Packed Column Sizing

Note Title 11/11/2013

Column Diameter (Sec. 10.10)

1) % of flooding (65% - 90%)
   (Use 70% default)
2) Specific pressure drop

Procedure:

1) Choose point in column to make calculation (e.g., top or bottom)

2) Physical properties
   a) Density of gas and liquid ρ_G and ρ_L
   b) Liquid viscosity μ in cP
   c) $\psi = \rho_{water}/\rho_L$
   d) F = packing factor from Table 10-3
   e) $g_c = 32.2$
   f) L/G = ratio of liquid to gas mass flow rates

3) For % Flooding
   a) Calculate $F_{LV} = \frac{L}{G}\left(\frac{\rho_G}{\rho_L}\right)^{1/2}$
      (mass flow rates)
   b) In Fig. 10-27, this is the x value. Determine y value at flooding (or calculate w/ Eq. 10-39a)

c) y-value is $\dfrac{G'^2 F \psi \mu^{0.2}}{\rho_G \rho_L g_c}$

Know everything but G'

Solve for G' = specific gas flowrate

$= lb/ft^2 s$ **

d) Now know G' and $G \Rightarrow$

Solve for area

e) Calculate diameter from area

f) Determine ΔP $\dfrac{\text{inches } H_2O}{\text{ft packing}}$

from Fig 10.27 or Eq. 10-39b
where α and β are in Table 10-3

4) For specified ΔP

a) Choose ΔP (see p. 397 for guidelines)

b) Read y-value from Fig 10-27 and determine G' as before

or

Calculate G' from Eq. 10-39b

Note: $L' = \dfrac{L'}{G'} G' = \dfrac{L}{G} G'$

c) With $G' \Rightarrow$ area $\Rightarrow$ diameter

d) Check % flooding

See Example 10-4 and first half Example 16-2

Physical properties - can be obtained from physical properties package in software such as ChemCAD

Example of calculation:

- $F_{LV} = 1.00 = \frac{L}{G}\left(\frac{\rho_G}{\rho_L}\right)^{1/2}$
- 25 mm Berl Saddles (ceramic)
- 65% flooding
- $\rho_V = 1.0$ lbm/ft^3
- $V = 1.0$ lbmol/s
- $M_V = 17.0$ lb/lbmol
- $\rho_{H_2O} = 62.4$ lbm/ft^3
- $\rho_L = 62.4$ lbm/ft^3
- $\mu = 1$ cP

From Table 10-3 $F = 110$

$$\frac{G'^2 F \Psi \mu^{0.2}}{\rho_G \rho_L g_c} = 0.022$$

$$G'^2 = \frac{(32.2)(1.0)(62.4)}{(110)(1)(1)^{0.2}}(0.022)$$

$$G'^2 = 0.402 \qquad G' = 0.634 \frac{lb}{ft^2 s}$$

at flooding!

G' at 65% of flooding =

$$(.65)\left(0.634 \frac{lb}{ft^2 s}\right) = 0.412 \frac{lb}{ft^2 s}$$

$$\text{Area} = \frac{\dot{V} M_v}{G'} = \frac{1.0 \frac{lbmol}{s} \; 17 \frac{lb}{lbmol}}{.412 \; lb/ft^2 s}$$

$$= 41.26 \; ft^2 = \frac{\pi D^2}{4}$$

$$D = 7.25 \; ft$$