

HYDRAULICS

$$\rho = \frac{m}{v} : \frac{kg}{m^3} \text{ Density}$$

$$V_s = \frac{1}{\rho} : \frac{m^3}{kg} \text{ Specific Volume}$$

$$\gamma = \frac{W}{v} = \rho g : \frac{N}{m^3} \text{ Unit Weight}$$

$$G_s = \frac{\rho_s}{\rho_w} = \frac{\rho_s}{\rho_w} = \frac{\gamma_s}{\gamma_w} \text{ Specific gravity}$$

water at 4°C
 $\gamma = 62.5 \text{ lb/ft}^3 = 9.81 \text{ kN/m}^3$
 $\rho = 1.94 \text{ slugs/ft}^3 = 1000 \text{ kg/m}^3$
 $s = 1$

$$\mu = \frac{\tau}{\frac{du}{dy}} : \text{po} : \text{sec Absolute Viscosity}$$

where
 $\tau = \text{lb/ft}^2 \text{ or Pa}$
 $\mu = \text{lb} \cdot \text{sec/ft}^2 \text{ or Pa} \cdot \text{sec}$
 $y = \text{ft or m}$
 $U = \text{ft/s or m/s}$

$$\nu = \frac{\mu}{\rho} : \text{m}^2/\text{s Kinetic Viscosity}$$

where
 $\mu = \text{Pa} \cdot \text{sec}$
 $\rho = \text{kg/m}^3$
 note:
 1 poise = 1 dyne · s/cm²
 1 stroke = 0.0001 m²/s
 1 dyne = 10⁻⁵ N

$$p = \frac{4\sigma}{d} : \frac{N}{m} \text{ Surface Tension } \sigma$$

$$h = \frac{4\sigma \cos \theta}{\gamma d} : \text{m Capillary}$$

$$h = \frac{4\sigma}{\gamma d} : \text{m Capillary (non circular)}$$

$$h = \frac{2\sigma \cos \theta}{\rho g r} : \text{m Capillary (tube)}$$

$$I_g = \frac{bh^3}{36} : \text{Triangle}$$

Flow rate

$$Q = Av : \text{Volume flow rate}$$

$$M = \rho Q : \text{Mass flow rate}$$

$$W = \gamma Q : \text{Weight flow rate}$$

where

$$Q = \text{discharge} : \text{m}^3/\text{s}$$

$$A = \text{cross-sectional Area} : \text{m}^2$$

$$v = \text{velocity} : \text{m/s}$$

$$\rho = \text{density} : \text{kg/m}^3$$

$$\gamma = \text{weight density} : \text{N/m}^3$$

$$z : \text{Elevation Head}$$

$$E_s = \frac{\Delta P}{\frac{\Delta V}{V}} : \text{MPa Bulk Modulus}$$

$$\beta = \frac{1}{E_s} : \frac{1}{\text{MPa}} \text{ Compressibility}$$

$$p = \frac{P}{RT} : \text{Ideal Gas}$$

where

$$P = \text{absolute Pressure} : \text{Pa}$$

$$R = \text{J/kg} \cdot ^\circ\text{K}$$

$$T = ^\circ\text{K}$$

$$R = 287 \text{ J/kg} \cdot ^\circ\text{K} : 1.716 \text{ lb} \cdot \text{ft/slug} \cdot ^\circ\text{K}$$

$$^\circ\text{K} = ^\circ\text{C} + 273 = ^\circ\text{F} + 460$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} : \text{New Ideal Gas}$$

$$P_1 V_1 = P_2 V_2 : \text{Isothermal}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} : \text{Isobaric}$$

$$C = \sqrt{\frac{E_s}{\rho}} = \sqrt{\frac{1}{\beta \rho}} : \text{Pressure Disturbance}$$

$$P_{abs} = P_{gauge} + P_{atm} \text{ Pressure abs}$$

$$P_{atm} = 101.325 \text{ kPa}$$

$$p = \frac{F}{A} : \text{stress formula}$$

$$h = \frac{p}{\gamma} : \text{m Pressure Head}$$

$$F = pA : \text{N force on plane surface}$$

$$F = \gamma \bar{h} A \text{ Force}$$

$$\bar{h} = \text{distance from centroid}$$

$$F = pA : \text{N force on plane surface}$$

$$I_g = \frac{bh^3}{12} : \text{Triangle}$$

$$Q_1 = Q_2 = Q_3$$

$$A_1 v_1 = A_2 v_2 = A_3 v_3 : \text{Incompressible}$$

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2 = \rho_3 A_3 v_3 : \text{Compressible}$$

$$\gamma_1 A_1 v_1 = \gamma_2 A_2 v_2 = \gamma_3 A_3 v_3 : \text{Compressible}$$

$$\frac{v^2}{2g} : \text{Velocity Head}$$

$$\frac{p}{\gamma} : \text{Pressure Head}$$

$$E = \frac{v^2}{2g} + \frac{p}{\gamma} + z : \text{Total Head}$$

$$T = \frac{PD}{2} : \text{Tensile Force}$$

$$s = \frac{PD}{2t} : \text{Tensile (thickness)}$$

$$P = \gamma_w h : \text{Kpa Pressure}$$

$$Bf = W : \text{Bouyancy Force}$$

$$\gamma V = W$$

$$Bf = W_{obj} + W_{applied} : \text{Total BF}$$

$$\tan \theta = \frac{a}{g} : \text{Horizontal}$$

$$\tan \theta = \frac{a_h}{g \pm a_v} : \text{Inclined}$$

$$p = \delta h \left(1 \pm \frac{a}{g} \right) : \text{Vertical}$$

Note:

downward -
 upward +
 acceleration +
 deceleration -

Rotating Vessels

$$y = \frac{\omega^2 r^2}{2g} : (\text{radius})$$

$$y = \frac{\omega^2 x^2}{2g} : (x \text{ is given})$$

where

$$\omega = \text{Angular velocity (rpm)}$$

$$y = \text{height}$$

note

$$1 \text{ rev} = 2\pi \text{ rad}$$

$$1 \frac{\text{rad}}{\text{sec}} = \frac{30}{\pi} \text{ rpm}$$

$$P = Q\gamma E : \text{Power}$$

$$\eta = \frac{\text{Output}}{\text{Input}} \times 100\% : \text{Efficiency}$$

note

$$1 \text{ hp} = 746 \text{ Watts} = 550 \text{ ft} \cdot \text{lb/sec}$$

$$1 \text{ watt} = 1 \text{ N} \cdot \text{m/s} = 1 \text{ joules/sec}$$

$$RN = \frac{VD}{\nu} : \text{Reynolds Number}$$

Where

$$V = \text{Velocity}$$

$$D = \text{inside Diameter}$$

$$\nu = \text{kinetic Density}$$

$$RN = \frac{VD}{\nu}$$

where

$$\rho = \text{density}$$

$$\mu = \text{dynamic viscosity}$$

note

$$< 2100 - \text{Laminar}$$

$$> 2100 - \text{turbulent}$$

Hidrolic Engineering Formulas

Jiyuan Zhang



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