

Useful Technical Data and Charts

SAE Viscosity Grades for Engine Oil (SAE J300)

SAE Viscosity Grade	Low-Temperature Cranking Viscosity Maximum ⁽¹⁾	Low-Temperature (°C) Pumping Viscosity with No Yield Stress Maximum ⁽²⁾	Low-Shear-Rate Kinematic Viscosity at 100°C ⁽³⁾	High-Shear-Rate Viscosity at 150°C. Minimum ⁽⁴⁾
0W	6,200 mPa-s at – 35°C	60,000 mPa-s at -40°C	≥ 3.8 mm ² /s	-
5W	6,000 mPa-s at – 30°C	60,000 mPa-s at -35°C	≥ 3.8 mm ² /s	-
10W	7,000 mPa-s at – 25°C	60,000 mPa-s at -30°C	≥ 4.1 mm ² /s	-
15W	7,000 mPa-s at – 20°C	60,000 mPa-s at -25°C	≥ 5.6 mm ² /s	-
20W	9,500 mPa-s at – 15°C	60,000 mPa-s at -20°C	≥ 5.6 mm ² /s	-
25W	13,000 mPa-s at – 10°C	60,000 mPa-s at -15°C	≥ 9.3 mm ² /s	-
8	-	-	≥ 4.0 to < 6.1 mm ² /s	1.7 mPa-s
12	-	-	≥ 5.0 to < 7.1 mm ² /s	2.0 mPa-s
16	-	-	≥ 6.1 to < 8.2 mm ² /s	2.3 mPa-s
20	-	-	≥ 6.9 to < 9.3 mm ² /s	2.6 mPa-s
30	-	-	≥ 9.3 to < 12.5 mm ² /s	2.9 mPa-s
40	-	-	≥ 12.5 to < 16.3 mm ² /s	3.5 mPa-s (0W-40, 5W-40 and 10W-40 grades)
40	-	-	≥ 12.5 to < 16.3 mm ² /s	3.7 mPa-s (15W-40, 20W-40, 25W-40, 40 grades)
50	-	-	≥ 16.3 to < 21.9 mm ² /s	3.7
60	-	-	≥ 21.9 to < 26.1 mm ² /s	3.7

Test Methods

- (1) ASTM D5293
- (2) ASTM D4684
- (3) ASTM D445
- (4) ASTM D5481

API Base Oil Classifications

Group	Viscosity Index	Saturates		Sulfur	Other
I	≥ 80 to < 120	$< 90\%$	and/or	$> 0.03\%$	-
II	≥ 80 to < 120	$\geq 90\%$	and	$\leq 0.03\%$	-
III	≥ 120	$\geq 90\%$	and	$\leq 0.03\%$	-
IV					PAO (Polyalpha Olefin)
V					Everything else

ISO 3887 – Industrial Oil Viscosity Grade

Industrial Oil ISO Grade	Kinematic Viscosity at 40oC (ASTM D 445). mm ² /s		
	Mid-point	Minimum	Maximum
ISO VG 2	2.2	2.8	2.42
ISO VG 3	3.2	2.88	3.52
ISO VG 5	4.6	4.14	5.06
ISO VG 7	6.8	6.12	7.48
ISO VG 10	10	9	11
ISO VG 15	15	13.5	16.5
ISO VG 22	22	19.8	24.2
ISO VG 32	32	28.8	35.2
ISO VG 46	46	41.4	50.6
ISO VG 68	68	61.2	74.8
ISO VG 100	100	90	110
ISO VG 150	150	135	165
ISO VG 220	220	198	242
ISO VG 320	320	288	352
ISO VG 460	460	414	506
ISO VG 680	680	612	748
ISO VG 1000	1000	900	1100
ISO VG 1500	1500	1350	1650

Passenger Car Engine Oil Laboratory Test for API SN-RC/ILSAC GF-5 Categories

Requirements	Test Method	Properties	Unit	Limits SN-RC/GF-5
Viscosity Grades	SAE J300	All those that apply, typically SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30		Manufacturer sets targets within SAE J300
Foam Tests	ASTM D892, Option A	Sequence I, tendency/stability	ml	10/0 max
		Sequence II, tendency/stability	ml	50/0 max
		Sequence III, tendency/stability	ml	10/0 max
		Sequence IV, tendency/stability	ml	100/0 max
EOFT	ASTM D6795	Filterability	% flow reduction	50 max
EOWTT	ASTM D6794	Filterability 0.6% water	% flow reduction	50 max
		Filterability 1.0% water	% flow reduction	50 max
		Filterability 2.0% water	% flow reduction	50 max
		Filterability 3.0% water	% flow reduction	50 max
Aged Oil Low-temperature Pumpability	ASTM D4684	MRV TP-1 Apparent Viscosity and Yield Stress	mPa-s	< 60,000 with no yield stress
TEOST 33C	ASTM D6335	High temperature deposits	Total deposit weight, mg	30 max
TEOST MHT	ASTM D7097	High temperature deposits	Deposit weight, mg	35 max
Emulsion retention	ASTM D7563	Oil mixed with 10% water and 10% E85	0°C and 25°C @ 24 hours	No water separation
Homogeneity and Miscibility	ASTM D6922	Oil Compatibility	None	Pass
Gelation Index	ASTM D5133	Scanning Brookfield Viscosity, Yield Stress	Calculated	12 max
Volatility	ASTM D5800 ASTM D6417	Evaporation Loss (Noack) Simulated distillation (GC)	% off @ 250°C	15 max
			% off @ 371°C	10 max

TECHNICAL SECTION

Requirements	Test Method	Properties	Unit	Limits SN-RC/GF-5
Ball Rust Test Elastomer compatibility	ASTM D6557 ASTM D7216, Annex A2	Rust Rating	Average Gray Value	100 min
Polyacrylate Rubber ACM-1 (SAE J2643)	ASTM D471 ASTM D2240 ASTM D412	Volume Hardness Tensile Strength	% change pts % change	-5,9 -10,10 -40,40
Hydrogenated Nitrile HNBR-1 (SAE J2643)	ASTM D471 ASTM D2240 ASTM D412	Volume Hardness Tensile Strength	% change pts % change	-5,10 -10,5 -20,15
Silicone Rubber VMQ-1 (SAE J2643)	ASTM D471 ASTM D2240 ASTM D412	Volume Hardness Tensile Strength	% change pts % change	-5,40 -30,10 -50,5
Fluorocarbon Rubber FKM-1 (SAE J2643)	ASTM D471 ASTM D2240 ASTM D412	Volume Hardness Tensile Strength	% change pts % change	-2,3 -6,6 -65,10
Ethylene Acrylic Rubber AEM-1 (SAE J2643)	ASTM D471 ASTM D2240 ASTM D412	Volume Hardness Tensile Strength	% change pts % change	-5,30 -20,10 -30,30
Phosphorus	ASTM D4951	Phosphorus content	%	0.06 to 0.08
Sulfur	ASTM D4951	Sulfur content of SAE 0W and SW multigrades	%	0.5 max
Sulfur	ASTM D4951	Sulfur content of SAE 10W multigrades	%	0.6 max

Passenger Car Engine Oil Laboratory Test for API SN-RC/ILSAC GF-4 Categories

Requirements	Test Method	Properties	Unit	Limits SN-RC/GF-4
Viscosity Grades	SAE J300	All those that apply, typically SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30		Manufacturer sets targets within SAE J300
Foam Tests	ASTM D892, Option A	Sequence I, tendency/stability Sequence II, tendency/stability Sequence III, tendency/stability Sequence IV, tendency/stability	ml ml ml ml	10/0 max 50/0 max 10/0 max 100/0 max
Phosphorus	ASTM D4951	Phosphorus content	%	0.06 to 0.08
EOFT	ASTM D6795	Filterability	% flow reduction	50 max
EOWTT	ASTM D6794	Filterability 0.6% water Filterability 1.0% water Filterability 2.0% water Filterability 3.0% water	% flow reduction % flow reduction % flow reduction % flow reduction	50 max 50 max 50 max 50 max
TEOST MHT4	ASTM D7097	High temperature deposits	Deposit weight, mg	35 max
Homogeneity and Miscibility	ASTM D6922	Oil Compatibility	None	Pass
Gelation Index	ASTM D5133	Scanning Brookfield Viscosity, Yield Stress	Calculated	12 max
Volatility	ASTM D5800 ASTM D6417	Evaporation Loss (Noack) Simulated distillation (GC)	% off @ 250oC % off @ 371oC	15 max 10 max
Ball Rust Test	ASTM D6557	Rust Rating	Average Gray Value	100 min
Sulfur	ASTM D4951	Sulfur content of SAE 0W and SW multigrades	%	0.5 to 0.7
Aged Oil Low-temperature Pumpability	ASTM D4684	MRV TP-1 Apparent Viscosity and Yield Stress	mPa-s	< 60,000 with no yield stress

Passenger Car Engine Oil Test for API SJ and SL

Requirements	Test Method	Properties	Unit	Limits SN-RC/GF-4	
				SJ/EC GF-2	SL/EC GF-3
Viscosity Grades	SAE J300	All those that apply, typically SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30		Manufacturer sets targets within SAE J300	
Foam Tests	ASTM D892	Sequence I Sequence II Sequence III Sequence IV	ml initial Foam/ml after settling	10/0 max 50/0 max 10/0 max 200/50 max	10/0 max 50/0 max 10/0 max 100/0 max
Phosphorus	ASTM D4951	Phosphorus content	%	0.10 max	0.10 max
EOFT	ASTM D6795	0.6% water – with dry ice – % reduction in flow	%	50 max	50 max
EOWTT	ASTM D6794	0.6% water – without dry ice – % rate of change 1.0% water – without dry ice – % rate of change 2.0% water – without dry ice – % rate of change 3.0% water – without dry ice – % rate of change	% % % %	report report report report	50 max 50 max 50 max 50 max
TEOST 33C	ASTM D6335	Total Deposit, max	mg	60 max	Not Required
TEOST MHT4	ASTM D7097	High temperature deposits	mg	Not Required	45 max
Homogeneity and Miscibility	ASTM D6922	Oil Compatibility		Pass	Pass
Scanning Brookfield	ASTM D5133	Gelation Index		12 max	12 max
Volatility	ASTM D5800 ASTM D6417	Evaporation Loss (Noack) Simulated distillation (GC)	% %	22 max 17 max	15 max 10 max
BRT	ASTM D6557	Rust Rating	Gray Value	100 min	100 min

Heavy-Duty Diesel Engine Test Category For API CJ-4

Requirements	Test	Properties	Unit	Limits	
Viscosity Grades	SAE J300	All those that apply, typically SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30		Manufacturer sets targets within SAE J300	
High Temperature Corrosion, 135°C	ASTM D6594	Copper, used oil increase, max Lead, used oil increase, max Copper Strip Rating, max (D130) Tin increase, max	ppm ppm - ppm	20 120 3 Report	
Foaming	ASTM D892	Foaming/Settling, max Sequence I Sequence II Sequence III	ml ml ml	10/0 max 20/0 max 10/0 max	
Shear Stability	ASTM D7109	KV @ 100oC after 90-passes for SAE Xw40 KV @ 100oC after 90-passes for SAE XW30	cSt cSt	12.5 min 12.5 min	
Noack Volatility	ASTM D5800	Evap loss @ 250oC, Vis grades other than SAE 10W-30, max Evap loss @ 250oCm SAE 10W-30, max	% %	13 15	
High Temperature / High Shear	ASTM D5481	Viscosity at 150oC, min	mPa-s	3.5	
Sooted Oil MRV	ASTM D6896	180 hour sample from Mack T-11 or T-11A Viscosity @ -20oC, max Yield stress	cP Pa	25,000 < 35	
Chemical Limits	ASTM D874 ASTM D4951 ASTM D4951	Sulfated Ash, max Phosphorus, max Sulfur, max	% % %	1.0 0.12 0.4	
		Volume Change	Hardness	Tensile Strength	Elongation
Seal Compatibility (ASTM D7216)	Nitrile Silicone Polyacrylate FKM Vamac G	+5 / -3 +TMC1006 / - +5 / -3 +5 / -2 +TMC1006 / -3	+7 / -5 +5 / - TMC1006 +8 / -5 +7 / -5 +5 / -TMC1006	+10 / TMC1006 +10 / -45 +18 / -15 +10 / -TMC1006 +10 / -TMC1006	+ 10 / - TMC1006 +20 / -30 +10 / -35 +10 / TMC1006 +10 / - TMC1006

Heavy-Duty Diesel Engine Test Category For API CI-4 and CI-4 Plus

Requirements	Test	Properties	Unit	Limits	
Viscosity Grades	SAE J300	All those that apply, typically SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30		Manufacturer sets targets within SAE J300	
High Temperature Corrosion Bench Test	ASTM D6594	Copper, used oil increase, max Lead, used oil increase, max Copper Strip Rating, max (D130) Tin increase, max	ppm ppm - ppm	20 120 3 Report	
Foaming	ASTM D892 (Option A not allowed)	Foaming/Settling, max Sequence I Sequence II Sequence III	ml ml ml	10/0 max 20/0 max 10/0 max	
Shear Stability	ASTM D6278	After shear viscosity, SAE 10W-30, min After shear viscosity, SAE 15W-40, min	cSt cSt	9.3 12.5	
Noack Volatility	ASTM D5800	Evaporative loss at 250°C, max	%	15	
High Temperature / High Shear	ASTM D5481	Viscosity at 150°C, min	mPa-s	3.5	
Low Temperature Pumpability	ASTM D4684	Viscosity of 75h used oil sample from T-10 Test at -20°C, max	mPa-s	25,000	
	Modified D4684 (if yield stress)	Viscosity at -20°C, max Yield stress, max	mPa-s Pa	25,000 35	
Chemical Limits	ASTM D874 ASTM D4951 ASTM D4951	Sulfated Ash, max Phosphorus, max Sulfur, max	% % %	1.0 0.12 0.4	
		Volume Change	Hardness	Tensile Strength	Elongation
Seal Compatibility (ASTM D7216)	Nitrile Silicone Polyacrylate FKM	+5 / -3 +TMC1006/ +5 / -3 +5 / -3 +5 / -2	+7 / -5 +5 / -TMC1006 +8 / -5 +7 / -5	+10 / -TMC1006 +10 / -45 +18 / -15 +10 / TMC1006	+ 10 / - TMC1006 +20 / -30 +10 / -35 +10 / -TMC1006

Heavy Duty Diesel Engine Test Category for API CH-4

Requirements	Test	Properties	Unit	Limits
Viscosity Grades	SAE J300	All those that apply, typically SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30		Manufacturer sets targets within SAE J300
High Temperature Corrosion Bench Test	ASTM D6594	Copper, used oil increase, max Lead, used oil increase, max Copper Strip Rating, max (D130) Tin increase, max	ppm ppm - ppm	20 120 3 Report
Foaming	ASTM D892 (Option A not allowed)	Foaming/Settling, max Sequence I Sequence II Sequence III	ml ml ml	10/0 max 20/0 max 10/0 max
Shear Stability	ASTM D6278	After shear viscosity, SAE 10W-30, min After shear viscosity, SAE 15W-40, min	cSt cSt	9.3 12.5
Volatility	ASTM D5800 ASTM D2887 or ASTM D5480	Noack (SAE 10W-30) Noack (SAE 15W-40) or GCD (SAE 10W-30) GCD (SAE 15W-40)	% loss % loss % loss % loss	20 18 17 15

ASTM Standard Specifications for Diesel Fuel Oils – ASTM D975

Property	Test Method	Grade						No. 4-D
		No. 1-D S15	No. 1-D S500	No. 1-D S5000	No. 2-D S15	No. 2-D S500	No. 2-D S5000	
Flash Point, °C, min	D 93	38	38	38	52	52	52	55
Water & Sediment,% vol, max	D 2709	0.05	0.05	0.05	0.05	0.05	0.05	—
Distillation Temp., °C 90%, % vol recovered								
min	D 86	—	—	—	282	282	282	—
max		288	288	288	338	338	338	—
Kinematic Viscosity, mm ² /s at 40°C								
min		1.3	1.3	1.3	1.9	1.9	1.9	5.5
max	D 445	2.4	2.4	2.4	4.1	4.1	4.1	24.0
Ash % mass, max	D 482	0.01	Sul	0.01	0.01	0.01	0.01	0.01
Sulfur, ppm (µg/g) max								
% mass, max	D 5453	15	—	—	15	—	—	—
% mass, max	D 2622	—	—	—	—	0.05	—	—
Copper Strip corrosion rating, max (3 h at a min. control temperature of 50°C)	D 130	No. 3	No. 3	No. 3	No. 3	No. 3	No. 3	—
Cetane Number, min								
One of the following properties must be met:	D 613	40	40	40	40	40	40	30
1) Cetane Index, min	D 976	40	40	—	40	40	—	—
Aromaticity, % vol, max	D 1319	35	35	—	35	35	—	—
Operability Requirements	D 2500							
Cloud Point, °C, max								
or	D 4539 /							
LFRT, CFPP, °C, max	D 6371	A	A	A	A	A	A	—
Ramsbottom carbon residue on 10% distillation residue, % mass, max	D524	0.15	0.15	0.15	0.35	0.35	0.35	—
Lubricity, HFRR @ 60oC, micron, max	D 6079	520	520	520	520	520	520	—
Conductivity, pS/m or Conductivity Units (C.U), min	D 2624/ D 4308	25	25	25	25	25	25	—

A – low temperature properties depend on operational ambient temperature.

ASTM Standard Specifications for Gas Turbine Fuel Oil – ASTM D 2880

Property	ASTM	Grade				
	Test Method	No. 0-GT	No. 1-GT	No. 2-GT	No. 3-GT	No. 4-GT
Flash Point, °C, min	D 93	A	38	38	55	66
Water and Sediment, % vol, max	D 2709	0.05	0.05	0.05	—	—
Distillation Temp., °C, 90% volume recovered						
min	—	—	282	—	—	—
max	—	288	338	—	—	—
Kinematic Viscosity, mm ² /s at 40 °C						
min			1.3	1.9	5.5	5.5
max			2.4	4.1	—	—
at 100°C max	D 445	A	—	—	50.0	50.0
Ramsbottom Carbon Residue on 10% distillation residue, % mass, max	D 524	0.15	0.15	0.35	—	—
Ash, % mass, max	D 482	0.01	0.01	0.01	0.03	—
Density at 15°C kg/m ³ max	D 1298	—	850	876	—	—
Pour Point, °C, max	D 97	—	-18	-6	—	—

Note : A When the flash point is below 38°C (100°F) or when kinematic viscosity is below 1.3 mm²/s at 40°C (104°F) or when both conditions exist, the turbine manufacturer should be consulted with respect to safe handling and fuel system design.