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How to Read an Oil Bottle - *What do those letters and numbers mean ...really?*

Before you can read an oil bottle it helps to understand what all of the abbreviations stand for that you may see posted on a bottle of motor oil. This information will deal specifically with the typical bottle of motor oil you will find at your local auto parts store in the U.S.

SAE - Society of Automotive Engineers (http://www.sae.org) - opens a new window
These guys set standards beyond those used in lubricants, but since this is the system most see on oil bottles dealing with viscosity, we'll list them first.
API - American Petroleum Institute (http://www.api.org/) - opens a new window
Created around 1930 they have set the standards for oil quality and performance in the U.S. market. The API is comprised of the major oil companies. In other words, for the most part oil standards in the U.S. have been set by the oil companies until recently when the JASO and ILSAC came into the scene. ILSAC, JASO and the ACEA represent auto/truck manufacturers that set oil quality standards.
ILSAC - International Lubricant Standardization and Approval Committee (http://www.ilma.org/) - opens a new window
ACEA - European Automobile Manufacturers Association (http://www.acea.be/collection/about_us) - opens a new window
JASO - Japanese Automobile Standards Organization (http://www.jsa.or.jp/default_english.asp) - opens a new window
ASTM - American Society of Testing Materials (http://www.astm.org/) - opens a new window
You may not see these guys on a bottle of motor oil, but they set standards worldwide for everything from bolts to electrical wiring. Their testing methods show up on all things including lubricants and filters.

The information here is organized by sections on viscosity, API service ratings, JASO and ILSAC oil service standards. First I will give you a history of how these systems have evolved into being: At one time motor oil was not additized and with poor filtration motor oil life was limited to around 500 miles oil life. As you can imagine, without friction modifiers engines didn't last very long and the absence of detergent (TBN) additives made oil degradation a serious problem. Combine that with the choice of poor quality base stocks made from Group I base oils, the first motor oils kept engines running, but not for a great length of time. Around 1930 the API was formed and oil standards were implemented. At this time the first API oil standard, API SA, was implemented. SA oils were not additized and therefore obsolete even before anyone could know how to label them. API SB oils employed a friction modifier to prevent excess wear on flat tappet camshafts. As more technology was introduced the marvel of oil chemistry saw oils developed that could fend off the effects of acidity and reduce the size of harmful particulate.

The European counterpart to the API was called the CCMC later the ACEA. The ACEA is comprised of auto and truck manufacturers who set oil quality standards. In Europe oil standards are designed by the engine manufacturers who consult with the oil companies to determine what is feasible and the cost to manufacture. The European ACEA oil standards are set up on a multi-tier system where a consumer can choose a higher oil standard or a lower price. Also this system allows some manufacturers to choose higher standards for warranty purposes. Recently some European auto manufacturers have gone so far as to set their own oil quality standards and require oils be certified for warranty purposes. This doesn't concern U.S. oils, but if you own one of these European autos you are probably already aware of the need to seek out the correct motor oil. If not, all you need to know is in the owner's manual. You won't see U.S. oils with the ACEA ratings except for possibly some high performance synthetic motor oils. ACEA oil quality standards are higher than API oil standards which is why you won't be seeing these ratings on most motor oil bottles. API standards are minimum and uniform which is why bargain brands sold at the discount store will carry the same API ratings as the major brands.

In 1992 the AAMA (American Automobile Manufacturers Association) and the JASO met and determined that the current system involving the SAE, ASTM and the API, called the tripartite system meaning three governing bodies, were much too slow in responding to the rapidly expanding and changing needs of modern day automobiles and light trucks only. The AAMA and JASO was concerned that this lack of timely response left them vulnerable to excessive warranty claims that could otherwise be reduced and/or avoided.

Therefore, they formed the International Lubricant Standardization and Approval Committee (ILSAC). The ILSAC was empowered to set minimum performance standards for gasoline powered passenger car and non-commercial light truck oils. The ILSAC and the tripartite system (SAE, ASTM & API) then joined together and formed the Engine Oil Licensing and Certification System (EOLCS). The EOLCS licenses oils approved through the ILSAC. The API provides the overall administration of the EOLCS system.

Now to compound things, a new specification called ILSAC GF was developed in order to meet the newest set of government regulations regarding fuel economy and long-term emission system performance and durability. The initial ILSAC GF-1 and API SH specification first appeared in 1996. In 1997 ILSAC GF-2 and API SJ specification was released which put increased demands on 0W-30, 0W-40, 5W-20, 5W-30, 5W-40, 5W-50, 10W-30, 10W-40 and 10W-50 motor oils in order to meet requirements for phosphorus content, low temperature operation, high temperature deposits and foam control.

ILSAC GF-3 and API-SL replaced ILSAC GF-2 and API-SJ in July 2001 with even more stringent parameters regarding long-term emission system durability and improved fuel economy as well as improved performance in the areas of volatility and deposit control, viscosity retention, additive depletion over the oils service life and reduced oil consumption rates.

As the JASO and ILSAC were formed and created their own improved standards, the API moved quickly to introduced their own upgrades which, for the most part, paralleled the JASO and ILSAC standards.

What's in This Stuff Anyway?

It has been a long time since motor oil was just oil. In the 1930s a wax modifier was added to oil to address the problem of wax residue after the refining process. Thus began the use of additives in the formulation of motor oil. Today, motor oils contain a variety of ingredients designed to improve their performance capabilities.

SURFACE PROTECTION ADDITIVES

Anti-wear agents reduce friction and wear, help prevent scoring or seizure and help prevent metal-to-metal contact.

Corrosion and rust inhibitors are used to prevent corrosion and rust on the internal metal

PERFORMANCE ADDITIVES

Pour point depressants enable lubricants to flow at lower temperatures by modifying wax crystal formation, thereby reducing interlocking.

Seal swell agents help to swell elastomeric seals by causing a chemical reaction in the elastomer.

PROTECTIVE ADDITIVES

Antifoamants reduce surface tension and speed the collapse of foam.

Antioxidants slow the rate of oxidation by decomposing peroxides and terminating free-radical reactions.

Metal deactivators are used

parts of the engine. Detergents keep surfaces free of deposits. Dispersants keep insoluble contam	Viscosity modifiers help reduce the rate of viscosity change when temperatures rise or drop.	to reduce catalytic effect of metals on the oxidation rate.

The question of phosphorus.

Phosphorus is the key component for valve train protection in an engine, and 1600ppm (parts per million) used to be the standard for phosphorus in engine oil. In 1996 that was dropped to 800ppm and then more recently to 400ppm - a quarter of the original spec. Valvetrains and their components are not especially cheap to replace and this drop in phosphorus content has been a problem for many engines. So why was the level dropped? Money. Next to lead, it's the second most destructive substance to shove through a catalytic converter. The US government mandated a 150,000 mile lifetime on catalytic converters and the quickest way to do that was to drop phosphorus levels and bugger the valvetrain problem. Literally.

In the US, Mobil 1 originally came out with the 0W40 as a 'European Formula' as it was always above 1000 ppm. This initially got them out of the 1996 800ppm jam and knowledgeable consumers sought it out for obvious reasons. Their 15W50 has also maintained a very high level of phosphorus and all of the extended life Mobil synthetics now have at least 1000ppm. How do they get away with this? They're not classified as energy/fuel conserving oils and thus do not interfere with the precious government CAFE (corporate average fuel economy) ratings. See the section on the EPA and fuel economy in the *Fuel and Engine Bible (http://www.carbibles.com/fuel_engine_bible.html#20060828)* for more info on this. This also means that they don't get the coveted ratings of other oils but they do protect your valvetrain.

Other manufacturers of performance synthetic motor oils, such as AMSOIL, do not even bother to have API or ILSAC certification on their top end high performance synthetic motor oils. Why? First off notice which oils AMSOIL actually does have API and ILSAC certification on. It is the less expensive, short oil drain motor oils. This is so their Dealers can sell bulk quantities of these motor oils to fleets and municipalities that may strongly require API and/or ILSAC certification. AMSOIL believes the 300,000 to 500,000 dollars required to certify these motor oils excessive and they are unwilling to comply with the reduced phosphorus (zincdithiophosphate also spelled zinc dithiophosphate or zinc dialkyldithiophosphate - abbreviated ZDDT - a friction modifier) especially since their higher priced performance motor oils are designed for extreme performance. Also, if a company wants to make any changes in formulation, they must once again resubmit the oils for certification and spend another 300,000 to 500,000 dollars. They limit the certified motor oils to those most designed for bulk use and less likely to need immediate formulation changes as new technology emerges. I use AMSOIL as an example because I am intimately associated with this company and know how they develop their market. But other companies that manufacture synthetic motor oils other than Mobil and AMSOIL are also dodging the API and ILSAC certification in favor of better performance and wear numbers. More detailed information on this follows about the API *read across approval* and how this doesn't fairly measure phosphorus levels reaching the catalytic converter. Basically, API standards are not worth dropping your standards for if you target a higher level of performance and have extremely low volatility.

The API has been criticized for lagging behind on oil standards compared to the European ACEA. However, be aware that in the United States market there were motor oils available to the public that were performing at or above the ACEA standards. Most consumers chose price over oil quality and performance, at least in the past, as Mobil 1 and AMSOIL sales numbers were never impressive until more recently. In Europe the oil quality standards were forced upon the consumer by the manufacturers. With ILSAC you now see oil standards set by the manufacturers in the U.S. market. In Europe motor oil has reached very high standards with some manufacturers forcing specialized motor oil ratings on car owners for the warranty even in the U.S. market where these oils are hard to find and expensive.

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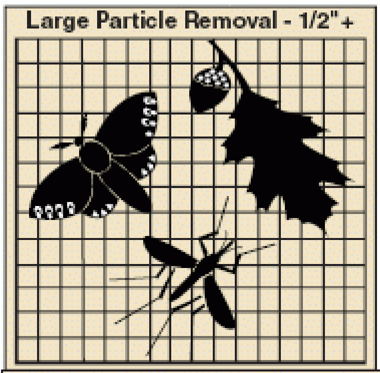
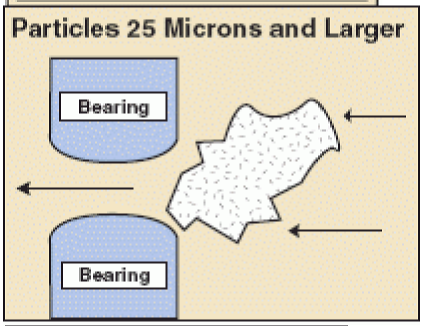
Superior Filtration Leads to Reduced Costs and Extended Equipment Life

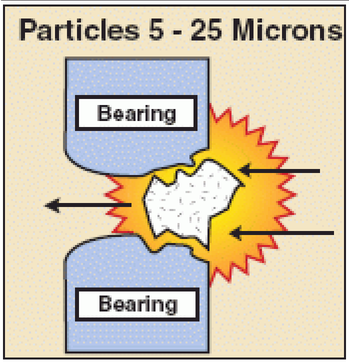
SAE study proved direct correlation between particle size and engine wear.



A great deal of emphasis is placed on the importance of using the most advanced high-quality lubricants, but superior filtration is often taken for granted. The general attitude displayed by many consumers is to use whatever is cheapest, even when they've invested in superior lubrication. While AMSOIL synthetic motor oils provide unbeatable protection, performance and economy, they require the assistance of filtration. Without filtration, by-products from the combustion process and abrasive materials ingested from the air will ultimately destroy an engine.

Some Contaminants Cause More Damage





The level of damage particles cause to an engine is directly related to the size of the particles. The oil stream within the engine flows between wear-sensitive surfaces that usually have clearances of between 2 and 22 microns. It is contaminants in this size range that pose the greatest threat as they can slip between moving components, causing a great deal of wear.

To appreciate how small these particles are, one must first understand the measurements involved in their classification.

A micron, or micrometer (µ), is a very small unit of linear measurement. One micron is equal to one millionth of a meter, and 25 microns is equal to 0.001 inch. To better put this in perspective, consider that the diameter of a human hair is 50 - 70 microns.

Large particles are particles measuring ½" or larger. They pose little threat to engines because they are easily removed by the air filter.

Medium particles are particles measuring 25µ to ½". While they are of greater concern than large particles because they are more difficult to remove, the threat they pose is diminished since they are still larger than many of the clearances within an engine. Their size will not allow them to enter the contact areas between many components to promote accelerated wear.

Small particles are particles measuring between 5 and 25µ. Small particles are of greatest concern because they can penetrate the clearances between wear-sensitive components and promote accelerated wear. And, because they are so small, they are difficult to remove from the oil stream.

SAE Testing

In the 1988 *Correlating Lube Oil Filtration Efficiencies With Engine Wear* technical paper published by the Society of Automotive Engineers (SAE), the relationship between oil filtration levels and abrasive engine wear was established. Testing determined that wear was reduced by as much as 70 percent by switching from a 40µ filter to a 15µ filter.

The SAE conducted tests on a heavy-duty diesel engine and an automotive gasoline engine, and both provided consistent results.

New Technology Provides New Options

Oil Filter	Micron Rating @ 98% Efficiency	Media Composition
	Diesel	
(A)	40	Cellulose
(B)	15	Glass
(C)	8.5	Glass
(D)	7	Glass
	Gasoline	
(E)	40	Cellulose
(F)	30	Glass/Cellulose
(G)	25	Glass/Cellulose
(H)	15	Glass

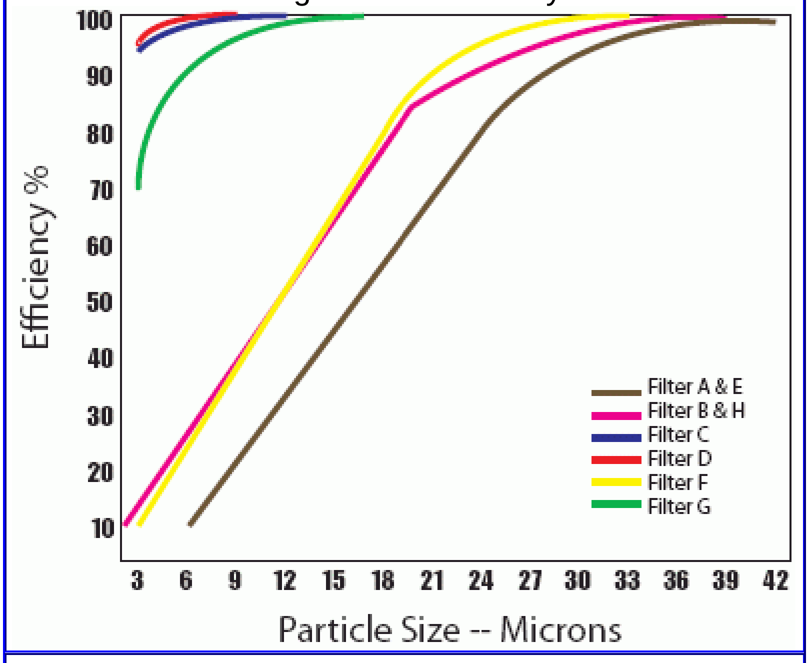
The SAE paper on filtration discusses the introduction of synthetic fibers into the oil filter market, which offer "the capability of achieving high levels of filtration without the traditional sacrifice of dirt holding capacity and increased flow restriction." Today, a new pinnacle has been reached with synthetic nanofiber technology and AMSOIL Ea Oil Filters. While today's filters offer even greater performance, the message then was the same as it is now; removal of particles measuring 2 to 25µ is the key to controlling engine wear, and there is a direct correlation between oil filter efficiency and engine wear.

Test Results

To establish a relationship between levels of filtration and engine wear rates, the SAE used a variety of oil filter types in its tests. Three glass filters and one traditional cellulose- media filter were used in the diesel tests, while one cellulose, one glass and two glass/cellulose-blend filters were used in the gasoline engine tests. The micron rating of each oil filter was determined, and testing was conducted according to SAE guidelines.

Oil Filter Particle Retention Curves

Single Pass Efficiency



Engine Wear Rates

"The Filter Particle Retention Curves chart to the right shows the particle retention for each filter tested. The filters were tested at their 98 percent efficiency point and their single pass efficiency curves were determined by comparing the number of particles upstream from the filter with the number of particles downstream. The Engine Wear Rates charts demonstrate the correlation between superior oil filtration and reduced engine wear. The filters that provided superior efficiency also provided superior engine protection.

Conclusions

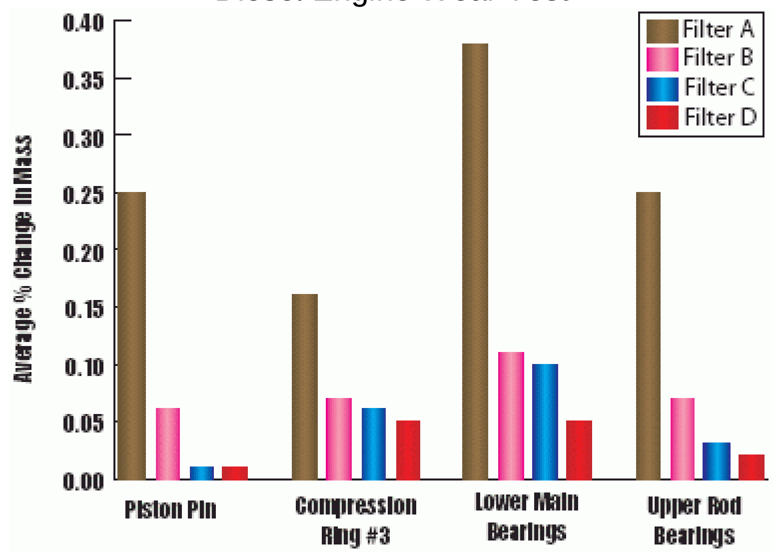
The SAE paper summarizes the test results with the following conclusions:

"Abrasive engine wear can be substantially reduced with an increase in filter single pass efficiency. Compared to a 40µ filter, engine wear was reduced by 50% with 30µ filtration. Likewise, wear was reduced by 70% with 15µ filtration.

"Controlling the abrasive contaminants in the range of 2 to 22µ in the lube oil is necessary for controlling engine wear.

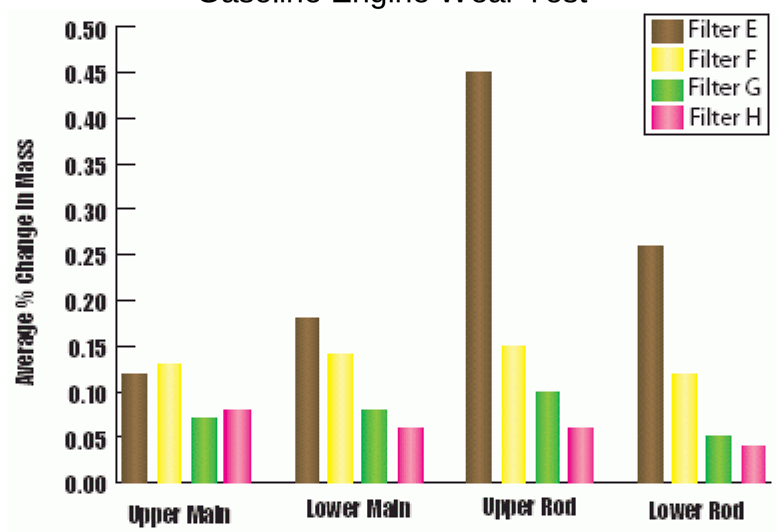
"The micron rating of a filter, as established in a single pass efficiency type test, does an excellent job in indicating the filter's ability to remove abrasive particles in the engine lube oil system."

Diesel Engine Wear Test



Engine Wear Rates

Gasoline Engine Wear Test



Motor Oil Viscosity Grades

What does the SAE Viscosity rating on your Motoroil bottle mean?
How do they come up with this rating . . .really?

Most of the time when viscosity is explained words are used that are too technical for the average person to quickly grasp. This leaves them still wondering what the viscosity numbers really mean on a bottle of motor oil. Simply put, viscosity is the oil's resistance to flow or, for the layman, an oil's speed of flow as measured through a device known as a viscometer. The thicker (higher viscosity) of an oil, the slower it will flow. You will see oil viscosity measurement in lube articles stated in kinematic (kv) and absolute (cSt) terms. These are translated into the easier to understand SAE viscosity numbers you see on an oil bottle.

OK . . .What does a 5W-30 do that an SAE 30 won't?

When you see a **W** on a viscosity rating it means that this oil viscosity has been tested at a ***Colder*** temperature. The numbers without the **W** are all tested at 210° F or 100° C which is considered an approximation of engine operating temperature. In other words, a SAE 30 motor oil is the ***same*** viscosity as a 10w-30 or 5W-30 at 210° (100° C). The difference is when the viscosity is tested at a much colder temperature. For example, a 5W-30 motor oil performs like a SAE 5 motor oil would perform at the cold temperature specified, but still has the SAE 30 viscosity at 210° F (100° C) which is engine operating temperature. This allows the engine to get quick oil flow when it is started cold verses dry running until lubricant either warms up sufficiently or is finally forced through the engine oil system. The advantages of a low **W** viscosity number is obvious. The quicker the oil flows cold, the less dry running. Less dry running means much less engine wear.

SAE Viscosity Chart (High Temp) 100° C (210° F)		
SAE Viscosity	**Kinematic (cSt) 100° C Min**	**Kinematic (cSt) 100° C Max**
20	**5.6**	**<9.3**
30	**9.3**	**<12.5**
40	**12.5**	**<16.3**
50	**16.3**	**<21.9**
60	**21.9**	**<26.1**

Winter or "W" Grades			
SAE Viscosity	**Low Temp (°C) Viscosity cP**		**Kinematic (cSt) 100° C Min**
	Cranking Max	**Pumping Max (NYS)**	
0W	**3,250 @ -**	**60,000 @ -**	**3.8**

	30	40	
5W	3,500 @ -25	60,000 @ -35	3.8
10W	3,500 @ -20	60,000 @ -30	4.1
15W	3,500 @ -15	60,000 @ -25	5.6
20W	4,500 @ -10	60,000 @ -20	5.6
25W	6,000 @ -5	60,000 @ -15	9.3

Obviously, cold temperature or **W** ratings are tested differently than regular SAE viscosity ratings. Simply put, these tests are done with a different temperature system. There is a scale for the **W**, or winter viscosity grades and, depending on which grade is selected, testing is done at different temperatures. See the Tables to the right below for more information.

Basically to determine non-winter grade viscosity using a viscometer a measured amount of oil at 100° C is allowed to flow through an orifice and timed. Using a table they determine SAE viscosity based on different ranges. Thicker or heavy viscosity oils will take longer to flow through the orifice in the viscometer and end up in higher number ranges such as SAE 50 or SAE 60 for example. If an oil flows through faster being thinner/lighter then it will wind up in a low number range such as SAE 10 or SAE 20 for example. Occasionally it is possible for an oil to barely fall into one viscosity range. For example, an oil is barely an SAE 30 having a time that puts it on the very low side. Then another oil is timed to be an SAE 20 on the high side not quite breaking into the SAE 30 numbers. Technically speaking these oils will be close to the same viscosity even though one is an SAE 20 and the other an SAE 30. But you have to draw the line somewhere and that's how the SAE system is designed. Another system takes more accurate numbers into account known as cSt abbreviated for centistokes. You'll see these numbers used often for industrial lubricants such as compressor or hydraulic oils. The table at the right, ***SAE Viscosity Chart (High Temp)***, shows the equivalents for cSt and SAE viscosity numbers. You'll see the ranges for cSt compared to SAE numbers. An oil that is 9.2 cSt will be nearly the same viscosity as an oil that is 9.3 cSt, yet one is an SAE 20 and the other is an SAE 30. This is why the cSt centistokes numbers more accurately show oil viscosity.

Now if you look at the table labeled ***Winter or "W" Grades***, you can get valuable information on how the **W** or winter grade viscosities are measured. Basically, as shown by the chart, when the oil is reduced to a colder temperature it is measured for performance factors. If it performs like a SAE 0 motor oil at the colder temperature, then it will receive the SAE 0W viscosity grade. Consequently, if the motor oil performs like a SAE 20 motor oil at the reduced temperatures (the scale varies - see the chart), then it will be a SAE 20W motor oil.

If a motor oil passes the cold temperature or **W** (winter grade) specification for a SAE 15W and at 210° F (100° C) flows through the viscometer like a SAE 40 motor oil, then the label will read 15W-40. Getting the picture? Consequently, if the motor oil performs like a SAE 5 motor oil on the reduced temperature scale and flows like a SAE 20 at 210° F (100° C), then this motor oil's label will read 5W-20. And so forth and so on!

I can't tell you how many times I have heard someone, usually an auto mechanic, say that they wouldn't use a 5W-30 motor oil because it is, "Too thin." Then they may use a 10W-30 or SAE 30 motor oil. At engine operating temperatures these oils are the same. The only time the 5W-30 oil is "thin" is at cold start up conditions where you need it to be "thin."

So how do they get a motor oil to flow in the cold when it is a thicker viscosity at 210° F?

The addition of Pour Point Depressant additives (VI) keep the paraffin in petroleum base oils from coalescing together when temperature drops. Pour Point Depressants can keep an oil fluid in extreme cold temperatures, such as in the arctic regions. We will not go into Pour Point Depressing additives at this time except to say they are only used where temperatures are very extreme to keep the motor oil from becoming completely immobilized by the cold temperature extreme. For now we will just discuss the Viscosity Improvers (VI) additives.

Why don't we just use a SAE 10 motor oil so we can get instant lubrication on engine start up?

The reason is simple: it would be a SAE 10 motor oil at 210° F! The lower the viscosity, the more wear will inevitably occur. This is why it is best to use the proper oil viscosity recommended by the auto manufacturer as it will protect hot and at cold start ups. Obviously a 10W-10 motor oil won't have the film strength to prevent engine wear at full operating temperature like a 5W-20, 10W-30 or 5W-30 motor oil for example.

The VI additives have the effect of keeping the oil from thinning excessively when heated. The actual mechanics of this system are a little more complex in that these additives are added to a *thinner* oil so that it will be fluid at a cold temperature. The VI additives then prevent thinning as the oil is heated so that it now can pass the SAE viscosity rating at 210. For example; if you have a SAE 10 motor oil it will flow like a 10W at the colder temperature. But at 210 degrees it will be a SAE 10 giving us a 10W-10 or SAE 10 viscosity rating. Obviously this is good at cold start up, but terrible at engine operating temperature especially in warmer climates. But by adding the VI additives we can prevent the oil from thinning as it is heated to achieve higher viscosity numbers at 210 degrees. This is how they make a petroleum based motor oil function for the 10W-30 rating. The farther the temperature range, like with a 10W-40, then more VI additives are used. With me so far? Good, now for the bad news.

Drawbacks of Viscosity Improving additives

Multi-grade motor oils perform a great service not being too thick at cold startup to prevent engine wear by providing more instantaneous oil flow to critical engine parts. However, there is a draw back. These additives shear back in high heat or during high shear force operation and break down causing some sludging. What's worse is once the additive begins to be depleted the motor oil no long resists thinning so now you have a *thinner* motor oil at 210 degrees. Your 10W-30 motor oil can easily become a 10W-20 or even a SAE 10 (10W-10) motor oil. I don't have to tell you why that is bad. The more VI additives the worse the problem which is why auto manufacturers decided to steer car owners away from motor oils loaded with VI additives like the 10W-40 and 20W-50 viscosities.

The less change a motor oil has from high to low temperatures gives it a high ***Viscosity Index***. Synthetic motor oils that are made from Group IV (4) PAO base stocks have Viscosity Indexes of more than 150 because they are manufactured to be a lubricant and don't have the paraffin that causes the thickening as they cool. But petroleum based motor oils (Group I (1) & II (2)) usually have Viscosity Indexes of less than 140 because they tend to thicken more at the colder temperature due to the paraffin despite the addition of Viscosity Improving additives. The higher the Viscosity Index number the less thinning and thickening the motor oil has. In other words, high number good, low number bad. Low numbers thicken more as they cool and thin more hot. You see these Viscosity Index ratings posted on data sheets of motor oils provided by the manufacturer.

As already mentioned, VI improving additives can shear back under pressure and high heat conditions leaving the motor oil unable to protect the engine properly under high heat conditions and cause sludging. Also there is a limit to how much viscosity improving additives can be added without affecting the rest of the motor oil's chemistry. Auto manufacturers have moved away from some motor oils that require a lot of viscosity improving additives, like the 10W-40 and 20W-50 motor oils, to blends that require less viscosity additives like the 5W-20, 5W-30 and 10W-30 motor oils. Because stress loads on multi viscosity motor oils can also cause thinning many racers choose to use a straight weight petroleum racing motor oil or a PAO based Synthetic which do not have the VI additives. But only the Group IV (4) PAO based synthetics generally don't need VI additives. Read on to learn why:

What about synthetic motor oils? Do they need Viscosity Additives?

Group IV (4) and Group V (5) base oil (synthetics) are chemically made from uniform molecules with no paraffin and generally don't need Viscosity Additives. However, in recent years Group III (3) based oils have been labeled "synthetic" through a legal loophole. These are petroleum based Group II (2) oils that have had the sulfur refined out making them more pure and longer lasting. Group III (3) "synthetic" motor oils must employ Viscosity Additives being petroleum based.

Group V (5) based synthetics are usually not compatible with petroleum or petroleum fuels and have poor seal swell. These are used for air compressors, hydraulics, etc. It's the Group IV (4) PAO based synthetics that make the best motor oils. They are compatible with petroleum based oils and fuels plus they have better seal swell than petroleum. Typically PAO based motor oils use no Viscosity Index additives yet pass the multi-grade viscosity requirements as a straight weight!

This makes them ideal under a greater temperature range. One advantage of not having to employ Viscosity Improving additives is having a more pure undiluted lubricant that can be loaded with more longevity and performance additives to keep the oil cleaner longer with better mileage/horsepower.

How do I know what motor oil is a Group IV (4) based PAO synthetic motor oil?

As more and more large oil companies switched their "synthetic" motor oils to the less expensive/more profitable Group III (3) base stocks it has become much easier to identify which are PAO based true synthetic. Of the large oil companies, only Mobil 1 Extended Performance, as of this writing (12-16-2012), is still a PAO based true synthetic. The rest, including regular Mobil 1 and Castrol Edge have switched to the cheaper/more profitable Group III (3) petroleum based "synthetic" motor oil. AMSOIL Synthetic Motor Oils are PAO based true synthetic motor oils with the exception of the short oil drain OE and XL synthetic motor oils sold at some Auto Parts Stores and Quick Oil Change Centers. This leaves more than 20 PAO based true synthetic motor oils manufactured and marketed by AMSOIL with only a few Group III (3) based synthetic motor oils identified by the "OE" and "XL" product name.

So as you can see, the average performance of motor oils can be affected by how they change during their service life. Multi grade petroleum can lose viscosity and thin causing accelerated wear as the VI additives shear back. Straight weight petroleum (i.e. SAE 30, SAE 40) thicken a lot as they cool meaning longer time before lubricant reaches critical parts on cold starts, but have no VI additives so they resists thinning. However, they can degrade and thicken as heat and by products of combustion affect the unsaturated chemistry. Group III (3) synthetics resists this degradation much better, but being petroleum based employ some VI additives which is a negative and typically don't have as good performance in the volatility viscosity retention areas. Only the Group IV (4) PAO base synthetics have the saturated chemistry to resist degrading when exposed to the by-products of combustion and heat, plus typically employ no VI additives making them very thermally stable for longer periods. For this reason the Group IV (4) synthetics maintain peak mileage and power throughout their service life

Modern motor oils are a marvel of chemistry to be sure. There are a lot more additives in play than the few mentioned here. The API (American Petroleum Institute - sets oil standards in the U.S.), ILSAC (International Lubricants Standardization and Approval Committee - U.S.& Japanese auto/truck manufacturers standards for motor oil) and ACEA (Association des Constructeurs Europeens d'Automobiles - European auto/truck manufacturer oil standards) are some of the different organizations you will see providing rating information on the service grades of different motor oils. Plus there are some auto manufacturers like Mercedes, BMW and Volkswagen that have unique oil standards for their cars. You need to read your owner's manual clearly to be sure you are using the proper oil for your application.
Some of these organizations, such as the API and ILSAC, have reduced friction modifier amounts in order to extend the life of catalytic converters and reduce pollution. These will increase wear but will be still within the "acceptable wear" range. Because of the increased wear and expense of licensing these oils some companies will not certify for API & ILSAC in order to achieve a higher level of performance. People with older engines that do not have roller cams find these oils especially attractive to maintain a reduced level of engine wear. AMSOIL only has 5 motor oils certified for the API & ILSAC for this reason (the four XL-7500 Branded motor oils and the semi-synthetic 15W-40 PCO). The rest of the nearly 30 synthetic motor oils are not certified in order to maintain the higher levels of friction modifier to maintain the enhanced level of performance necessary for their targeted market. In other words, the less expensive motor oils made by AMSOIL are API & ILSAC certified while the high end more expensive performance motor oils are not. One reason companies like AMSOIL and Mobil are at odds with the reduced friction modifier standards is they don't take into consideration the reduced volatility of PAO based motor oils which leads to much less pollution and thereby less problems for the catalytic converter. Even with the full wear preventing additives these oils do not produce the pollution of petroleum motor oils. For this reason AMSOIL has left the friction modifier levels high and skips certification for these higher performing motor oils. For more information read these:

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Motor Oil Quality Progresses with Engine Technology

ILSAC Standards for Passenger Car Motor Oil		
GF-5	Introduced in October 2010	For 2011 and older vehicles, designed to provide improved high temperature deposit protection for pistons and turbochargers, more stringent sludge control, improved fuel economy, enhanced emission control system compatibility, seal compatibility, and protection of engines operating on ethanol-containing fuels up to E85
GF-4	Obsolete	Valid until September 30, 2011. Use GF-5 where GF-4 is recommended
GF-3	Obsolete	Use GF-5 where GF-3 is recommended
GF-2	Obsolete	Use GF-5 where GF-2 is recommended
GF-1	Obsolete	Use GF-5 where GF-1 is recommended

API Engine Oil Service Category Chart

"S"	Status	Service Gasoline Engines
SN	Introduced October 2010	Category SM were ntroduced in October 2010 for 2011 and older vehicles, designed to provide improved high temperature deposit protection for pistons, more stringent sludge control, and seal compatibility. API SN with Resource Conserving matches ILSAC GF-5 by combining API SN performance with improved fuel economy, turbocharger protection, emission control system compatibility, and protection of engines operating on ethanol-containing fuels up to E85
SM	Introduced on 30 November 2004	Category 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. Some SM oils may also meet the latest ILSAC specification and/or qualify as Energy Conserving. They may be used where API Service Category SJ and SL earlier categories are recommended.
SL	2001 Gasoline Engine Service	Category SL was adopted to describe engine oils for use in 2001. It is for use in service typical of gasoline engines in present and earlier passenger cars, sports utility vehicles, vans and light trucks operating under vehicle manufacturers recommended maintenance procedures. Oils meeting API SL requirements have been tested according to the American Chemistry Council (ACC) Product Approval Code of Practice and may utilize the API Base Oil Interchange and Viscosity Grade Engine Testing Guidelines. They may be used where API Service Category SJ and earlier categories are recommended..
SJ	1997 Gasoline Engine Service	Category SJ was adopted in 1996 to describe engine oil first mandated in 1997. It is for use in service typical of gasoline engines in present and earlier passenger cars, vans, and light trucks operating under manufacturers recommended maintenance procedures. Oils meeting API SH requirements have been tested according to the American Chemistry Council (ACC) Product Approval Code of Practice and may utilize the API Base Oil Interchange and Viscosity Grade Engine Testing Guidelines. They may be used where API Service Category SH and earlier categories are recommended.

"C"	Status	Service Diesel Engines
CJ-4	Current - 2006	Introduced in 2006 for high-speed four-stroke engines. Designed to meet 2007 on-highway exhaust emission standards. CJ-4 oils are compounded for use in all applications with diesel fuels ranging in sulphur content up to 500ppm (0.05% by weight). However, use of these oils with greater than 15ppm sulfur fuel may impact exhaust after treatment system durability and/or oil drain intervals. CJ-4 oils are effective at sustaining emission control system durability where particulate filters and other advanced after treatment systems are used. CJ-4 oils exceed the performance criteria of CF-4, C-4, AH-4 and C-4.
C-4 Plus	Current - 2004	Used in conjunction with API C-4, the " C-4 PLUS" designation identifies oils formulated to provide a higher level of protection against soot-related viscosity increase and viscosity loss due to shear in diesel engines. Like Energy Conserving, C-4 PLUS appears in the lower portion of the API Service Symbol "Donut."
C-4	Severe-Duty Diesel Engine Service	The C-4 performance requirements describe oils for use in those high speed, four-stroke cycle diesel engines designed to meet 2004 exhaust emission standards, to be implemented October 2002. These oils are compounded for use in all applications with diesel fuels ranging in sulfur content up to 0.05% by weight. These oils are especially effective at sustaining engine durability where Exhaust Gas Recirculation (EGR) and other exhaust emission componentry may be used. Optimum protection is provided for control of corrosive wear tendencies, low and high temperature stability, soot handling properties, piston deposit control, valve train wear, oxidative thickening, foaming and viscosity loss due to shear. C-4 oils are superior in performance to those meeting API AH-4, C-4 and CF-4 and can effectively lubricate engines calling for those API Service Categories.
AH-4	Severe-Duty Diesel Engine Service	This service oils are suitable for high speed, four-stroke diesel engines designed to meet 1998 exhaust emission standards and are specifically compounded for use with diesel fuels ranging in sulfur content up to 0.5% weight. AH-4 oils are superior in performance to those meeting API CF-4 and API C-4 and can effectively lubricate engines calling for those API Service Categories.
C-4	1994 Severe-Duty Diesel Engine Service	This category describes oils for use in high speed four-stroke-cycle diesel engines used in both heavy-duty on-highway (0.05% wt sulfur fuel) and off-highway (less than 0.5% wt sulfur fuel) applications. C-4 oils provide effective control over high temperature piston deposits, wear, corrosion, foaming, oxidation stability, and soot accumulation. These oils are specially effective in engines designed to meet 1994 exhaust emission standards and may also be used in engines requiring API Service Categories CD, CE, and CF-4. Oils designed for this service have been in existence since 1994.

CF	Indirect-Injected Diesel Engine Service	Service typical of indirect-injection diesel engines and other diesel engines that use a broad range of fuel types, including those using fuel with high sulfur content; for example, over 0.5% wt. Effective control of piston deposits, wear and copper-containing bearing corrosion is essential for these engines, which may be naturally aspirated, turbocharged or supercharged. Oils designated for this service have been in existence since 1994 and may be used when API Service Category CD is recommended.
CF-4	1990 Diesel Engine Service	Service typical of high speed, four-stroke cycle diesel engines. API CF-4 oils exceed the requirements for the API CE category, providing improved control of oil consumption and piston deposits. These oils should be used in place of API CE oils. They are particularly suited for on-highway, heavy-duty truck applications. When combined with the appropriate S category, they can also be used in gasoline and diesel powered personal vehicles i.e., passenger cars, light trucks and vans when recommended by the vehicle or engine manufacturer.