VISCOSITY

Viscosity is a measure of the resistance of a fluid to deformation under shear stress. In engineering this gets prominence under lubrication.

Explained

It is commonly perceived as "thickness", or resistance to pouring. Viscosity describes a fluid's internal resistance to flow and may be thought of as a measure of fluid friction. Thus, water is "thin", having a low viscosity, while vegetable oil is "thick" having a high viscosity.

Newton's theory

In many situations, we are concerned with the ratio of the viscous force to the inertial force, the latter characterised by the fluid density ρ. This ratio is characterised by the kinematic viscosity, defined as follows:

$$\nu = \frac{\mu}{\rho}.$$

Viscosity is the principal means by which energy is dissipated in fluid motion, typically as heat.

Measurement of viscosity

Viscosity is measured with various types of viscometer, typically at 25°C (standard state). For some fluids, it is a constant over a wide range of shear rates. The fluids without a constant viscosity are called Non-Newtonian fluids.

Units

Viscosity (dynamic viscosity): μ

The SI physical unit of dynamic viscosity (greek symbol: μ) is the pascal-second (Pa·s), which is identical to 1 kg•m-1•s-1. In France there have been some attempts to establish the poiseuille (Pl) as a name for the Pa·s but without international success. Care must be taken in not confusing the poiseuille with the poise named after the same person!

The cgs physical unit for dynamic viscosity is the poise (P) named after Jean Louis Marie Poiseuille[[2]]. It is more commonly expressed, particularly in ASTM standards, as centipoise (cP). The centipoise is commonly used because water has a viscosity of 1.0020 cP (at 20 °C; the closeness to one is a convenient coincidence).

1 poise = 100 centipoise = 1 g•cm−1•s−1 = 0.1 Pa•s.

1 centipoise = 1 mPa•s.

Kinematic viscosity: $\nu = \mu/\rho$

Kinematic viscosity (Greek symbol: ν) has SI units ($m^2 \cdot s^{-1}$). The cgs physical unit for kinematic viscosity is thestokes (abbreviated S or St), named after George Gabriel Stokes[[3]] . It is sometimes expressed in terms ofcentistokes (cS or cSt). In U.S. usage, stoke is sometimes used as the singular form.

1 stokes = 100 centistokes = 1 $cm^2 \cdot s^{-1}$ = 0.0001 $m^2 \cdot s^{-1}$.

Conversion between kinematic and dynamic viscosity, then, is given by $\nu\rho = \mu$, and so if ν=1 St then

$\mu=\nu\rho=0.1\ kg \cdot m^{-1}s^{-1} \cdot (\rho/(g/cm^3))=0.1\ poise \cdot (\rho/(g/cm^3))$. [4]

Gases

Viscosity in gases arises principally from the molecular diffusion that transports momentum between layers of flow. The kinetic theory of gases allows accurate prediction of the behaviour of gaseous viscosity, in particular that, within the regime where the theory is applicable:

Viscosity is independent of pressure; and *Viscosity increases as temperature increases.

Liquids

In liquids, the additional forces between molecules become important. This leads to an additional contribution to the shear stress though the exact mechanics of this are still controversial. Thus, in liquids:

Viscosity is independent of pressure (except at very high pressure); and

Viscosity tends to fall as temperature increases (for example, water viscosity goes from 1.79 cP to 0.28 cP in the temperature range from 0°C to 100°C);
see temperature dependence of liquid viscosity for more details.

The dynamic viscosities of liquids are typically several orders of magnitude higher than dynamic viscosities of gases.

Viscosity of some common materials a Data from CRC Handbook of Chemistry and Physics, 73rd ion, 1992-1993.

Fluids with variable compositions, such as honey, can have a wide range of viscosities.

A more complete table can be found here

Can solids have a viscosity?

viscosity is only the property of liquid

Bulk viscosity and Eddy viscosity

Fluidity

The reciprocal of viscosity is fluidity, usually symbolised by φ (=1/μ) or F (=1/η), depending on the convention used, measured in reciprocal poise (cm•s•g-1), sometimes called the rhe. Fluidity is seldom used in engineering practice.

The concept of fluidity can be used to determine the viscosity of an ideal solution. For two components (a and b), the fluidity of a solution of a and b is:

$$F \approx [\chi(a)F(a)] + [\chi(b)F(b)]$$

which is only slightly simpler than the equivalent equation in terms of viscosity:

$$\eta \approx 1/[\chi(a)/\eta(a) + \chi(b)/\eta(b)]$$

Where χ = mole fraction of a or b and η = the viscosity of pure a or b

Source: http://engineering.wikia.com/wiki/Viscosity