Technical Data Book: Chapter 11—Viscosity

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SCOPE

Technical Report TDB-11 provides methods for estimating both liquid and vapor viscosity of pure components, petroleum fractions and mixtures that are common in refinery applications. Computer algorithms and figures are presented for estimation of this property. An estimate of the accuracy and range of application for each method is presented.

Any references to other chapters within this document refer to the corresponding Technical Data Book Chapter which is published as API Technical Report TDB-x, where x is the chapter number.

11-0 Introduction

Viscosity is a measure of the ability of a fluid to resist shear. When the shear stress on any differential volume element of flowing fluid is proportional to the velocity gradient in the direction perpendicular to the direction of flow, the fluid is called a Newtonian fluid.

The methods presented in this chapter are for Newtonian fluids and should not be expected to maintain their accuracy for non-Newtonian fluids. Almost all gases and most hydrocarbon liquids are Newtonian fluids. Very heavy asphalts with low UOP K's exhibit non-Newtonian behavior. Some other common non-Newtonian fluids are polymers, pastes, slurries, waxy oils and some silicate esters.

Viscosity is a function of temperature, pressure and molecular species. For non-Newtonian fluids, the viscosity is also a function of the local velocity gradient.

The absolute viscosity is defined as the shear stress at a point divided by the velocity gradient at that point. The unit of absolute viscosity is the Poise, which is equal to 1 g/cm·s.

The kinematic viscosity is defined as the ratio of the absolute viscosity to the density, both at the same temperature and pressure. The unit of kinematic viscosity corresponding to the Poise is the Stoke which is equal to 1cm^2/s. The conversion from absolute to kinematic viscosity is given by the following equation:

$$\nu = \frac{\mu}{\rho} \qquad (11\text{-}0.1)$$

Where:

ν	=	*kinematic viscosity, in Stokes (St)*
μ	=	*absolute viscosity, in Poises (P)*
ρ	=	*density, in g/cm^3*

The units cP (0.01 Poise) and centistoke (0.01 Stoke) are used most frequently.

Saybolt Universal viscosity is the time in seconds for a 60-mm sample to flow through a standard orifice in the bottom of a tube. Saybolt Furol viscosity is determined in the same manner as Saybolt Universal viscosity except that a larger orifice is used. The orifice and tube geometry are specified in ASTM standards.