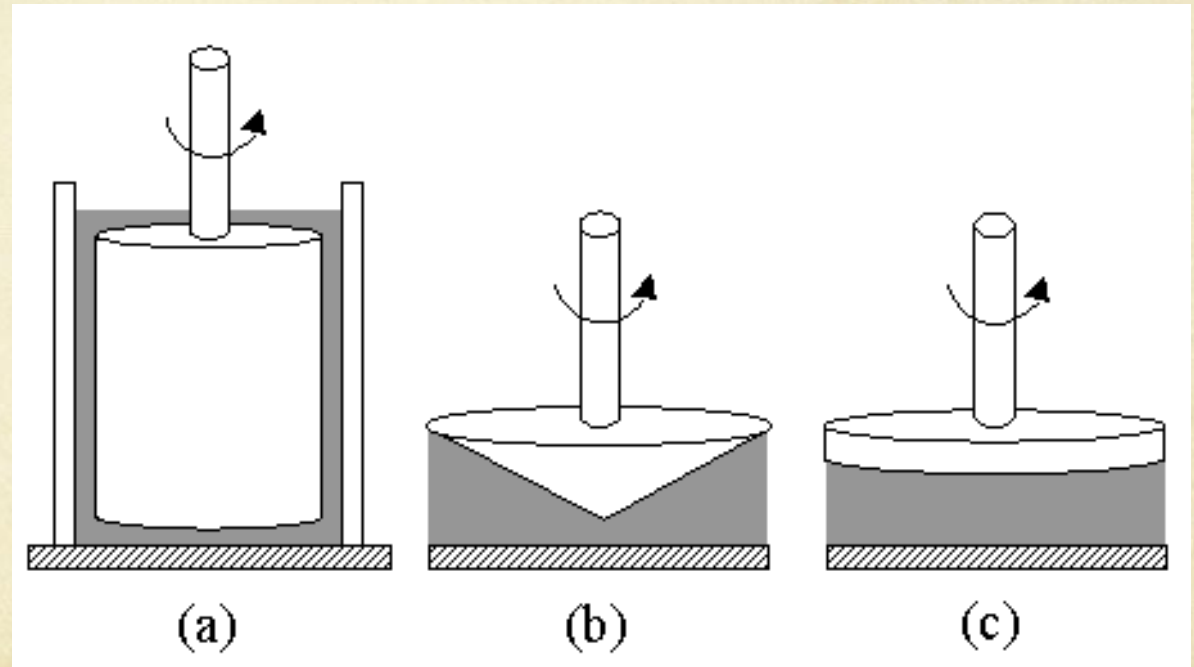# Viscous Fluids

Viscous Fluids

○ Viscosity is how engineers measure the resistance of fluids when being deformed:

$$\tau = \mu(du/dy)$$

○ The less viscous the fluid, the greater its ease of movement.

○ Viscosity is useful for calculating the force needed to move a fluid. For example, in these industries:

  ○ petroleum
  ○ printing
  ○ food and beverages

Measuring Viscosity: Rheometer

(a)   (b)   (c)

Fluid Behavior: Newtonian

- Newtonian identified by
  - linear behavior
  - constant viscosity that is independent of velocity

- Slope is defined as the viscosity

- Examples:
 - water
  - gasoline
  - most gases
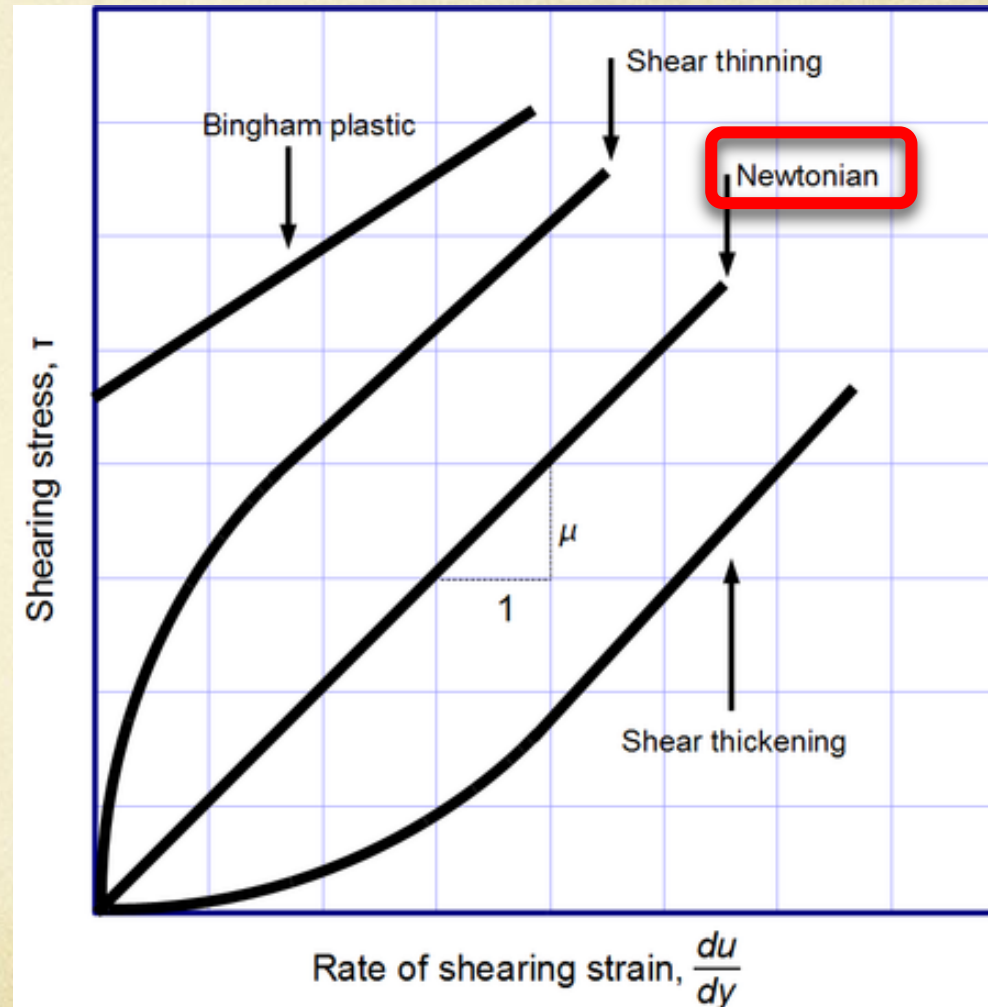
Fluid Behavior: shear thinning

- Shear thinning identified by: viscosity decreases as velocity increases

- Scientists do not fully understand what causes this phenomenon

- Examples:
  - ketchup
  - whipped cream
  - paint
  - motor oil
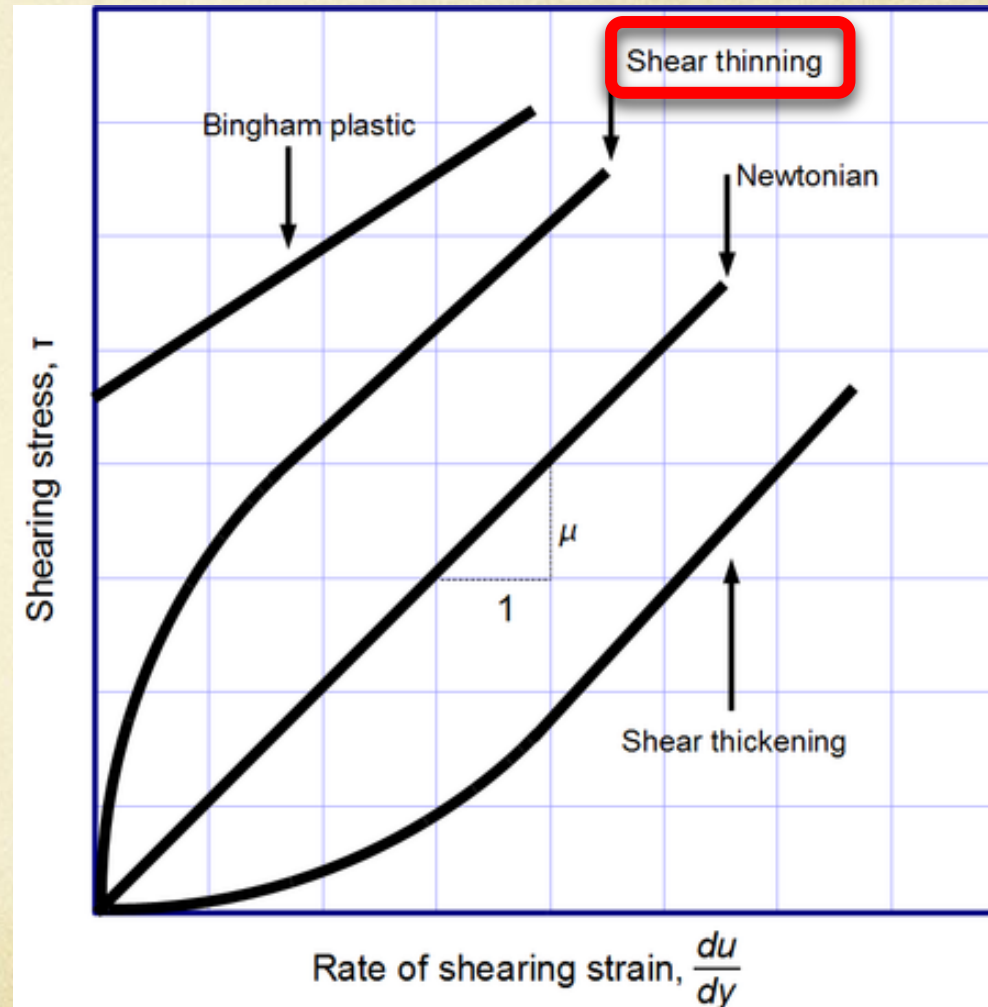
Fluid Behavior: shear thickening

- Shear thickening identified by: viscosity increases as velocity increases

- Due to closely packed particles that are combined with enough fluid to fill the space between them

- Examples:
  - body armor
  - viscous coupling unit (traction control)
  - cornstarch
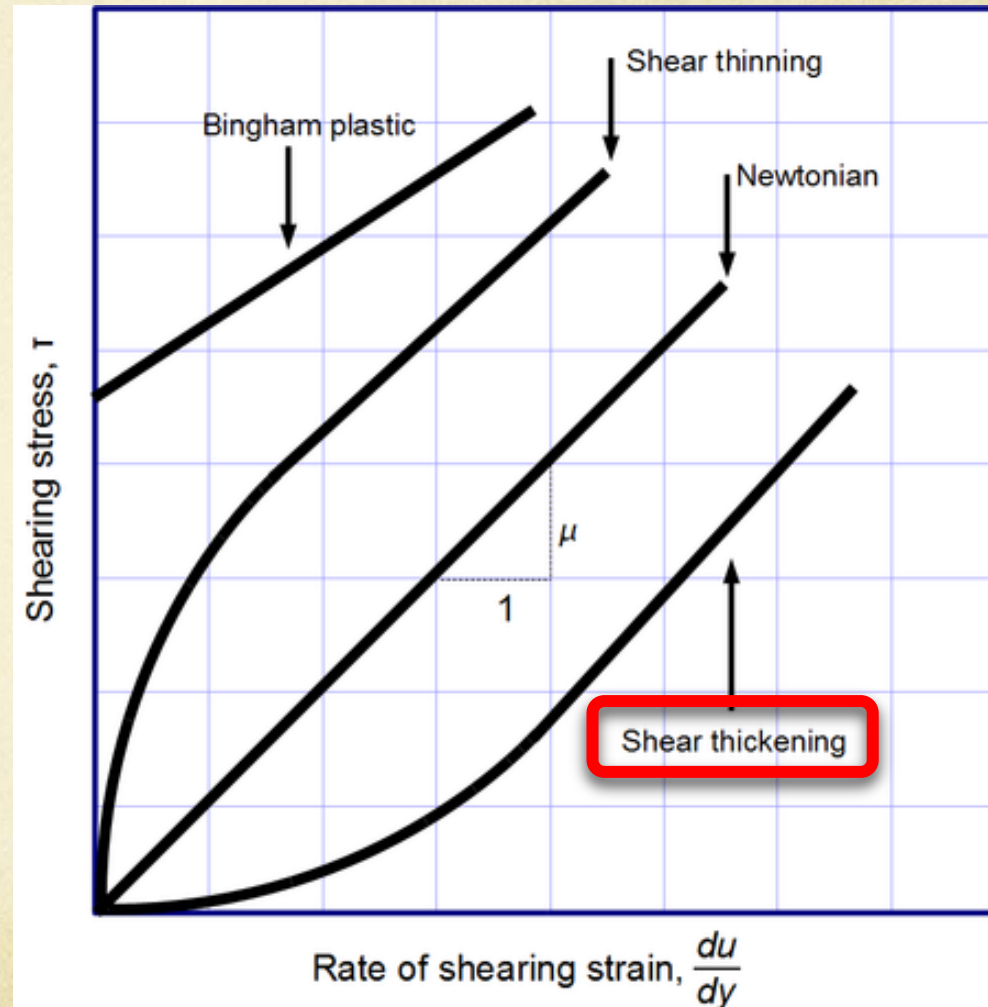
Fluid Behavior: Bingham plastic

○ Bingham plastic behaves as a solid at low stresses, but flows as a viscous fluid at high stresses

○ Due to particles in material having weak bonds that can be broken, allowing material to flow. Yet, when stress is gone, the bonds form again.

○ Example:
   ○ toothpaste

Bingham plastic
Shear thinning
Newtonian
Shear thickening

Shearing stress, τ

μ

1

Rate of shearing strain, $\frac{du}{dy}$