly become restricted as debris builds up on the paper surface, forcing the filter relief valve to open and allow unfiltered oil into the engine.

Normal Oil Circulation



Media Efficiency Comparison

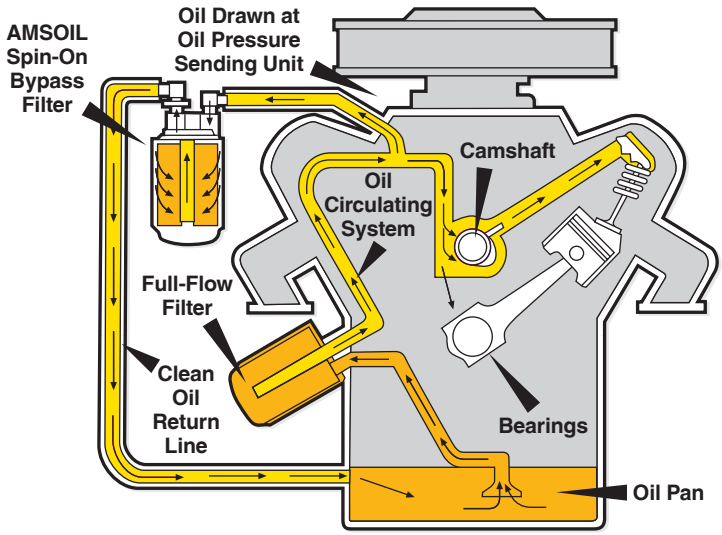


Bypass Oil Filtration

Because oil must be filtered quickly while removing most of the particles, the average full-flow filter can only trap particles as small as 20 microns.

Bypass oil filtration uses a secondary filter with the purpose of eliminating nearly all contaminants in engine oil. Bypass filters have high capacities and eliminate much smaller particles than full-flow filters, including those in the two to 20 micron range, soot and sludge.

Oil Circulation using an AMSOIL Spin-On Bypass Filter



Bypass filters operate by filtering oil on a “partial-flow” basis. They draw approximately 10 percent of the oil pump’s capacity at any one time and trap the extremely small, wear-causing contaminants that full-flow filters can’t remove. The continual process cleans the oil, reducing long-term wear and helping extend oil life.

AMSOIL Synthetic Motor Oils

AMSOIL revolutionized the automotive world with its introduction of the first synthetic motor oil to meet American Petroleum Institute service requirements. Today, AMSOIL is the recognized leader in synthetic lubricant technology.

With three premium synthetic motor oil lines available, everyone from casual motorists to hardcore performance enthusiasts can experience the many benefits of AMSOIL synthetics throughout the drain interval they prefer.

Maximum Fuel Efficiency

AMSOIL synthetic motor oils reduce friction, resulting not only in enhanced performance and protection, but helping increase fuel efficiency as well. With less resistance to internal moving parts, engines are able to operate at peak efficiency and deliver maximum mpg.

Reliable Protection

By controlling friction and heat more effectively than conventional oils, AMSOIL synthetic motor oils significantly reduce the rate of component wear and failure. During cold starts when most wear occurs, they remain fluid to circulate and deliver almost immediate lubrication to critical engine parts.

Premium Performance

AMSOIL synthetic motor oils' low coefficient of friction allows more energy to reach the vehicle's wheels, maximizing power and performance. Their sophisticated chemistries reduce oil consumption and inhibit sludge formation for a cleaner, more efficient engine.

SIGNATURE SERIES

AMSOIL Signature Series Synthetic Motor Oil is the industry benchmark in quality, providing maximum performance and protection throughout drain intervals up to 25,000 miles/ 700 hours of operation/one year.

SYNTHETIC MOTOR OIL XL EXTENDED LIFE

AMSOIL XL Synthetic Motor Oil uses extended drain boost technology to deliver superior performance for up to 10,000 miles/ six months, or even longer when recommended in owners' manuals or indicated by electronic oil life monitoring systems.

SYNTHETIC MOTOR OIL ORIGINAL EQUIPMENT OE

AMSOIL OE Synthetic Motor Oil is engineered to outperform conventional oils throughout original equipment manufacturer-recommended drain intervals.

Oil Analysis

A qualified laboratory can determine the degree of protection an oil is delivering and ensure it has not been contaminated. Oil analysis can also detect impending engine failure.

The combination of superior lubrication and reliable oil analysis provides peace of mind over extended drain intervals. A perfect complement to using AMSOIL synthetic motor oils, OIL ANALYZERS INC. provides state-of-the-art oil analysis testing. Oil analysis helps motorists derive the longest life from both AMSOIL synthetic motor oil and their engines.

Oil Analyzers INC.

OIL ANALYZERS testing kits (KIT01, KIT02, KIT06) are available from AMSOIL. For more information on oil analysis and OIL ANALYZERS INC. visit www.oaitesting.com or call (715) 392-0222.

AMSOIL Ea® Oil Filters

Full-synthetic media provides maximum filtration capacity, efficiency and durability.

AMSOIL Ea Oil Filters deliver higher capacity, higher efficiency, better durability and lower restriction. They effectively trap and hold 98.7 percent of particles 20 microns and larger, an improvement over the efficiency offered by traditional cellulose media. During the engine warm-up period, Ea Oil Filters allow the oil to flow through at a colder temperature than typical cellulose filters, decreasing engine wear. Used with AMSOIL synthetic motor oils, Ea Oil Filters have a maximum recommended service life of either 15,000 miles/one year or 25,000 miles/one year, depending on the application.

AMSOIL Ea Bypass Filters use a two-stage pleated and layered cellulose/full-synthetic media to provide an efficiency rating of 98.7 percent at two microns.

The **AMSOIL Universal Dual Remote Bypass System** replaces the location of the conventional full-flow filter by mounting in any convenient location near the engine and providing both full-flow and bypass oil filtration protection. Filter changes are quick, clean and easy, and the Dual Remote system effectively increases the engine's oil capacity.

AMSOIL also offers premium **WIX, MANN** and **Donaldson filters** to complement the AMSOIL filter line and help meet virtually every automotive and heavy-duty filtration need.

AMSOIL Ea FILTERS

Donaldson Filtration Solutions

WIX FILTERS

MANN FILTER

AMSOIL The First in Synthetics®

Contact your full-service AMSOIL Dealer for more information on AMSOIL products or to place an order. You may also order direct by calling AMSOIL INC. at 1-800-956-5695 and providing the referral number listed here. ▼

Referral #_____

AMSOIL INC., 925 Tower Ave., Superior, WI 54880 • 715-392-7101 • Printed in the USA.