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Chapter 1
FLUID PROPERTIES

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Learning Outcomes

Upon completing this chapter, the students are expected to be able to:
1. *State the fluid phases and the types of fluid.*
2. *List and define the physical properties of fluid.*
3. *Relate each fluid property.*
4. *Calculate the fluid properties.*

1.1) Introduction

a) Phases of Fluid

Liquid – incompressible (water, oil, etc)
Gas – compressible (water vapor, etc)

b) Types of Fluid

Ideal Fluid – No viscosity, no friction while moving
Real Fluid – With viscosity, have friction while moving

1.2) Fluid Properties

Only physical properties will be discussed (Not on chemical properties)

a) **Density, ρ**

$$Density = \frac{Mass}{Volume} \qquad \boxed{\rho = \frac{m}{V}} \qquad \text{kg/m}^3$$

Example: Plain water, ρ = 1000 kg/m^3
Mercury, ρ = 13570 kg/m^3

b) **Specific Gravity, *sg***

Is also known as Relative Density.

$$SpecificGravity = \frac{FluidDensity}{WaterDensity} \qquad \boxed{sg = \frac{\rho_{fluid}}{1000}} \qquad \text{no unit}$$

$$\therefore \rho_{fluid} = 1000(sg)$$

c) **Specific Weight, γ**

$$Specific Weight = \frac{Weight}{Volume} \qquad \text{N/m}^3$$

$$\gamma = \frac{W}{V} = \frac{mg}{V} \qquad \text{but} \qquad \frac{m}{V} = \rho$$

therefore $\boxed{\gamma = \rho g}$ where g = gravitational acceleration
= 9.81 m/s^2

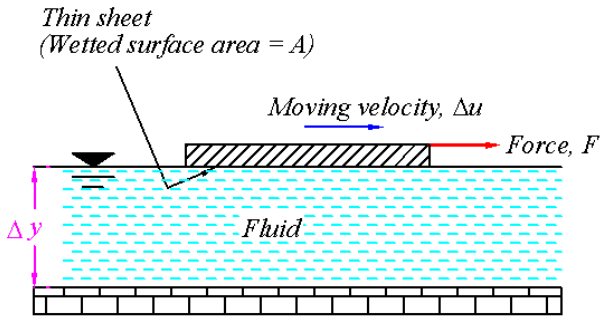
d) **Specific Volume, V_S**

$$Specific Volume = \frac{Volume}{mass} \qquad V_S = \frac{V}{m} \qquad \text{m}^3/\text{kg}$$

$$\boxed{V_S = \frac{1}{\rho}}$$

e) **Dynamic Viscosity, μ**

Is the fluid property that resists shear force.
Is the shear force per unit area to drag a thin sheet on a fluid.



$$\boxed{\mu = \tau \frac{\Delta y}{\Delta u}} \qquad \text{unit} = \frac{Ns}{m^2} \quad \text{or} \quad \text{Pa.s} \quad \text{or} \quad \frac{kg}{m.s} \qquad \text{where} \quad \tau = \frac{F}{A}$$

Example: Water flow easily than oil.
Oil is viscous than water.

f) **Kinematics Viscosity, υ**

$$\boxed{\upsilon = \frac{\mu}{\rho}} \qquad \frac{m^2}{s}$$

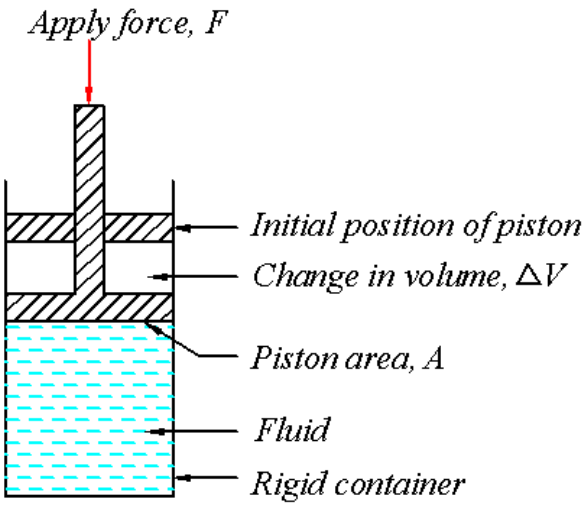
g) **Modulus of Elasticity, *E***

The concept of modulus of elasticity of a fluid is illustrated in the following figure, where:

ΔP = change in pressure (Pa) where $P = \frac{F}{A}$

ΔV = change in volume (m^3)

V_1 = Initial volume before the pressure is applied (m^3)



Then, $\boxed{E = -\frac{V_1(\Delta P)}{\Delta V}}$ unit = Pa or $\frac{N}{m^2}$

h) Surface Tension, σ (N/m)

i) Capillarity

j) Vapor Pressure, P_v

Note: All physical properties of fluid are depends on the fluid temperature.