

Production Engineering Laboratory

Viscosity

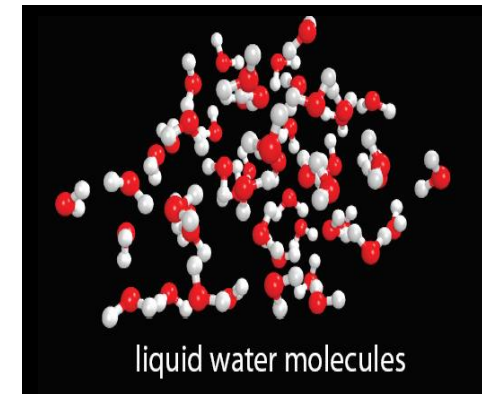
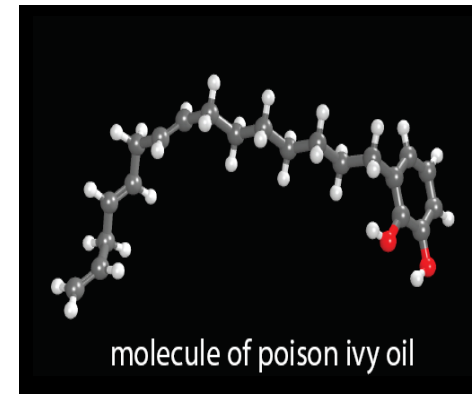
BY

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Definitions

- Fluid
 - Anything that flows (liquid or gas)
- Viscosity
 - The resistance of fluid to flow
 - Viscosity depends on the strength of the intermolecular bonds and the shape of the molecules.
 - Why oils are more viscous?
 - The long chain molecules can be easily entangled and this slow down the flow.



Definitions

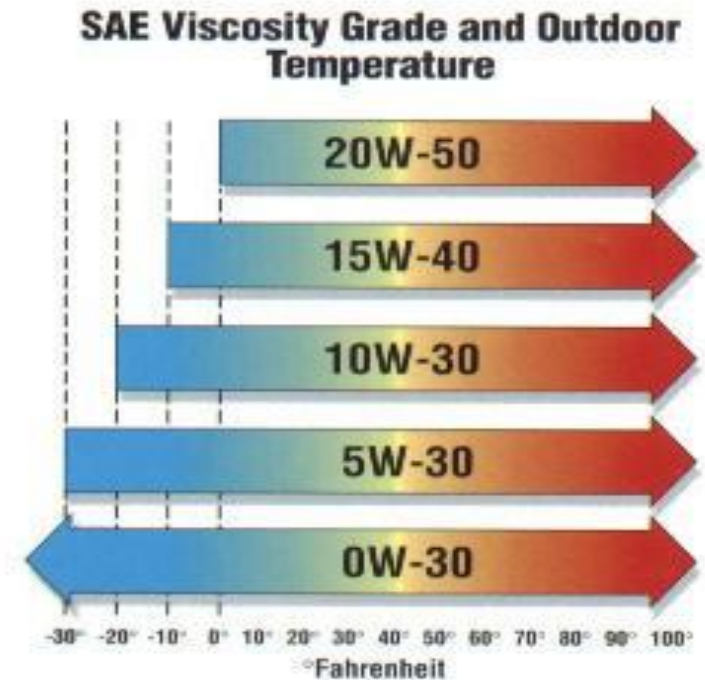
Motor oil

What does 10W-30 mean?

Viscosity index
cold engine

viscosity index
hot engine

A higher viscosity index indicates the viscosity changes less with temperature than a lower viscosity index.



Definitions

Dynamic (shear) viscosity

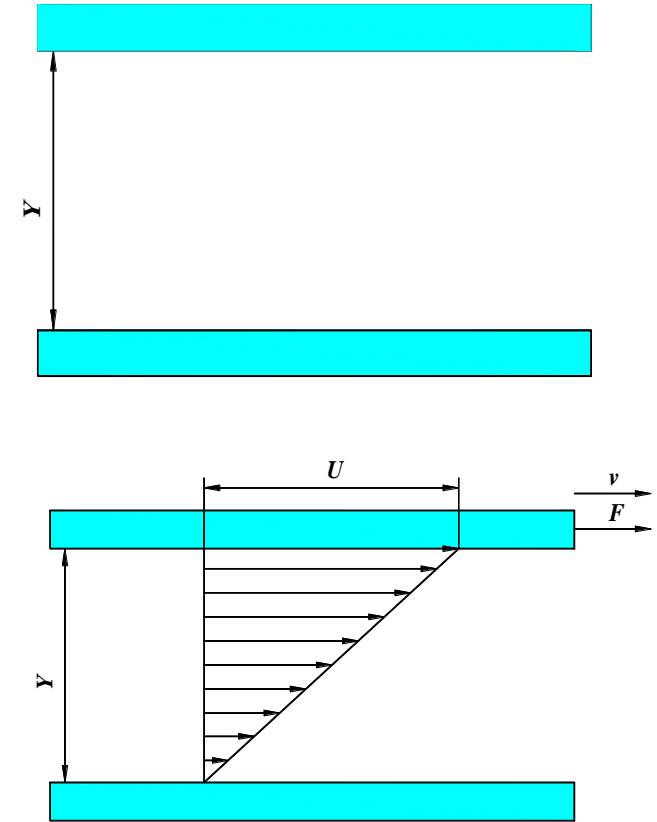
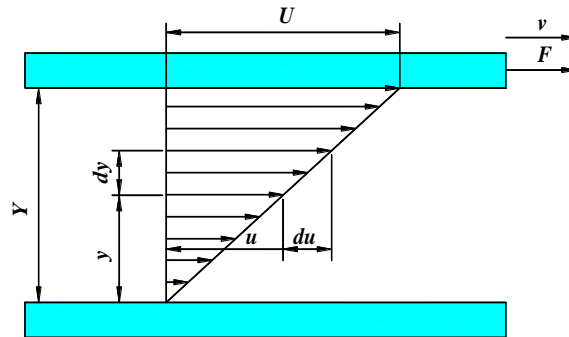
$$\tau \propto \frac{du}{dy}$$

Shear stress

$$\tau = \mu \frac{du}{dy}$$

Rate of strain

Viscosity



Definitions

Kinematic viscosity

The kinematic viscosity - also called "momentum diffusivity" - is the ratio of the dynamic viscosity μ to the density of the fluid ρ .

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

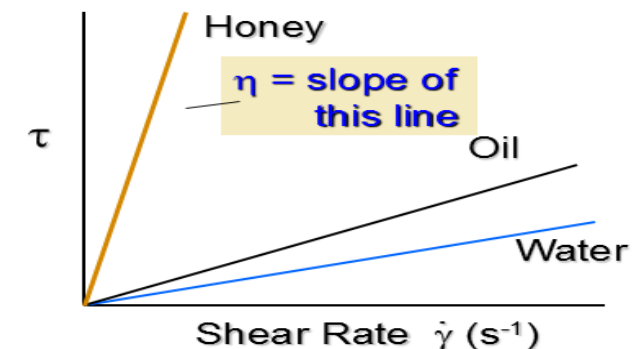
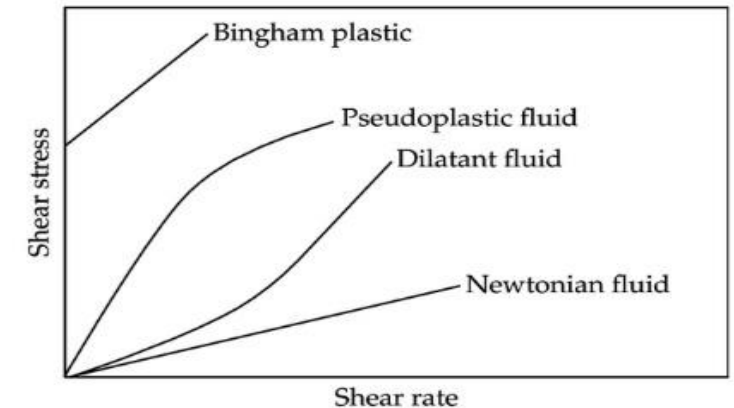
Classification

Newtonian fluids

Non-Newtonian fluids

Example

- Water, Oil, Gasoline, Alcohol, Kerosene, Benzene, Glycerin ...
- Soup solution, Food (butter, cheese, jam,...), Natural substances (magma, lava,...), Biological fluids (blood, saliva,...), ...
- http://www.youtube.com/watch?v=2mYHGn_Pd5M
- http://www.youtube.com/watch?v=G1Op_1yG6lQ



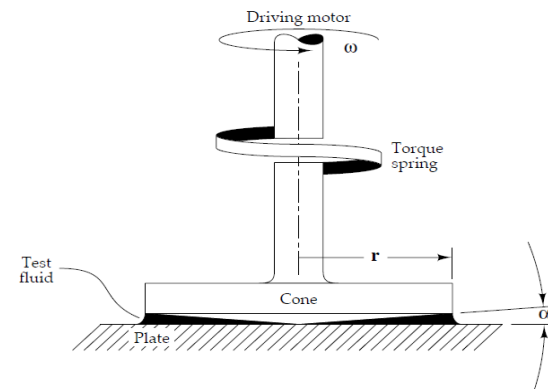
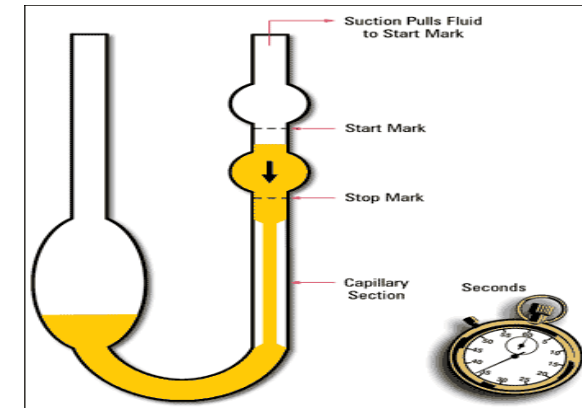
Classification

Approximate Viscosities of Common Materials (At Room Temperature: 70°F)

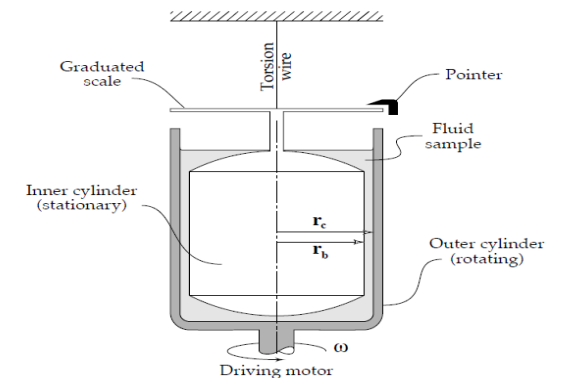
Material	Viscosity in Centipoise
Water	1 cps
Milk	3 cps
SAE 10 Motor Oil	85-140 cps
SAE 20 Motor Oil	140-420 cps
SAE 30 Motor Oil	420-650 cps
SAE 40 Motor Oil	650-900 cps
Castrol Oil	1,000 cps
Karo Syrup	5,000 cps
Honey	10,000 cps
Chocolate	25,000 cps
Ketchup	50,000 cps
Mustard	70,000 cps
Sour Cream	100,000 cps
Peanut Butter	250,000 cps

Measurement

- Capillary viscometers (kinematic)
- Rotational viscometers (dynamic or absolute)
- Rotating cylinder viscometers
- Cone-on-plate viscometers



Schematic diagram of a cone on plate viscometer.



Schematic diagram of a rotating cylinder viscometer.

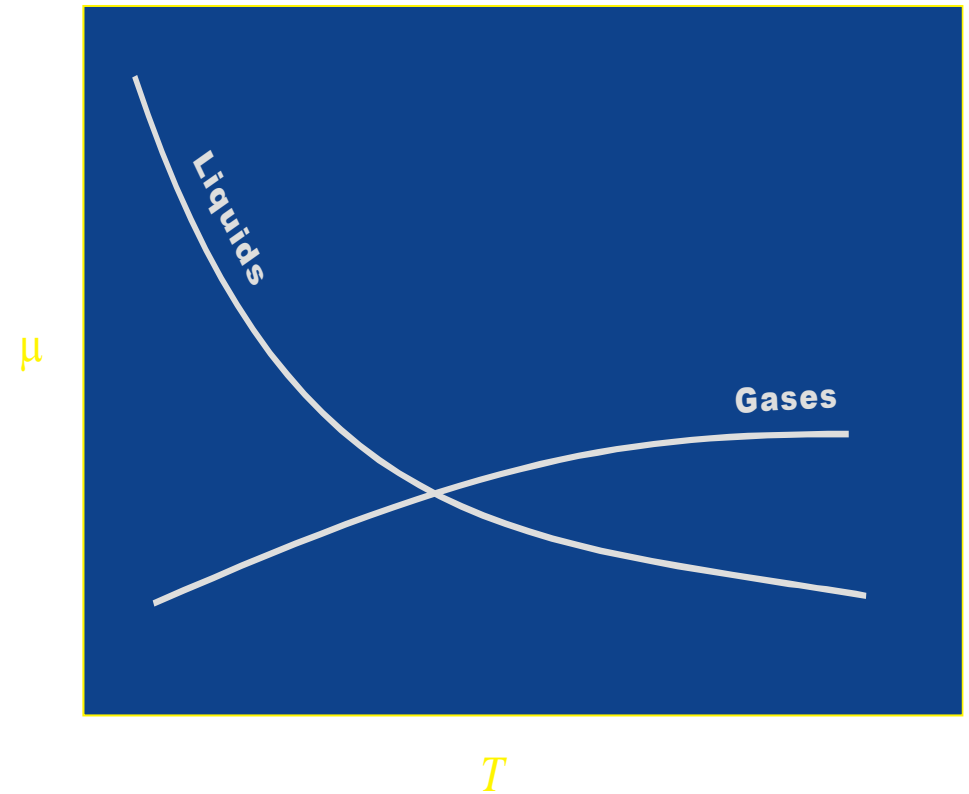
Parameters Effects

Effect of temperature

- Liquid
 - Decrease with temperature
- Gases
 - Increases with temperature ?

Effect of pressure

- Increases with pressure



Discussion

What is the importance of viscosity in the oil industry?