

MOTOR OIL Grades

The [Society of Automotive Engineers](#) (SAE) has established a numerical code system for grading motor oils according to their [viscosity](#) characteristics. SAE viscosity grading includes the following, from low to high viscosity: 0, 5, 10, 15, 20, 25, 30, 40, 50 or 60. The numbers 0, 5, 10, 15 and 25 are suffixed with the letter W, designating they are "winter" (not "weight") or cold-start viscosity, at lower temperature. The number 20 comes with or without a W, depending on whether it is being used to denote a cold or hot viscosity grade. The document SAE J300 defines the viscometrics related to these grades.

[Kinematic viscosity](#) is graded by measuring the time it takes for a standard amount of oil to flow through a standard orifice, at standard temperatures. The longer it takes, the higher the viscosity and thus higher SAE code.

The SAE has a separate viscosity rating system for gear, axle, and manual transmission oils, SAE J306, which should not be confused with engine oil viscosity. The higher numbers of a gear oil (e.g., 75W-140) do not mean that it has higher viscosity than an engine oil.

In anticipation of new lower engine oil viscosity grades, to avoid confusion with the "winter" grades of oil the SAE adopted SAE 16 as a standard to follow SAE 20 instead of SAE 15. Regarding the change Michael Covitch of Lubrizol, Chair of the SAE International Engine Oil Viscosity Classification (EOVC) task force was quoted stating "If we continued to count down from SAE 20 to 15 to 10, etc., we would be facing continuing customer confusion problems with popular low-temperature viscosity grades such as SAE 10W, SAE 5W, and SAE 0W," he noted. "By choosing to call the new viscosity grade SAE 16, we established a precedent for future grades, counting down by fours instead of fives: SAE 12, SAE 8, SAE 4." ^[9]

Single-grade

A single-grade engine oil, as defined by SAE J300, cannot use a polymeric [Viscosity Index Improver](#) (also referred to as Viscosity Modifier) additive. SAE J300 has established eleven viscosity grades, of which six are considered Winter-grades and given a W designation. The 11 viscosity grades are 0W, 5W, 10W, 15W, 20W, 25W, 20, 30, 40, 50, and 60. These numbers are often referred to as the "weight" of a motor oil, and single-grade motor oils are often called "straight-weight" oils.

For single winter grade oils, the dynamic viscosity is measured at different cold temperatures, specified in J300 depending on the viscosity grade, in units of mPa·s, or the equivalent older non-SI units, [centipoise](#) (abbreviated cP), using two different test methods. They are the Cold Cranking Simulator (ASTM D5293) and the Mini-Rotary Viscometer (ASTM D4684). Based on the coldest temperature the oil passes at, that oil is graded as SAE viscosity grade 0W, 5W, 10W, 15W, 20W, or 25W. The lower the viscosity grade, the lower the temperature the oil can pass. For example, if an oil passes at the specifications for 10W and 5W, but fails for 0W, then that oil must be labeled as an SAE 5W. That oil cannot be labeled as either 0W or 10W.

For single non-winter grade oils, the kinematic viscosity is measured at a temperature of 100 °C (212 °F) in units of mm²/s (millimeter squared per second) or the equivalent older non-SI units, [centistokes](#) (abbreviated cSt). Based on the range of viscosity the oil falls in at that temperature, the oil is graded as SAE viscosity grade 20, 30, 40, 50, or 60. In addition, for SAE grades 20, 30, and 1000, a minimum viscosity measured at 150 °C (302 °F) and at a high-shear rate is also required. The higher the viscosity, the higher the SAE viscosity grade is.

Multi-grade

The temperature range the oil is exposed to in most vehicles can be wide, ranging from cold temperatures in the winter before the vehicle is started up, to hot operating temperatures when the vehicle is fully warmed up in hot summer weather. A specific oil will have high viscosity when cold and a lower viscosity at the engine's operating temperature. The difference in viscosities for most single-grade oil is too large between the extremes of temperature. To bring the difference in viscosities closer together, special [polymer](#) additives called [viscosity index improvers](#), or VIIs are added to the oil. These additives are used to make the oil a *multi-grade* motor oil, though it is possible to have a multi-grade oil without the use of VIIs. The idea is

to cause the multi-grade oil to have the viscosity of the base grade when cold and the viscosity of the second grade when hot. This enables one type of oil to be used all year. In fact, when multi-grades were initially developed, they were frequently described as *all-season oil*. The viscosity of a multi-grade oil still varies logarithmically with temperature, but the slope representing the change is lessened. This slope representing the change with temperature depends on the nature and amount of the additives to the base oil.

The SAE designation for multi-grade oils includes two viscosity grades; for example, *10W-30* designates a common multi-grade oil. The first number '10W' is the viscosity of the oil at cold temperature and the second number is the viscosity at 100 °C (212 °F). The two numbers used are individually defined by SAE J300 for single oils. Therefore, an oil labeled as 10W-30 must pass the SAE J300 viscosity grade requirement for both 10W and 30, and all limitations placed on the viscosity grades (for example, a 10W-30 oil must fail the J300 requirements at 5W). Also, if an oil does not contain any VIIs, and can pass as a multi-grade, that oil can be labeled with either of the two SAE viscosity grades. For example, a very simple multi-grade oil that can be easily made with modern base oils without any VII is a 20W-20. This oil can be labeled as 20W-20, 20W, or 20. Note, if any VIIs are used however, then that oil cannot be labeled as a single grade.

Breakdown of VIIs under shear is a concern in motorcycle applications, where the [transmission](#) may share lubricating oil with the motor. For this reason, synthetic oil or motorcycle-specific oil is sometimes recommended. The necessity of higher-priced motorcycle-specific oil has also been challenged by at least one consumer organization.
