SAE Viscosity Grades for Engine Oils[2] – SAE J300 Dec 99

SAE Viscosity Grade	Low Temperature Viscosities		High Temperature Viscosities		
	Cranking (cP) max at temp °C	Pumping (cP) max with no yield stress at	Low Shear Rate Kinematic (cSt) at 100°C Minimum	Low Shear Rate Kinematic (cSt) at 100°C Maximum	High Shear Rate (cP) at 150°C Minimum
0W	6200 at -35	60,000 at -40	3.8	...	...
5W	6600 at -30	60,000 at -35	3.8	...	...
10W	7000 at -25	60,000 at -30	4.1	...	...
15W	7000 at -20	60,000 at -25	5.6	...	...
20W	9500 at -15	60,000 at -20	5.6	...	...
25W	13,000 at -10	60,000 at -15	9.3	...	...
20			5.6	<9.3	2.6
30			9.3	<12.5	2.9
40			12.5	<16.3	2.9 (0W-40, 5W-40, 10W-40 grades)
40			12.5	<16.3	3.7 (15W-40, 20W-40, 25W-40, 40 grades)
50			16.3	<21.9	3.7
60			21.9	<26.1	3.7

Table 1

Viscosity and Temperature

For correct lubrication, viscosity is the single most important property of any lubricant. For correct lubrication to occur there must be two surfaces moving relative to each other, and the surfaces must be separated by a layer of lubricant. Clearances between the two surfaces will vary, and there will be a position of minimum clearance. Where the lubricant is squeezed from a position of greater clearance to the position of minimum clearance a lubricant wedge is formed, and the minimum viscosity to sustain the lubricant wedge can be calculated. This is the minimum viscosity required for correct lubrication.

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Viscosity is most commonly measured by timing how long it takes for the sample to flow, under gravity, between two marks in a thin tube. Because the viscosity of any fluid changes with temperature, the measuring temperature is critical.

The standard measuring temperature is 40°C for industrial lubricants and 100°C and lower temperatures for automotive lubricants. The lower temperatures depend on the actual viscosity grade being measured, as seen in tables 1 and 2 for crankcase and gear lubricants respectively.

Because the lubricant flows in this analytical method, the viscosity measured is called the lubricants' kinematic viscosity; the units of kinematic viscosity are Stokes or centiStokes (cSt) (because a Stoke is too large) and the viscosity is recorded as centi Stokes at the measuring temperature, eg, 100 cSt at 40°C.

For example, by changing from a monograde SAE 40 to a multigrade SAE 15W-40, fuel savings of between 4% and 5% can be expected

It is clear from tables 1 and 2 that viscosity changes with temperature. The rate of change of viscosity with temperature is called the lubricant's viscosity index commonly called VI – this is an arbitrary number originally determined by comparison with upper and low viscosity index fluids. Low VI fluids have a large rate of viscosity change with temperature, and the higher the VI the less the viscosity will change. Most industrial and monograde lubricants have a VI in the range of 80-100, and multigrades or cross grade lubricants have higher VI's.

Reducing friction

The optimum viscosity for any lubricated component or system can be calculated, but that viscosity will only hold for a specific operating temperature. If the temperature rises the viscosity will fall, with the result that complete separation of the lubricated surface cannot be maintained, and friction and wear will increase rapidly because the viscosity is too low. On the other hand if temperature drops, a thicker lubricant film is formed and energy is wasted shearing this abnormally thick oil film.

Viscosity index now becomes important because the

SAE Viscosity Grade	Maximum Temperature for Viscosity of 150,000 mPa-s, °C (Using ASTM D 2983)	Kinematic Viscosity at 100 °C, cSt (Using ASTM D 445)	
		Minimum	Maximum
70W	-55	4.1	...
75W	-40	4.1	...
80W	-26	7.0	...
85W	-12	11.0	...
80	...	7.0	<11.0
85	...	11.0	<13.5
90	...	13.5	<24.0
140	...	24.0	<41.0
250	...	41.0	...

Table 2

higher the lubricants VI, the wider the temperature range that the lubricant's viscosity will remain within the desired limits for that application. It is obvious that higher viscosity index lubricants have the potential to reduce friction in a system over monograde lubricants. This potential is less for industrial systems operating at a steady temperature, but will apply during start up and shut down, and if any temperature fluctuations do occur. The potential is significant in automotive applications.

For those who care

Modern engines all require multigrade lubricants, and the viscosity grades are continually being lowered to decrease friction in the engine. This is also true of gear lubricants. Many drivers on our roads still use monograde SAE 30 or SAE 40 lubricants in their cars engines. Simply changing this lubricant to an appropriate multigrade can generate significant energy savings. For example, by changing from a monograde SAE 40 to a multigrade SAE 15W-40, fuel savings of between 4% and 5% can be expected. Of course most motorists would not notice that relatively small change, and will probably use the advantage as extra power, thus seeing no difference in fuel consumption and being unaware of the extra power.

For those of us who care, by using the optimum viscosity lubricants, and driving sensibly, you will generate real savings in fuel consumption.

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