Viscosity of Lubricating Oil

Viscosity is a useful fluid parameter used to describe a fluid's internal friction or resistance to motion. A large viscosity will require a large shear force to overcome the internal friction. Shear forces can occur during operations such as pouring, mixing, spreading, or spraying.

The internal friction arises from attractive forces between the molecules of the fluid. When a shear force is applied, it must overcome the intermolecular forces in order to move the liquid.

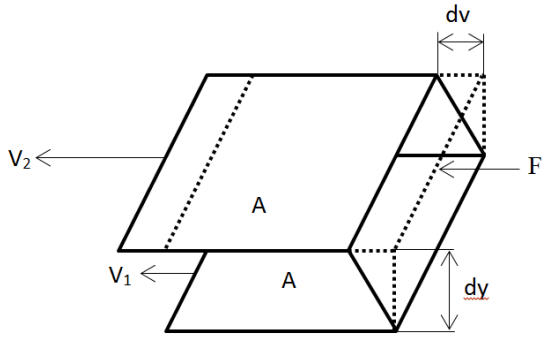

Figure 1. Two parallel planes of fluid in shear motion.

Newton defined viscosity, μ, by considering a situation like Figure 1 where two parallel planes of fluid of equal area, A, are separated by a distance, dx, and traveling at different velocities, V_1 and V_2. He assumed that the shear stress, τ, required to cause the difference in velocity was proportional to the change in velocity across dx, or the velocity gradient. Mathematically, it is expressed as Equation 1.

Equation 1. $$\tau = \frac{F}{A} = \mu \frac{dv}{dy}$$

Fluids that behave according to Equation 1 are called Newtonian. Typical Newtonian fluids are water and thin lubricating oils.

Motor oil viscosity is an important consideration for improving the performance and extending the lifetime of any engine. If the oil viscosity is too low, the lubrication layer between parts will be too thin to prevent engine parts from grinding against each other. However, if oil viscosity is too high, the oil may not pump properly during start-up when the engine is still cold. This requires that the correct viscosity oil be used.

To facilitate this, oils are classified based on their viscosity and given a certification grade, such as 5, 10, 20, 30 40, or 50; these grades are defined by the Society of Automotive Engineers

(SAE). Some oils are given two ratings, such as 5W-30, to indicate oil that has been treated with additives to flow like SAE 5 oil at start-up but SAE 30 after the engine reaches operating temperature. This allows for better engine performance and lifetime.

A 5W-30 motor oil was tested using a Brookfield LV-II+ Pro Viscometer. This viscometer has a measuring range of 1 cP to $6•(10)^6$ cP (1 cP is equal to 10^{-3} Pa•s). Coupled with appropriate temperature control equipment, the LV-II+ provides excellent accuracy and repeatability in viscosity measurements at temperatures ranging from -20°C to 300°C. The measurement results are presented in Figure 2.

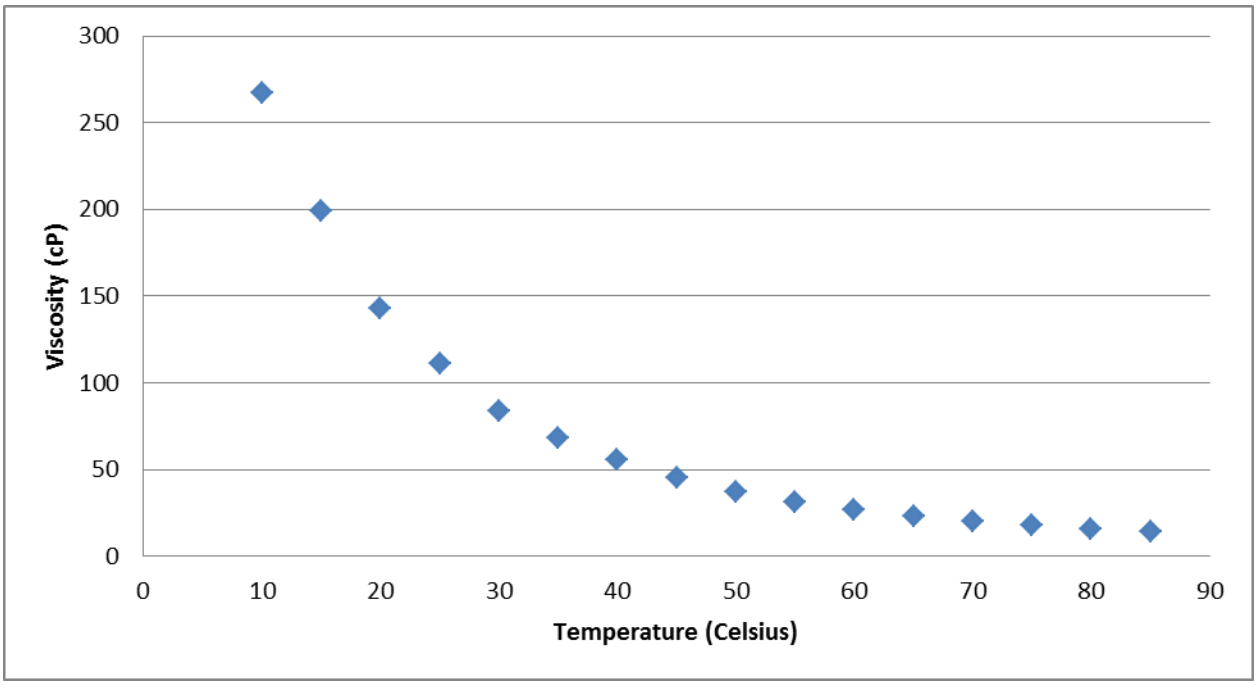

Figure 2. The viscosity of 5W-30 motor oil as a function of temperature.