

# Production Engineering Laboratory

## Viscosity

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BY

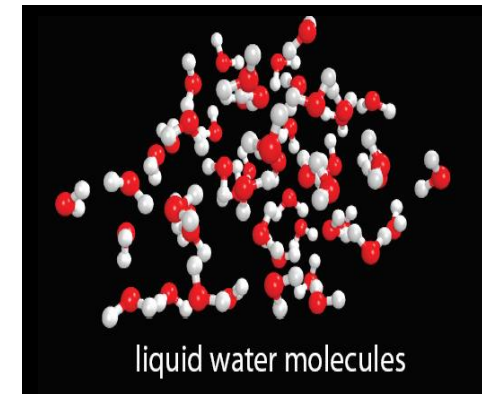
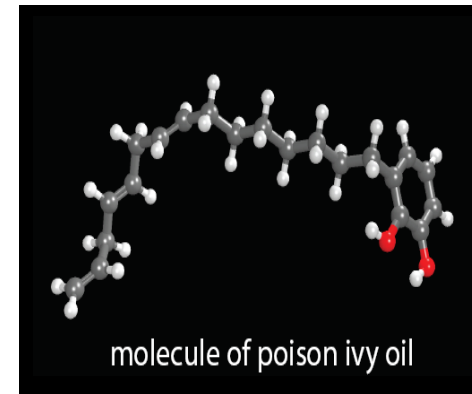
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# Definitions

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- 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

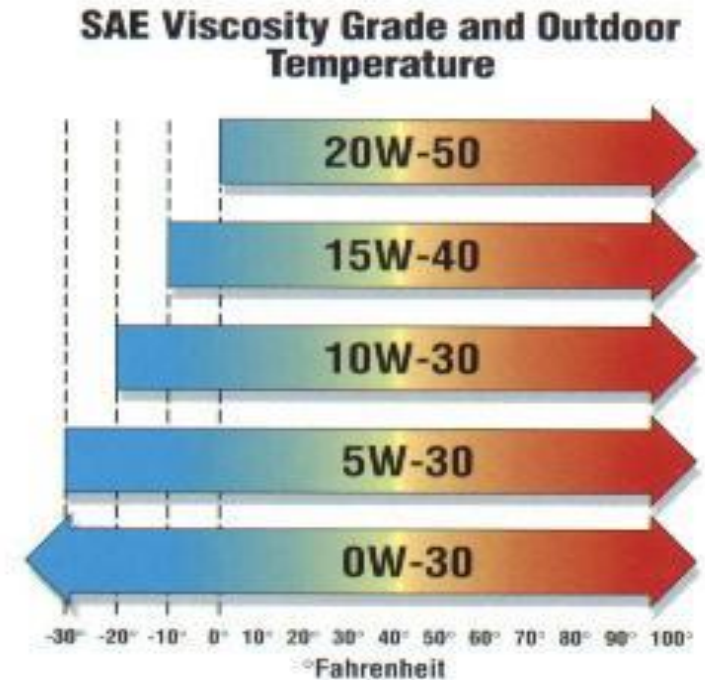
Motor oil

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

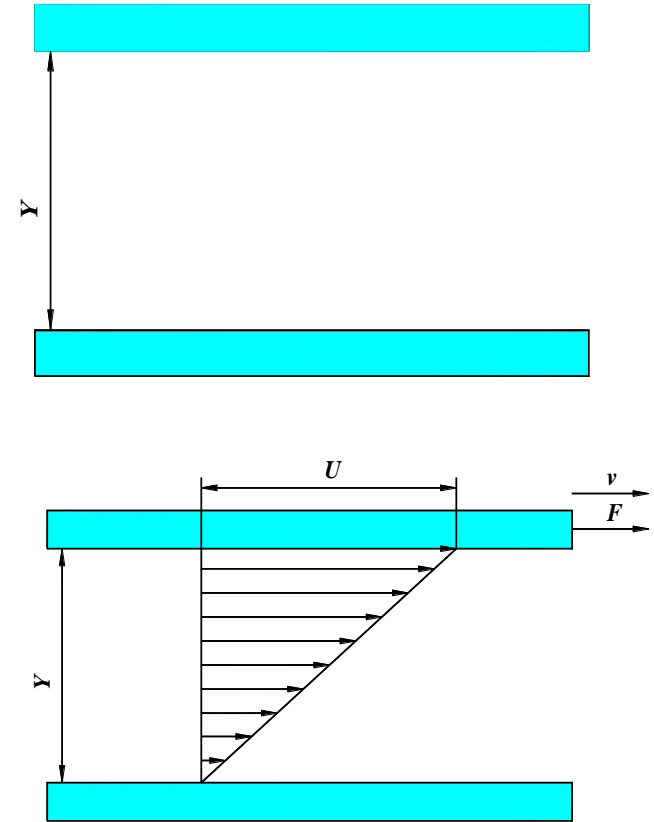
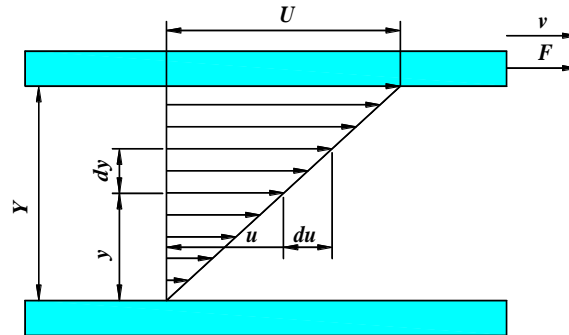
$$\tau \propto \frac{du}{dy}$$

Shear stress

Rate of strain

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

Viscosity



# Definitions

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## Kinematic viscosity

The kinematic viscosity - also called "momentum diffusivity" - is the ratio of the dynamic viscosity  $\mu$  to the density of the fluid  $\rho$ .

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

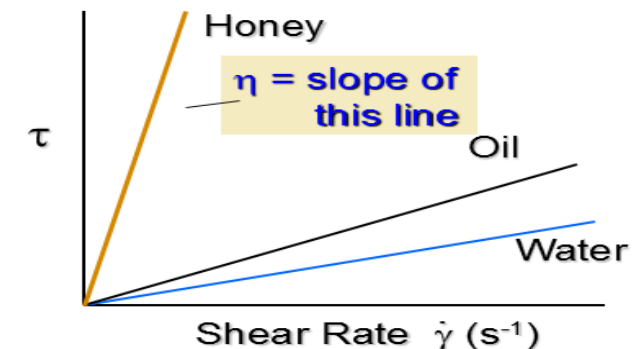
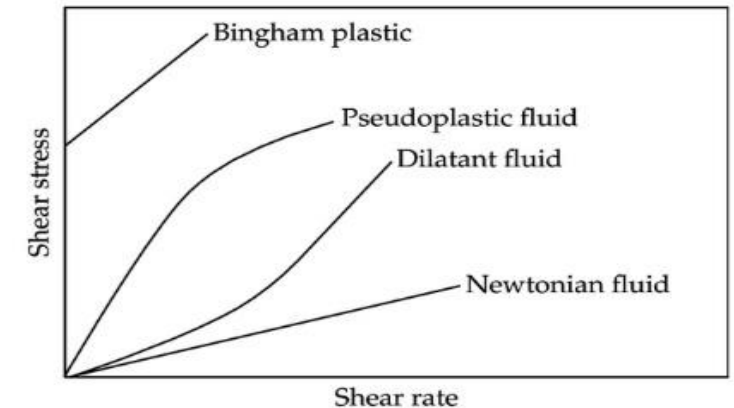
# Classification

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=2mYHGn_Pd5M)
- [http://www.youtube.com/watch?v=G1Op\\_1yG6lQ](http://www.youtube.com/watch?v=G1Op_1yG6lQ)



# Classification

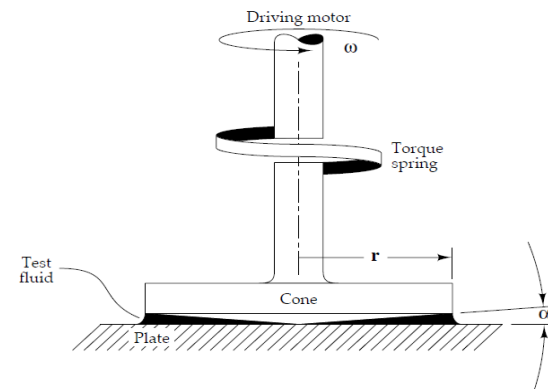
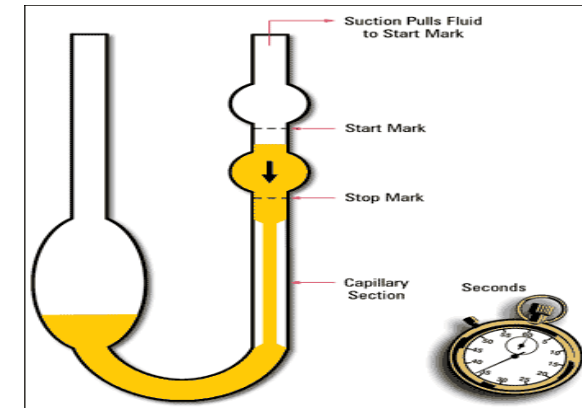
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## Approximate Viscosities of Common Materials (At Room Temperature: 70°F)

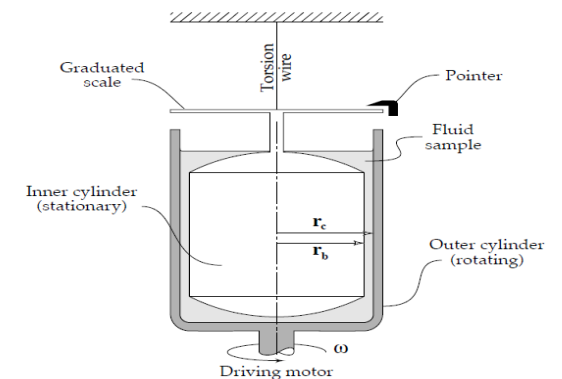
Material	Viscosity in Centipoise
Water	1 cps
Milk	3 cps
SAE 10 Motor Oil	85-140 cps
SAE 20 Motor Oil	140-420 cps
SAE 30 Motor Oil	420-650 cps
SAE 40 Motor Oil	650-900 cps
Castrol Oil	1,000 cps
Karo Syrup	5,000 cps
Honey	10,000 cps
Chocolate	25,000 cps
Ketchup	50,000 cps
Mustard	70,000 cps
Sour Cream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



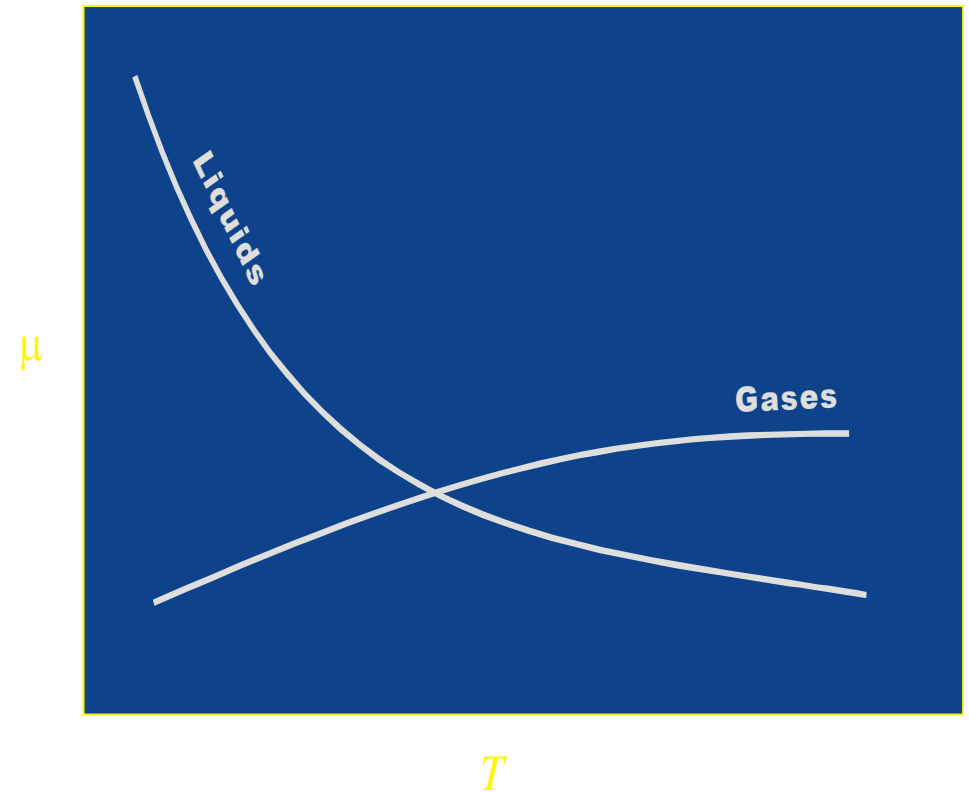
# Parameters Effects

## Effect of temperature

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

## Effect of pressure

- Increases with pressure



# Discussion

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What is the importance of viscosity in the oil industry?