TABLE F.2 Commonly Used Equations

Ideal gas law
$p = \rho RT$ (Eq. 1.10, p. 14)

Specific weight
$\gamma = \rho g$ (Eq. 2.3, p. 31)

Specific gravity
$S = \dfrac{\rho}{\rho_{H_2O \text{ at } 4°C}} = \dfrac{\gamma}{\gamma_{H_2O \text{ at } 4°C}}$ (Eq. 2.5, p. 32)

Kinematic viscosity
$\nu = \mu/\rho$ (Eq. 2.15, p. 38)

Definition of viscosity
$\tau = \mu \dfrac{dV}{dy}$ (Eq. 2.16, p. 39)

Pressure equations
$p_{gage} = p_{abs} - p_{atm}$ (Eq. 3.3a; p. 62)
$p_{vacuum} = p_{atm} - p_{abs}$ (Eq. 3.3b, p. 62)

Hydrostatic equation
$\dfrac{p_1}{\gamma} + z_1 = \dfrac{p_2}{\gamma} + z_2 = \text{constant}$ (Eq. 3.10a, p. 66)
$p_z = p_1 + \gamma z_1 = p_2 + \gamma z_2 = \text{constant}$ (Eq. 3.10b, p. 66)
$\Delta p = -\gamma \Delta z$ (Eq. 3.10c, p. 66)

Manometer equations
$p_2 = p_1 + \sum_{\text{down}} \gamma_i h_i - \sum_{\text{up}} \gamma_i h_i$ (Eq. 3.21, p. 74)
$h_1 - h_2 = \Delta h(\gamma_B/\gamma_A - 1)$ (Eq. 3.22, p. 75)

Hydrostatic force equations (flat panels)
$F_P = \bar{p}A$ (Eq. 3.28, p. 80)
$y_{cp} - \bar{y} = \dfrac{\bar{I}}{\bar{y}A}$ (Eq. 3.33, p. 81)

Buoyant force (Archimedes equation)
$F_B = \gamma V\!\!\!-_D$ (Eq. 3.41a, p. 87)

The Bernoulli equation
$\left(\dfrac{p_1}{\gamma} + \dfrac{V_1^2}{2g} + z_1\right) = \left(\dfrac{p_2}{\gamma} + \dfrac{V_2^2}{2g} + z_2\right)$ (Eq. 4.21b, p. 133)
$\left(p_1 + \dfrac{\rho V_1^2}{2} + \rho g z_1\right) = \left(p_2 + \dfrac{\rho V_2^2}{2} + \rho g z_2\right)$ (Eq. 4.21a, p. 133)

Coefficient of pressure
$C_p = \dfrac{p_z - p_{zo}}{\rho V_o^2/2} = \dfrac{h - h_o}{V_o^2/(2g)}$ (Eq. 4.47, p. 147)

Volume flow rate equation
$Q = \bar{V}A = \dfrac{\dot{m}}{\rho} = \int_A V\,dA = \int_A \mathbf{V} \cdot d\mathbf{A}$ (Eq. 5.10, p. 174)

Mass flow rate equation
$\dot{m} = \rho A\bar{V} = \rho Q = \int_A \rho V\,dA = \int_A \rho \mathbf{V} \cdot d\mathbf{A}$ (Eq. 5.11, p. 174)

Continuity equation
$\dfrac{d}{dt}\int_{cv} \rho\, dV\!\!\!- + \int_{cs} \rho \mathbf{V} \cdot d\mathbf{A} = 0$ (Eq. 5.28, p. 183)
$\dfrac{d}{dt}M_{cv} + \sum_{cs} \dot{m}_o - \sum_{cs} \dot{m}_i = 0$ (Eq. 5.29, p. 183)
$\rho_2 A_2 V_2 = \rho_1 A_1 V_1$ (Eq. 5.33, p. 189)

Momentum equation
$\sum \mathbf{F} = \dfrac{d}{dt}\int_{cv} \mathbf{v}\rho\, dV\!\!\!- + \int_{cs} \mathbf{v}\rho \mathbf{V} \cdot d\mathbf{A}$ (Eq. 6.7, p. 213)
$\sum \mathbf{F} = \dfrac{d(m_{cv}\mathbf{v}_{cv})}{dt} + \sum_{cs} \dot{m}_o \mathbf{v}_o - \sum_{cs} \dot{m}_i \mathbf{v}_i$ (Eq. 6.10, p. 213)

Energy equation
$\left(\dfrac{p_1}{\gamma} + \alpha_1 \dfrac{\bar{V}_1^2}{2g} + z_1\right) + h_p = \left(\dfrac{p_2}{\gamma} + \alpha_2 \dfrac{\bar{V}_2^2}{2g} + z_2\right) + h_t + h_L$ (Eq. 7.29; p. 262)

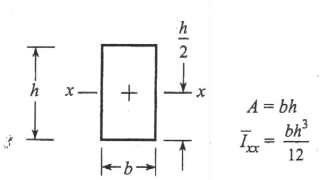
The power equation
$P = FV = T\omega$ (Eq. 7.3, p. 255)
$P = \dot{m}gh = \gamma Q h$ (Eq. 7.31; p. 265)

Efficiency of a machine
$\eta = \dfrac{P_{output}}{P_{input}}$ (Eq. 7.32; p. 267)

Reynolds number (pipe)
$\text{Re}_D = \dfrac{VD}{\nu} = \dfrac{\rho VD}{\mu} = \dfrac{4Q}{\pi D \nu} = \dfrac{4\dot{m}}{\pi D \mu}$ (Eq. 10.1, p. 361)

Combined head loss equation
$h_L = \sum_{\text{pipes}} f \dfrac{L}{D}\dfrac{V^2}{2g} + \sum_{\text{components}} K \dfrac{V^2}{2g}$ (Eq. 10.45, p. 382)

Friction factor f (Resistance coefficient)
$f = \dfrac{64}{\text{Re}_D}$ $\quad \text{Re} \le 2000$ (Eq. 10.34, p. 370)
$f = \dfrac{0.25}{\left[\log_{10}\left(\dfrac{k_s}{3.7D} + \dfrac{5.74}{\text{Re}_D^{0.9}}\right)\right]^2}$ (Re ≥ 3000) (Eq. 10.39, p. 375)



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