Reference Booklet

for the

L3
(CORE COMPETENCY) EXAM

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Heat Transfer Correlations

Correlation	Conditions
$Nu_D = 4.36$	Circular tube, Laminar, fully developed, uniform $q''_{s'}$, $Pr \geq 0.6$
$Nu_D = 3.66$	Circular tube, Laminar, fully developed, uniform T_s, $Pr \geq 0.6$
$Nu_D = 0.023Re_D^{4/5}Pr^{1/3}$	Circular tube, turbulent, fully developed, $0.6 \leq Pr \leq 160$ $Re_D \geq 10{,}000$, $(L/D) \geq 10$
$Nu_x = 0.0296Re_x^{4/5}Pr^{1/3}$	Flat plate, turbulent, local, T_f, $Re_x \leq 10^8$, $0.6 \leq Pr \leq 60$
$\overline{Nu}_L = \left(0.037Re_L^{4/5} - 871\right)Pr^{1/3}$	Flat plate, mixed, average, T_f, $Re_{x,c} = 5 \times 10^5$, $Re_L \leq 10^8$, $0.6 < Pr < 60$
$\overline{Nu}_D = 2 + 0.6Re_D^{1/2}Pr^{1/3}$	Falling drop or flow over a sphere, average, T_∞
$Nu_D = 0.027Re_D^{0.805}Pr^{1/3}$	External flow (cross flow) over a cylinder, average, T_f, $4\text{x}10^4 < Re_D < 4\text{x}10^5$, $Pr \geq 0.7$

Useful Equations

$$\text{Friction Head Loss} = h_L = f\frac{L}{D}\frac{V^2}{2g}$$

$$\frac{\Delta P}{\rho} + \frac{\Delta V^2}{2} + g\Delta z = 0$$

$$\Delta\left(\frac{P}{\rho}\right) + \frac{\Delta V^2}{2} + g\Delta z = w_s - gh_L$$

$$x_i P_i^{sat} = y_i P$$

$$q'' = -k\nabla T$$

Steady state CSTR material balance of species A

$$0 = F_{A,in} - F_{A,out} + r_A V$$

$$J_A^* = -cD_{AB}\nabla x_A$$

Definition of conversion of A

$$F_{A,out} = F_{A,in}(1 - X_A)$$

$$\Delta T_{\text{lm}} = \frac{[(\Delta T)_1 - (\Delta T)_2]}{\ln[(\Delta T)_1/(\Delta T)_2]}$$

Surface Area of a Sphere

$$SA_{sphere} = 4\pi r^2$$

Dimensionless variables/groups

$$Sc = \frac{\nu}{D_{AB}} \qquad Pr = \frac{\nu}{\alpha} = \frac{C_p\mu}{k} \qquad Nu_D = \frac{hD}{k} \qquad Sh_D = \frac{h_m D}{D_{AB}}$$

Other Information Available in the Printed Booklet

1. Conversion Factors (e.g. inside the cover of many textbooks)
2. Values of the gas constant
3. Moody friction factor diagram
4. Antoine Equation Constants (e.g. Table B.4, Felder and Rousseau)
5. Steam tables (e.g. Tables B.5-B.7, Felder and Rousseau)