

Technical Bulletin

Viscosity

What is Viscosity?

Viscosity is a measure of the resistance of fluid to flow. It is referred to as viscosity. The most important factor affecting viscosity is temperature. The viscosity decreases as the temperature increases in liquids. Low viscosity refers to thin and easy flowing fluid, while high viscosity refers to thick and hard flowing fluid. Thanks to viscosity, a layer of oil is formed between two surfaces under pressure and the system components can be used for many years without wear.

Dynamic viscosity (μ)
The dynamic viscosity (absolute viscosity) refers to the inner friction resistance of the fluid layers against the flowing motion.
SI physical unit of dynamic viscosity $[Pa.s]=N.s / m^2 = kg / (m.s)$
CGS physical unit of dynamic viscosity Poise(P) $=g / (cm.s)$
It is expressed as centipoise (cP) in ASTM standards.
 $1 P = 100 cP$, $1 P = 0,1 Pa.s$, $1 cP = 1 mPa.s = g / (m.s)$

Kinematic viscosity (ν)
Kinematic viscosity is obtained by dividing the dynamic viscosity (μ) of the fluid at a given temperature with its density (ρ) at the same temperature.
 $\nu = \mu / \rho$
Classification of engine oils and industrial oils is based on kinematic viscosity.
SI physical unit of kinematic viscosity (m^2 / s)
CGS physical unit of kinematic viscosity Stokes(St) $= cm^2 / s$
It is expressed as centistokes(cSt) in practice.
 $1 St = 100 cSt$, $1 cSt = 1 mm^2 / s$

SI : International System of Units
CGS : The unit of length is based on centimeters (cm), the unit of mass is based on gram (g), and the unit of time is based on second (s).
ASTM: American Society for Testing and Materials

SAE Viscosity Classification for Engine Oils

SAE (Society of Automotive Engineers) classifies oils according to their kinematic viscosity values at 100°C. For SAE 10W-30 engine oil, '10' represents cold operating conditions. W stands for Winter. '30' represents the range of viscosity at 100 °C. Accordingly, the kinematic viscosity value of SAE 10W-30 oil at 100°C should be 9.30 cSt - 12.50 cSt. Furthermore, the viscosity of this oil at -25°C should be maximum 7000 cP and should be pumpable at -30°C.

| SAE Viskozite Sınıfı | | °C Sıcaklıkta cP Olarak Maks. Viskozite | | 60.000 cP Viskozite için Pompalama Sınır Sıcaklığı °C Maks. | 100 °C'de mm ² /s Olarak Viskozite | |
|----------------------|-----|---|-----|---|---|-------|
| Kış | Yaz | cP | °C | | Min. | Maks. |
| 0 W | - | 6200 | -35 | -40 | 3,80 | - |
| 5 W | - | 6600 | -30 | -35 | 3,80 | - |
| 10 W | - | 7000 | -25 | -30 | 4,10 | - |
| 20 W | - | 7000 | -20 | -25 | 5,60 | - |
| 25 W | - | 9500 | -15 | -20 | 5,60 | - |
| - | - | 13000 | -10 | -15 | 9,30 | - |
| - | 20 | - | - | - | 5,60 | 9,30 |
| - | 30 | - | - | - | 9,30 | 12,50 |
| - | 40 | - | - | - | 12,50 | 16,30 |
| - | 50 | - | - | - | 16,30 | 21,90 |
| - | 60 | - | - | - | 21,90 | 26,10 |

$\frac{1 \text{ centipoise (cP)}}{\text{yoğunluk}} = 1 \text{ mm}^2/\text{s}$ $1 P = 1 \text{ gr/cm.s}$ veya $10 P = 1 \text{ Pa.s}$. $1 cP = \frac{1p}{100}$



ISO Viscosity Classification of Industrial Oils

ISO (International Organization for Standardization) classifies oils according to their kinematic viscosity values at 40 °C.

| ISO Viskozite Sınıfı | Kinematik Viskozite 40°C'de mm ² /s | Kinematik Viskozite Limitleri 40 °C'de mm ² /s | |
|----------------------|--|---|-------|
| | | Min. | Max. |
| 2 | 2,20 | 1,98 | 2,42 |
| 3 | 3,20 | 2,88 | 3,52 |
| 5 | 4,60 | 4,14 | 5,06 |
| 7 | 6,80 | 6,12 | 7,48 |
| 10 | 10 | 9,00 | 11,00 |
| 15 | 15 | 13,50 | 16,50 |
| 22 | 22 | 19,80 | 24,20 |
| 32 | 32 | 28,80 | 35,20 |
| 46 | 46 | 41,40 | 50,60 |
| 68 | 68 | 61,20 | 74,80 |
| 100 | 100 | 90,00 | 110 |
| 150 | 150 | 135 | 165 |
| 220 | 220 | 198 | 242 |
| 320 | 320 | 288 | 352 |
| 460 | 460 | 414 | 506 |
| 680 | 680 | 612 | 748 |
| 1000 | 1000 | 900 | 1100 |
| 1500 | 1500 | 1350 | 1650 |

Other Viscosity Measurements in cP:

CCS (Cold Crank Simulator)
Engine oil testing under laboratory conditions at -15 OC to -35 OC in high shear rates. This test represents the engine start-up at low temperatures.

MRV (Mini Rotary Viscometer)
Engine oil testing under laboratory conditions at -20 OC to -40 OC in low shear rates. This test represents the pumpability of engine at low temperatures.

HT-HS (High Temperature – High Shear)
Testing of motor oil at high temperatures of 150 OC and high shear rate of 106 s⁻¹ under laboratory conditions. HTHS viscosity value of any SAE 10W-30 oil should be 2.9 cP. The low HTHS value provides more fuel economy, while the High HTHS value provides greater protection in challenging conditions. Therefore, it is critical to determine the HTHS value during engine oil development.