Back

Oil Viscosity

Weighing in on engine lubrication

by Wayne Scraba

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Most people are familiar with oil's viscosity rating—10W40, for example. However, very few may know that the "W" refers to "winter," not "weight." And most of us have no idea what the weight-rating numbers actually mean other than that the vehicle's manufacturer specifies a particular viscosity.

Oil Duties

Inside an engine, oil is in a Catch-22 scenario: it has to seal rings and valves, but it also must reduce friction. In simple terms, oil has to accomplish two functions that have directly opposite requirements.

The viscosity of any oil changes with temperature. The higher the temperature, the lower the viscosity—the oil thins out. On the flipside, the lower the temperature, the higher the viscosity. Because of this, the Society of Automotive Engineers (SAE) has established a series of viscosity classifications that establish oil performance at 100 and 0 degrees Celsius (212 and 32 degrees Fahrenheit, respectively).

Highs & Lows

Low-viscosity oils flow better than high-viscosity ones—the lighter-weight fluid is easier to pump and therefore circulates faster through the engine's various galleries. Low-viscosity oils also maintain a lower oil pressure, but the oil pump delivers a greater volume through the galleries than it would with thicker (higher-viscosity) oils. Heavier oils also tend to operate at higher temperatures because the oil pump has to work harder to force the lubricant through the system. Oil does not compress readily, so the added pressure increases the temperature. In the end, high-viscosity oils maintain a higher oil pressure, but the pump delivers a smaller volume of oil.

Multigrades

Multigrade oils typically begin as base oils, such as 10W. Then viscosity-index modifiers (polymers) are added in an effort to stabilize the viscosity. This allows a 10W40 oil to flow like a 10W at cold temperatures and a 40W at higher temperatures. In other words, multigrade oils are formulated to pass viscosity tests across a range of weights. For example, 10W30 meets the requirements for 10-weight at cold temperatures and 30-weight at high temps.

The multigrade oils' viscosity modifiers are long-chain molecules that lessen the change of viscosity with temperature variance. In the past, the polymer additives (used to thicken the oil) were sometimes susceptible to viscosity loss. Permanent viscosity loss occurred when high shear forces (such as the relationship between the main bearings and the crankshaft) actually break the polymer molecules into less-effective smaller pieces. On a similar note, temporary viscosity loss also occurred when the polymer molecules aligned themselves in order to create a path of least resistance.

Fortunately, today's additive packages have improved oil's shear-resistance. However, oils with the same rating from different manufacturers can exhibit different viscosity ratings in an operating engine, depending on the shear stability of their viscosity-modifying additives.

For technoids, weights are defined thusly (stokes and centistrokes are measurements of viscosity):

"SAE 30 is SAE 30 no matter what the "W" prefix number is: 0W, 5W or 10W. This viscosity in centistokes (cSt) @ 100 degrees C is with the minimum of 9.3 cSt and a maximum of 12.5 cSt.

"SAE 40 is SAE 40 no matter what the "W" prefix number is: 5W, 10W, 15W or 20W. The viscosity @ 100 degrees C is within the minim of 12.5 cSt and a maximum of 16.3 cSt.

"SAE 50 is SAE 50 no matter what the "W" prefix number is: 5W, 10W, 15W or 25W. The viscosity @ 100 degrees C is within the minimum of 16.3 cSt and a maximum of 21.9 cSt.

"SAE 60 is SAE 60 no matter what the "W" prefix number is: 10W, 15W or 25W. The viscosity @ 100 degrees C is within the minimum of 21.9 cSt and a maximum of 26.1 cSt.

"There is no SAE 70 and no one is likely to make one with a "W" prefix number although it is possible using a synthetic base oil. This viscosity is identified as Grade 70. The viscosity @ 100 degrees C has a minimum of 26.1 cSt and no maximum."

The difference between a multigrade and a singlegrade oil: The singlegrade can't pass the low temperature viscosity test. If it did meet one of the following "W" viscosities, it would be a multigrade.

Singlegrade oils will become obsolete for performance engines in the future. We dropped SAE 30 and SAE 40 because SAE 10W40 does everything 30 or 40 can do—and some things the straight grades can't do—like increasing horsepower. If an off-roader doesn't like 10W40, then use 20W50. It can do everything a 10W40 can do except pass the sub-zero viscosity test at -20 degrees C.

Multigrade viscosities are run at six different sub-zero temperatures. When a racing-oil designer puts a formula together, he has to know the viscosity at 100 degrees C of every component in the additive composition. He has to have a target viscosity objective for the finished oil in each SAE grade. Once a formula is established, the technician who supervises the blending has to duplicate this formula in the correct proportions every time the product is blended. The viscosity at 100 degrees C has a plus or minus written into the oil's quality-control specification.

Multi-Viscosity

One oil manufacturer claims that "some people in the industry use multi-viscosity as if it means the same thing as multigrade. An oil cannot be multi-viscosity, but it can be multigrade by meeting the viscosity requirements for SAE 30, 40, 50 or 60 and one of the sub-zero "W" viscosity requirements. At one time, some oil companies labeled oils SAE 10W, 20W30—as if the oil could be 10W and 20W at the same time. This is impossible because 10W is measured at -20 degrees C and 20W is measured at -10 degrees C, which eliminates the multi-viscosity theory."

API Numbers

Shortly after WWII, the American Petroleum Institute (API) developed a system that established three basic types of engine oils: regular, premium and heavy-duty. Naturally, three oil classifications could never hope to cover all of the different applications ranging from conventional passenger cars to heavy-duty trucks. The API eventually realized that other variables had to be considered, such as the type of engine and its usage. In 1952, the API launched the service classifications system.

The API system revolves around two general classification: S for Service (typical passenger cars and light trucks) and C for commercial applications (typical diesel equipment). The breakdown of "S" varieties is as follows:

SA: This is a plain mineral oil that doesn't contain additives common in today's high-tech lubricants. This oil was primarily used in the 1920s and is obsolete today.

SB: Lubes that contain anti-wear and oxidation inhibitors as well as corrosion inhibitors. This oil was primarily in use prior to 1964, was created for vehicles that saw moderate conditions and is obsolete today.

SC: This classification was originally recommended for use in 1964-67 vehicles. It contains additives that control rust, wear, corrosion and engine deposits. It too is now obsolete.

SD: SD lubes were recommended for use in 1968-70 vehicles as well as certain post-1970 passenger cars. This oil contains the same additive packages as the SC class and can be used in place of it. SD is obsolete today.

SE: This category was recommended for certain 1971 vehicles as well as most 1972 vehicles. This classification offered more protection than the SD group of lubricants and was suitable for severe-duty applications. This classification is used in place of SD oils, but it is now obsolete.

SF: Recommended with 1988 and older passenger vehicles. This oil has superior anti-wear properties and enhanced oxidation stability over SE lubricants. It too is obsolete today.

SG: The SG rating was introduced in 1989 and combined the performance properties of the commercial rating CC (lubricants designed for use in supercharged/turbocharged diesel applications in moderate to severe service). Its designated use is for 1993 and older engines, and is also obsolete.

SH: Now obsolete, SH was designed for 1996 and older engines.

SJ: Introduced in 1996, this rating is for all automotive engines, early 2001 and older and is still current.

SL: This rating is for all gasoline engines currently in use. SL oils are manufactured for better high-temperature deposit control and lower oil consumption. Some SL oils also qualify as "Energy Conserving." SL is the most current of all categories. Look shortly for the soon-to-be-announced SM

Conserving." SL is the most current of all categories. Look shortly for the soon-to-be-announced SM category.

Generally speaking, think of the API system as a blueprint for oil. In order to gain an API classification, oil manufacturers have to follow a set of limitations. This creates a few problems for oil companies, especially those who produce racing oils. Race oil must conform to viscosity-grade standards but not to those for chemical-additive composition and base-oil composition. That's why you'll find several brands of race oil without API classifications.

To get the most from your engine oil, always follow the vehicle manufacturer's recommendation for oil change intervals and refer to your owner's manual for the type of oil to use in your specific vehicle, being sure to choose the correct SAE viscosity and the recommended API category. And—as always—make sure to properly and safely discard your used motor oil. For more information about disposal, contact: www.recycleoil.org.