SOLUTION

CHE 305 – Separation Processes
Spring 2010 – In Class Exercise on Column Sizing

Given:

- Flooding velocity = 0.8 m/s
- Operation at 85% of flooding

$$u = \frac{0.8\,m}{s}\left|0.85 = 0.68\,\frac{m}{s}\right.$$

- V = 100 kmol/hr
- T = 80 °C
- Pressure = 1 atm

$$\rho = \frac{n}{V} = \frac{P}{RT}$$

- Gas Constant R = 0.08206 L atm/mol K
- Each downcomer occupies 5% of the tray area
- Tray spacing is 0.6 m
- Total theoretical stages (by McCabe-Thiele) = 14 stages
- Partial Reboiler, Partial Condenser

Use the design criteria to do the following:

a. Determine the volumetric gas flow rate.

$$\dot{V} = \frac{100\,kmol}{hr}\left|\frac{10^3\,mol}{1\,kmol}\right|\frac{0.08206\,L\cdot atm}{1\,atm\cdot mol\cdot K}\left|\frac{353\,K}{1}\right|\frac{1\,m^3}{10^3\,L} = 2897\,\frac{m^3}{hr}$$

b. Determine the bubble area.

$$BA = \frac{\dot{V}}{u} = \frac{2897\,m^3}{hr}\left|\frac{s}{0.68\,m}\right|\frac{1\,hr}{3600\,s} = 1.18\,m^2$$

c. Determine the column cross-sectional area.

$$Area = \frac{1.18\,m^2}{(1-0.05-0.05)} = 1.31\,m^2 = \frac{\pi D^2}{4}$$

d. Determine the column diameter.

$$D = \sqrt{\frac{1.31(4)}{\pi}} = \boxed{1.29\,m}$$

e. Determine the column height.

$$(14-1-1)(0.6m) = \boxed{7.2m}$$