1. Viscosity

The viscosity of oil is a measure of its resistance to internal flow and an indication of its oiliness in the lubrication of surfaces. There are two types of viscosity: dynamic and kinematics viscosity.

Kinematic viscosity (υ) = dynamic viscosity (μ) / density (ρ)

The unit of dynamic viscosity is poise (0.1 Pa·s). It is more commonly expressed, particularly in ASTM standards, as centipoises (cP). While the kinematics viscosity as centi Stokes – cSt (10^{-6} m^2 $\cdot s^{-1}$). The following equations can be used to calculate the liquid viscosities of petroleum fractions at atmospheric pressure and at temperatures of 37.8 °C(100 °F) and 98.9 °C (210 °F)

$$\log \nu_{210} = -0.463634 - 0.166532(\mathrm{API}) + 5.13447 \times 10^{-4}(\mathrm{API})^2 - 8.48995 \times 10^{-3} K(\mathrm{API}) + \frac{8.0325 \times 10^{-2} K + 1.24899(\mathrm{API}) + 0.197680(\mathrm{API})^2}{\mathrm{API} + 26.786 - 2.6296K}$$

$$\log \nu_{100} = 4.39371 - 1.94733K + 0.127690K^2 + 3.2629 \times 10^{-4}(\mathrm{API})^2 - 1.18246 \times 10^{-2} K(\mathrm{API}) + \frac{0.17161K^2 + 10.9943(\mathrm{API}) + 9.50663 \times 10^{-2}(\mathrm{API})^2 - 0.860218K(\mathrm{API})}{\mathrm{API} + 50.3642 - 4.78231K}$$

where ν_{100} and ν_{210} are the kinematic viscosities at 100 and 210 °F, in centistokes. The viscosity can be measured by several instruments (U-tube Viscometer, Saybolt Universal Viscosity (SSU), thermo-viscosity, Red wood viscometer and Englar)

Thermo. = 15 + 148.5 kinematic Vis. = 46 SSU – 1183

The comparison of viscosity by different instruments is shown in Figure 1

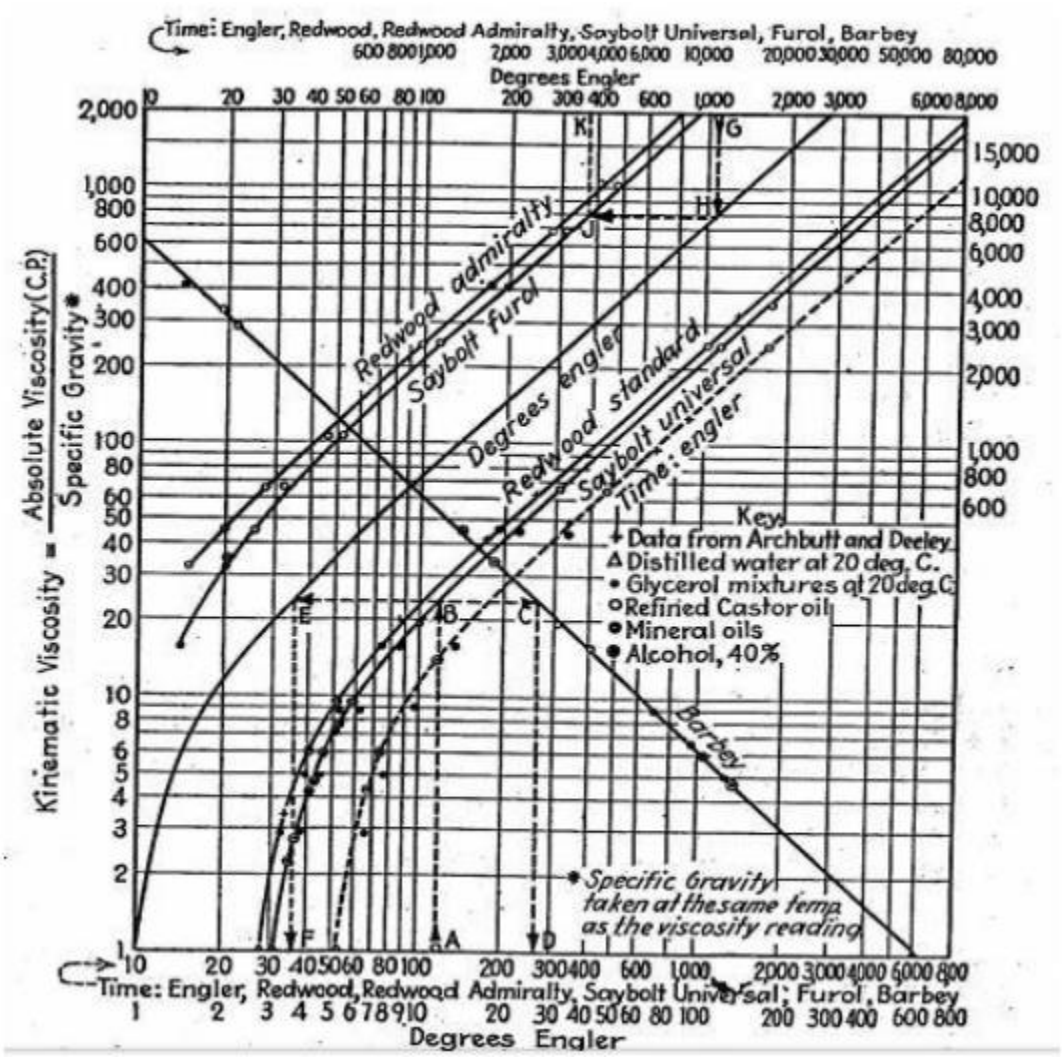

Figure1. Comparison of viscosity by different instruments (Viscosity must be at the same T)

2. Flash point

Flash point TF, for a hydrocarbon or a fuel is the minimum temperature at which vapor pressure of the hydrocarbon is sufficient to produce the vapor needed for spontaneous ignition of the hydrocarbon with the air with the presence of an external source, i.e., spark or flame. From this definition, it is clear that hydrocarbons with higher vapor pressures (lighter compounds) have lower flash points. Generally flash point increases with an increase in boiling point. Flash point is an important parameter for safety considerations, especially during storage and transportation of volatile petroleum products (i.e., LPG, light naphtha, gasoline) in a high-temperature environment. The flash point can be estimated using the following equation:

$$T_F = 15.48 + 0.70704\,T_{10}$$

Where T10 is normal boiling point for petroleum fractions at 10 vol% distillation temperature. Both temperatures (T10 and flas point (TF) in Kelvin).

Notes:

1. Flash point of petroleum fractions is the minimum temperature at which vapours arising from the oil will ignite, i.e. flash, when exposed to a flame under specified conditions.
2. The flash point indicates the maximum temperature that the fuel can be stored without serious fire hazard.

3. Flash point is an important test for light petroleum fractions especially in high temperature environment and is directly related to the safe storage and handling of petroleum products.
4. Flash point decreases with increasing volatility of fuel, i.e. the higher vapour pressure the lower is the flash point.
5. Generally for crude oils with RVP greater than 0.2 bar the flash point is less than 20°C.
6. High flash point means higher temperature is required for the fuel to flash. The fuel therefore does not ignite easily and is safe.

3. Aniline Point

The lowest temperature at which an equal volume mixture of the petroleum oil and aniline are miscible is the aniline point. Since aniline is an aromatic compound, petroleum fractions with high aromatic content will be miscible in aniline at ambient conditions. Aniline point can be estimated using the following relation:

$$\mathrm{AP} = -183.3 + 0.27(\mathrm{API})T_b^{1/3} + 0.317T_b$$

Where AP is in °C Tb is the mid boiling point in kelvin and API is API gravity.