Introduction

Fluid Power with Applications, 7th ed., is a great introduction to the field of hydraulics and pneumatics. Most of the equations are algebraic, such as Equation 3-6: $T = F\,R$, where the units of torque T depend on the units used for force F and lever arm R. Some equations include constants that are missing their units. For example, Equation 3-7: $HP = \frac{T\,N}{63{,}000}$. The units for the constant are $\frac{\text{hp}}{\text{in. lb. rpm}}$, so the equation only works if you enter torque T in units of in.·lb. and rotational speed N in units of rpm. This handout lists canned equations used in the textbook and the units for their constants.

Chapter 3

Eq. 3-5, $HP = \frac{F\,v}{550}$ where power HP = hp, force F = lb., velocity v = ft./s, and the constant = $550\frac{\text{lb. ft.}}{\text{hp s}}$.

Eq. 3-7, $HP = \frac{T\,N}{63{,}000}$ where power HP = hp, torque T = in.·lb., rotational speed N = rpm, and the constant = $\frac{63{,}000\,\text{in.}\cdot\text{lb.}\cdot\text{rpm}}{\text{hp}}$.

Eq. 3-25, $HHP = \frac{p\,Q}{1714}$ where hydraulic horsepower HHP = hp, pressure p = psi, flow rate Q = gpm, and the constant = $\frac{1714\,\text{psi}\cdot\text{gpm}}{\text{hp}}$.

Eq. 3-29, $H_P = \frac{3950\,HHP}{Q\;\;SG}$ where pump head H_P = ft., hydraulic horsepower HHP = hp, flow rate Q = gpm, and the constant = $\frac{3950\,\text{ft.}\cdot\text{gpm}}{\text{hp}}$.

Eq. 3-37, $\text{Power} = \frac{T\,\omega}{1000}$ where power = kW, torque T = N·m, rotational speed ω = rad/s, and the constant = $\frac{1000\,\text{N}\cdot\text{m}}{\text{kW}\cdot\text{s}}$.

Eq. 3-37, $\text{Power} = \frac{T\,N}{9550}$ where power = kW, torque T = N·m, rotational speed N = rpm, and the constant = $\frac{9550\,\text{N}\cdot\text{m}\cdot\text{rpm}}{\text{kW}}$.

Chapter 4

Eq. 4-2, $N_R = \frac{7740\,v\,D\,SG}{\mu}$ where fluid velocity v = ft./s, pipe diameter D = in., absolute viscosity μ = cP, and the constant = $7740\frac{\text{cP}\cdot\text{s}}{\text{ft.}\cdot\text{in.}}$.

Eq. 4-2M, $N_R = \frac{1000\,v\,D\,SG}{\mu}$ where fluid velocity v = m/s, pipe diameter D = mm, absolute viscosity μ = cP, and the constant = $1000\frac{\text{cP}\cdot\text{s}}{\text{m}\cdot\text{mm}}$.

Eq. 4-3, $N_R = \frac{7740\,v\,D}{\nu}$ where fluid velocity v = ft./s, pipe diameter D = in., kinematic viscosity ν = cP, and the constant = $7740\frac{\text{cS}\cdot\text{s}}{\text{ft.}\cdot\text{in.}}$.

Eq. 4-3M, $N_R = \frac{1000\,v\,D}{\nu}$ where fluid velocity v = m/s, pipe diameter D = mm, kinematic viscosity ν = cP, and the constant = $1000\frac{\text{cS}\cdot\text{s}}{\text{m}\cdot\text{mm}}$.

Chapter 5

Eq. 5-2, $Q_T = \frac{V_D\,N}{231}$ where pump flow rate Q_T = gpm, volumetric displacement V = in.^{3}/rev., rotational speed N = rpm, and the constant = $\frac{231\,\text{in.}^3}{\text{gal.}}$.

Chapter 6

Eq. 6-5, $HP=\frac{vF}{550}$ where cylinder power HP = hp, cylinder velocity v = ft./s, force F = lb., and the constant = $\frac{550\,\text{hp}\cdot\text{s}}{\text{ft.}\cdot\text{lb.}}$.

Chapter 8

Eq. 8-1, $Q=38.1\,C\,A\sqrt{\frac{\Delta p}{SG}}$ where flow rate Q = gpm, orifice area A = in.^{2}, pressure p = psi, and the constant = $\frac{38.1\,\text{gpm}}{\text{in.}^2\sqrt{\text{psi}}}$.

Eq. 8-1M, $Q=0.0851\,C\,A\sqrt{\frac{\Delta p}{SG}}$ where flow rate Q = Lpm, orifice area A = mm^2, pressure p = kPa, and the constant = $\frac{0.0851\,\text{Lpm}}{\text{mm}^2\sqrt{\text{kPa}}}$.

Chapter 13

Eq. 13-8, $V_R=\frac{14.7\,t(Q_T-Q_C)}{p_{max}-p_{min}}$ where receiver size V_R = ft.^{3}, time t = min., flow rate Q = scfm, pressure p = psi, and the constant = 14.7 psia.

Eq. 13-8M, $V_R=\frac{101\,t(Q_T-Q_C)}{p_{max}-p_{min}}$ where receiver size V_R = m^3, time t = min., flow rate Q = std. m^3/min., pressure p = kPa, and the constant = 101 kPa$_{abs}$.

Eq. 13-9, $\text{Theoretical power}=\frac{p_{in}Q}{65.4}\left[\left(\frac{p_{out}}{p_{in}}\right)^{0.286}-1\right]$ where power = hp, pressure p = psia, flow rate Q = scfm, and the constant = $\frac{65.4\,\text{psi}\cdot\text{scfm}}{\text{hp}}$.

Eq. 13-9M, $\text{Theoretical power}=\frac{p_{in}Q}{17.1}\left[\left(\frac{p_{out}}{p_{in}}\right)^{0.286}-1\right]$ where power = kW, pressure p = kPa$_{abs}$, flow rate Q = std. m^3/min., and the constant = $\frac{17.1\,\text{kPa}\cdot\text{m}^3}{\text{kW}\cdot\text{min}}$.

Chapter 14

Eq. 14-3, $p_f=\frac{0.1025\,L\,Q^2}{3600\,CR\,d^{5.31}}$ where pressure drop p_f = psi, pipe length L = ft., flow rate Q = scfm, pipe diameter d = in., one constant = $\frac{0.1025\,\text{in.}^{5.31}}{\text{ft.}^7\cdot\text{s}^2}$, and the second constant = $\frac{3600\,\text{s}^2}{\text{min.}^2}$.