

Production Engineering Laboratory

Viscosity

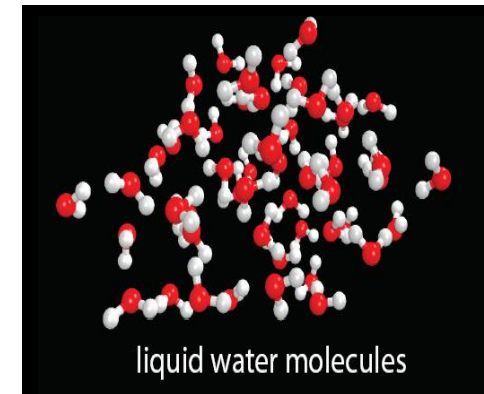
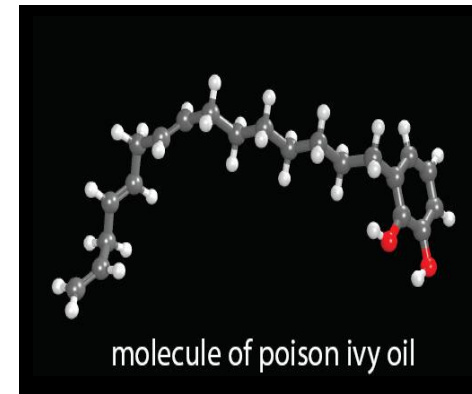
BY

DR. MOHAMMED A. KHAMIS

27-02-2017

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

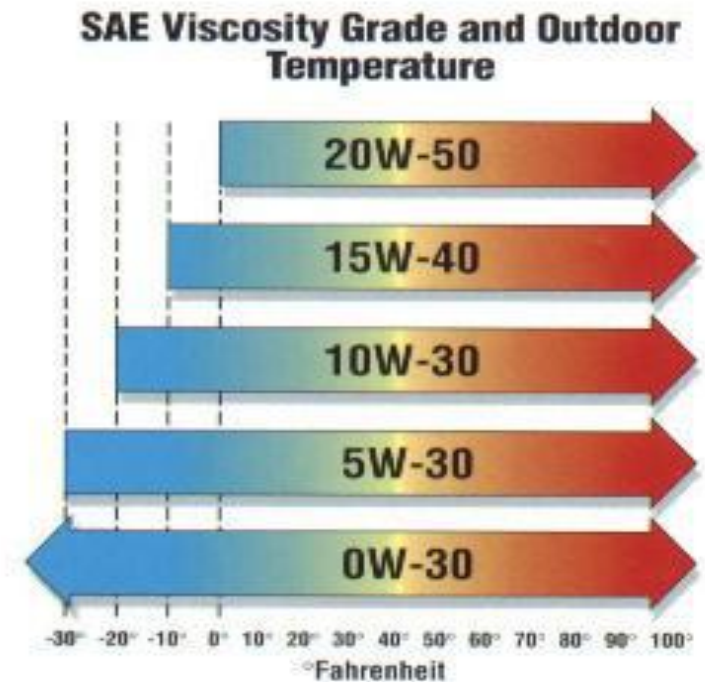
Motor oil

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

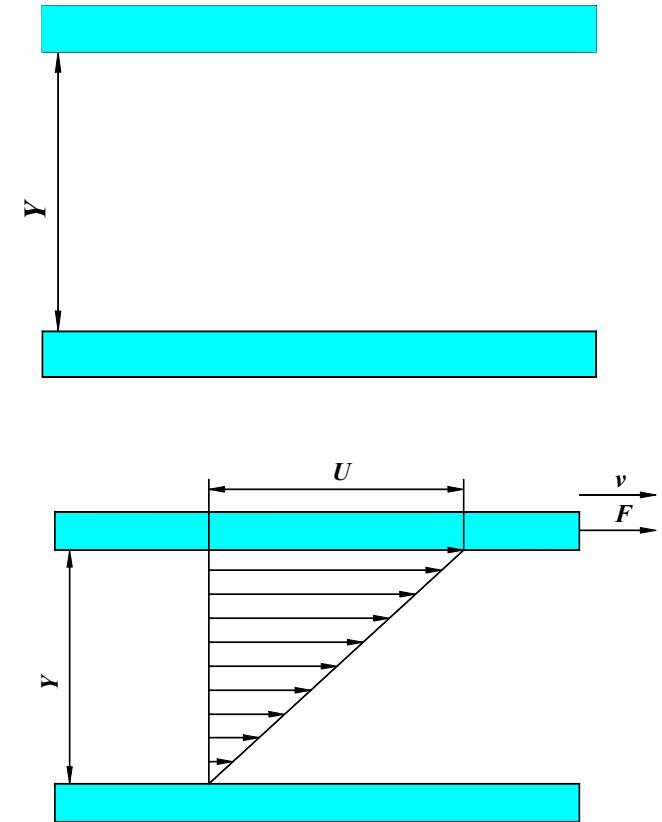
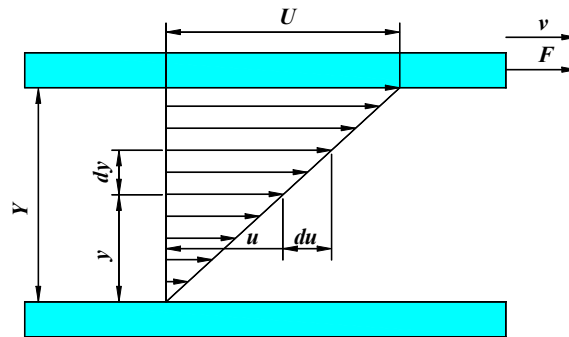
$$\tau \propto \frac{du}{dy}$$

Shear stress

Rate of strain

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

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 .

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

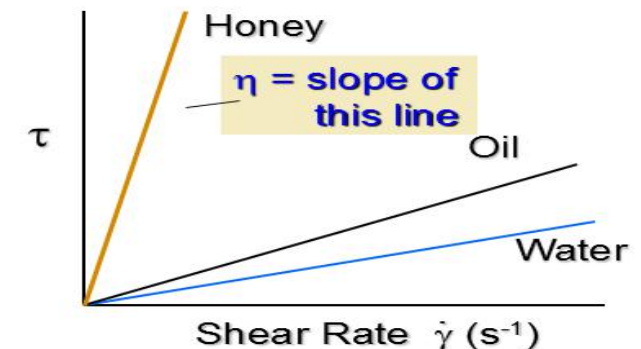
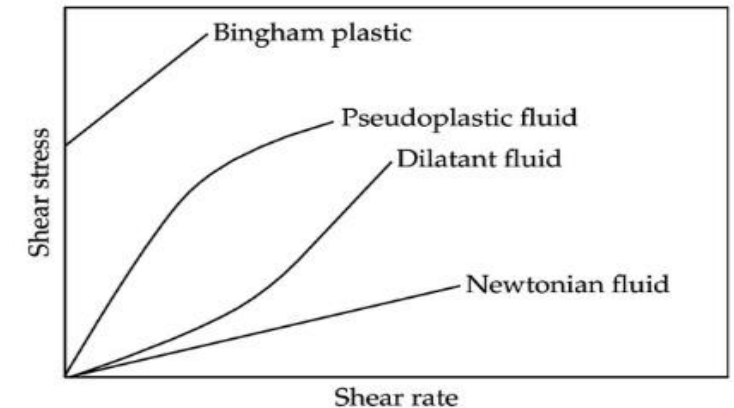
Classification

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



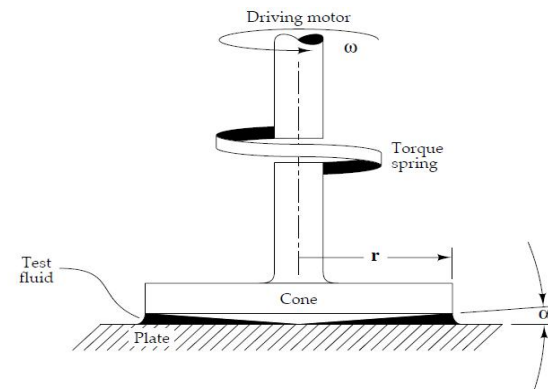
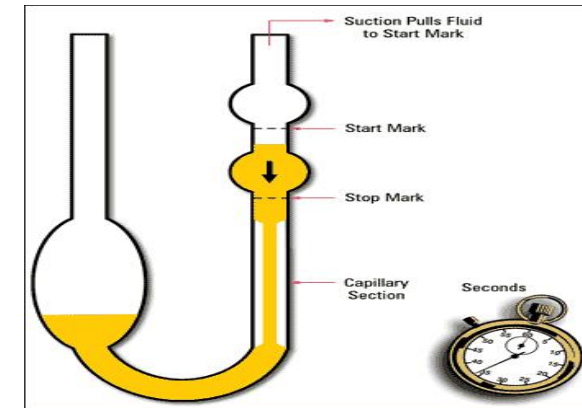
Classification

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

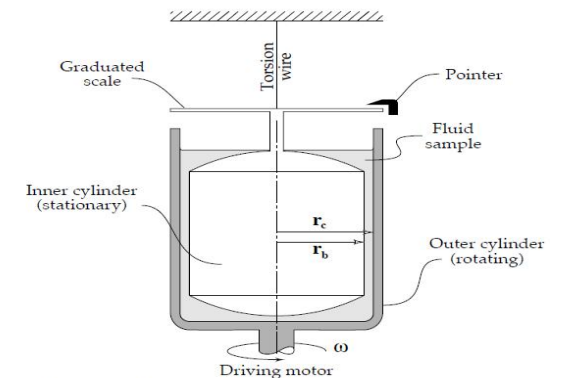
| Material | Viscosity in Centipoise |
|------------------|-------------------------|
| Water | 1 cps |
| Milk | 3 cps |
| SAE 10 Motor Oil | 85-140 cps |
| SAE 20 Motor Oil | 140-420 cps |
| SAE 30 Motor Oil | 420-650 cps |
| SAE 40 Motor Oil | 650-900 cps |
| Castrol Oil | 1,000 cps |
| Karo Syrup | 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.

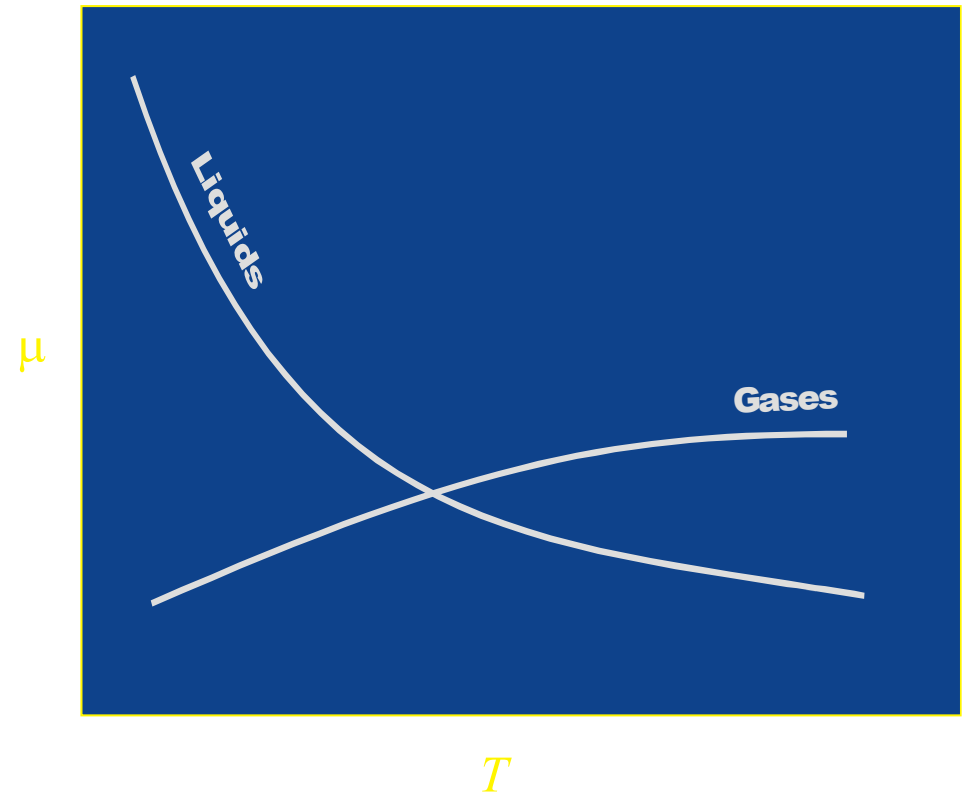
Parameters Effects

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?