Chap. 2 What is a fluid and how much so?

Three phases : solid / liquid / gas
(liquid / gas = fluid)

· solids : resist shear deformation

$$\frac{F}{S} = G\theta$$: Hookean solid

G : shear modulus

· fluids : cannot resist shear deformation

$$\frac{F}{S} = \mu\dot{\theta}$$: Newtonian fluid

$\dot{\theta} = \frac{d\theta}{dt}$: shear rate [1/s] $(= \frac{du}{dy})$

μ : (dynamic) viscosity [Pa·s]

* Deborah number

$$De = \frac{\text{observation time}}{\text{relaxation time}}$$

$$= \frac{\text{time a process takes}}{\text{time for significant plastic deformation}}$$

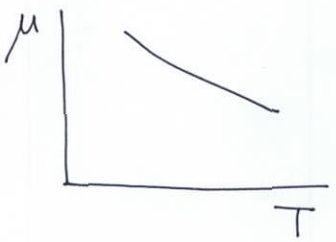
$\ll 1$ ~ solid

$\gg 1$ ~ fluid

In this course, we shall assume (mostly) fluids are Newtonian, continua, incompressible flows are steady.

§ Inverse viscosity - temperature relationship

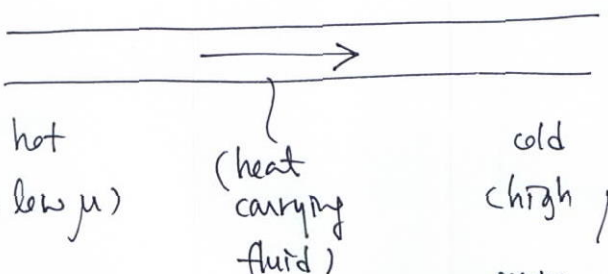
$T \downarrow - \mu \uparrow$



- sinking rate ↑ as T ↑ : shape change to reduce sinking rate
  Fig. 2.5 (water flea)

- as T ↑ - μ ↓ - drag ↓ : whale, tuna release body heat ?

internal circulation



more energy consumption