# A Beginner's Guide to Motor Oil: What You Need to Know

 John Baker|May 15, 2018 8:39 AM

If you awoke this morning asking yourself, "Gee, I wonder what there is to know about motor oil," you're in luck. Here, we present a primer on motor oil fundamentals.

**Here's what we'll cover:**



Ready? Let's go.

## What is motor oil?

Motor oil is one of the most important factors in your engine's performance and longevity. Put simply, it's the lubricant that prevents all those metal parts from tearing each other apart or welding themselves together into the world's coolest boat anchor. Without motor oil, your engine would destroy itself in a matter of seconds.

## What is motor oil made from?

Motor oil contains two fundamental components: **base oils** and **additives**. The two work in tandem to produce the final product you put in your engine. Think of coffee as an analogy – the base oil is the water and the additive package is the coffee beans.

The base oils comprise the largest portion of the oil. They lubricate internal moving parts, absorb heat and seal the piston rings.

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

**Petroleum (or conventional) base oils** are refined from crude oil. Contaminating elements such as sulfur, nitrogen, oxygen and metal components such as nickel or vanadium are inherent to crude oil and cannot be completely removed through the refining process. The oil refining process separates the various types of molecules in the oil by weight, leaving molecules similar in weight but dissimilar in structure, reducing performance.

**Synthetic base oils,** on the other hand, are highly engineered to include only beneficial molecules. As such, they contain no contaminants or molecules that don't serve a designed purpose. Their versatility and pure, uniform molecular structures impart properties that provide better friction-reduction, optimum fuel efficiency, maximum film strength and extreme-temperature performance conventional lubricants just can't touch.

## Motor oil 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 dispersion properties. A few examples of chemical additives include zinc, phosphorus and boron. Striking the perfect balance of the proper additives in relation to the base oil is a tough balancing act for oil formulators, especially as vehicles grow more demanding and sophisticated.

## What must a motor oil do?

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

**Minimize Friction**
Lubricants reduce contact between components, minimizing friction and wear.

**Clean**
Lubricants maintain internal cleanliness by suspending contaminants within the fluid or by preventing the contaminants from adhering to components. Base oils possess a varying degree of solvency that assists in maintaining internal cleanliness. Solvency is the ability of a fluid to dissolve a solid, liquid or gas.

Detergents help keep critical components, like the pistons, clean and functioning properly.

While the solvency of the oil is important, detergents and dispersants play a key role. Detergents are additives that prevent contaminants from adhering to components, especially hot components such as pistons or piston rings. Dispersants are additives that keep contaminants suspended in the fluid. Dispersants act as a solvent, helping the oil maintain cleanliness and prevent sludge formation.

**Cool**
Reducing friction minimizes heat in moving parts, which lowers the overall operating temperature of the equipment. Lubricants also absorb heat from contact surface areas and transport it to a location to be safely dispersed, such as the oil sump.

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

**Seal**
Motor oil acts as a dynamic seal in locations like the piston ring/cylinder interface. A dynamic seal helps keep combustion gases in the combustion chamber, which maximizes horsepower and helps prevent hot gases from contaminating the motor oil in the sump.

**Dampen Shock**
A lubricant can cushion the blow of mechanical shock. A highly functional lubricant film can resist rupture and absorb and disperse these energy spikes over a broad contact area. As the mechanical shock to components is dampened, wear and damaging forces are minimized, extending the component's overall operating life.

**Protect Against Corrosion**
A lubricant must have the ability to prevent or minimize internal component corrosion. Lubricants accomplish this either by chemically neutralizing corrosive products or by forming a barrier between the components and the corrosive material.

Fun Fact: Motor oil has no natural ability to resist rust and corrosion; those properties must be added through use of motor oil additives.

**Transfer Energy**
Because motor oil is incompressible, it makes an excellent energy-transfer medium, such as when used with hydraulic valve lifters or to actualize components in an engine with variable valve timing.

Viscosity is a motor oil's most important property. The lower the viscosity, the faster the oil flows, like water. Thicker oils flow more slowly, like honey.

## What is 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.

Although oil must flow at cold temperatures to lubricate the engine at startup, it must also remain thick enough to protect the engine at high operating temperatures. When an oil is used at a variety of temperatures, as with most engines, the change in viscosity should be as minimal as possible.

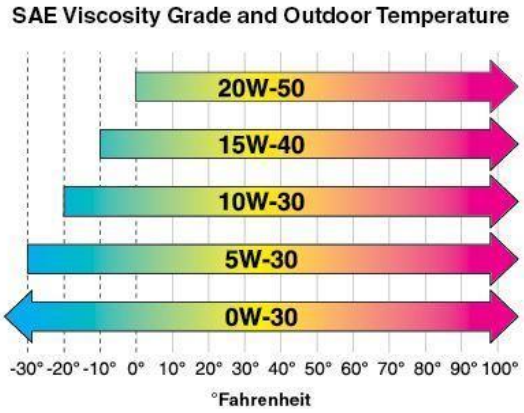
Wouldn't it be handy to have a number that indicated the oil's viscosity change? We do, and it's called the Viscosity Index (VI). It is measured by comparing the viscosity of the oil at 40°C (104°F) with its viscosity at 100°C (212°F). The higher the VI, the less the viscosity changes with temperatures changes and the better the oil protects the engine. Synthetics typically have a higher VI than conventional oils.

## SAE viscosity grades

The Society of Automotive Engineers (SAE) has developed several viscosity classifications or grades, such as 5W-30, 10W-40 and 15W-50.

These viscosity grades designate the specific ranges in which the 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.

The overwhelming majority of oils today are multi-viscosity, meaning they behave differently at different operating temperatures to provide the best of both worlds – good cold-flow when the temperature drops and reliable protection once the engine reaches operating temperature. For example, a 5W-30 motor oil performs like an SAE 5W at 40°C and an SAE 30 motor oil at 100°C.




## How is gasoline motor oil classified?

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 engines. When an oil passes a series of both bench tests and engine tests (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-PLUS, may be used in any engine calling for it or a previous

API specification unless otherwise specified. The API SN-PLUS category is the most recent classification, replacing those before it. SN-PLUS oils are designed to provide…

- Improved oxidation resistance
- Deposit protection
- Maximum fuel economy
- Emissions-system performance
- Resistance to a new type of engine knock called low-speed pre-ignition (LSPI)


## How is diesel engine oil classified?

C-series classifications pertain to diesel engines and include those shown below. Not all C-series classifications supersede one another. Note the new FA-4 classification, which pertains only to some 2017 and newer diesel engines. The FA-4 classification was introduced primarily to help maximize fuel economy in over-the-road trucks.

## What's the key takeaway?

That's a ton on information, but it boils down to this: **motor oil is more than a commodity. It's a vital part of your engine's longevity and performance.** As such, it pays in the long run to use the best oil for your vehicle. The initial price of a high-quality synthetic motor oil may be more, but the lifetime cost can be far less compared to conventional oil, especially if you practice extended drain intervals.

**Online Product Application Guide:**
http://www.amsoil.com/mygarage/vehiclelookup.aspx?zo=4901

## API C-Series & F-Series Service Classification for Diesel Engine Oil

| CATEGORY | STATUS | SERVICE |
|---|---|---|
| FA-4 | Current | API Service Category FA-4 describes certain XW-30 oils specifically formulated for use in select high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway greenhouse gas (GHG) emission standards. These oils are formulated for use in on-highway applications with diesel fuel sulfur content up to 15 ppm (0.0015% by weight). Refer to individual engine manufacturer recommendations regarding compatibility with API FA-4 oils. These oils are blended to a high-temperature/high-shear (HTHS) viscosity range of 2.9 cP – 3.2 cP to assist in reducing GHG emissions. These oils are especially effective at sustaining emission-control system durability where particulate filters and other advanced after-treatment systems are used. API FA-4 oils are designed to provide enhanced protection against oil oxidation, viscosity loss due to shear, and oil aeration as well as protection against catalyst poisoning, particulate filter blocking, engine wear, piston deposits, degradation of low- and high-temperature properties and soot-related viscosity increase. API FA-4 oils are not interchangeable or backward compatible with API CK-4, CJ-4, CI-4 with CI-4 PLUS, CI-4 and CH-4 oils. Refer to engine manufacturer recommendations to determine if API FA-4 oils are suitable for use. API FA-4 oils are not recommended for use with fuels having greater than 15 ppm sulfur. For fuels with sulfur content greater than 15 ppm, refer to engine manufacturer recommendations. |
| CK-4 | Current | API Service Category CK-4 describes oils for use in high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway and Tier 4 non-road exhaust emission standards as well as for previous model year diesel engines. These oils are formulated for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact exhaust after-treatment system durability and/or oil drain interval. These oils are especially effective at sustaining emission-control-system durability where particulate filters and other advanced after-treatment systems are used. API CK-4 oils are designed to provide enhanced protection against oil oxidation, viscosity loss due to shear and oil aeration as well as protection against catalyst poisoning, particulate filter blocking, engine wear, piston deposits, degradation of low- and high-temperature properties and soot-related viscosity increase. API CK-4 oils exceed the performance criteria of API CJ-4, CI-4 with CI-4 PLUS, CI-4 and CH-4 and can effectively lubricate engines calling for those API Service Categories. When using CK-4 oil with higher than 15 ppm sulfur fuel, consult the engine manufacturer for service interval recommendations. |
| CJ-4 | Current | For high-speed four-stroke cycle diesel engines designed to meet 2010 model year on-highway and Tier 4 non-road exhaust emission standards as well as for previous model year diesel engines. These oils are formulated for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact exhaust after-treatment system durability and/or drain interval. API CJ-4 oils exceed the performance criteria of API CI-4 with CI-4 PLUS, CI-4, CH-4, CG-4 and CF-4 and can effectively lubricate engines calling for those API Service Categories. When using CJ-4 oil with higher than 15 ppm sulfur fuel, consult the engine manufacturer for service interval. |
| CI-4 | Current | Introduced in 2002. For high-speed, four-stroke engines designed to meet 2004 exhaust emission 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% 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 | Introduced in 1998. 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. |