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Chapter 6. Special Fluid Topics

Practice Problems

1.

A 3 ft diameter column is packed with 1 in Intalox® saddles. 5000 lbm/hr of air at an average pressure of 1 atm and an average temperature of 70°F flows through the tower. The viscosity and density of air are 0.044 lbm/ft-hr and 0.075 lbm/ft^3, respectively. Use the Ergun equation to estimate the pressure drop through the dry packing.

(A)

0.29 psf/ft

(B)

1.00 psf/ft

(C)

1.44 psf/ft

(D)

3.00 psf/ft

Solutions

1.

As in *NCEES Handbook:* Liquid-Liquid Extraction Equipment: Packed Columns,

$$\begin{aligned}
\epsilon &= 0.73 \\
a_p &= 256\ \text{m}^2/\text{m}^3 = 78\ \text{ft}^2/\text{ft}^3 \\
D_p &= \frac{6\left(1-\epsilon\right)}{a_p} = \frac{(6)\left(1-0.73\right)}{78\ \frac{\text{ft}^2}{\text{ft}^3}} = 0.0207\ \text{ft}
\end{aligned}$$

The superficial gas velocity is

$$G_0 = \frac{\dot{m}_g}{A} = \frac{5000\ \frac{\text{lbm}}{\text{hr}}}{\left(\frac{\pi}{4}\right)\left(3\ \text{ft}\right)^2} = 707\ \text{lbm/hr-ft}^2$$

equationCHRM19001(b) is used to estimate the pressure drop in dry packing.

$$\begin{aligned}\frac{\Delta p}{L} &= \left(\frac{1-\epsilon}{\epsilon^3}\right)\left(\frac{G_0^2}{D_p g_c \rho_g}\right)\left(\frac{150\,(1-\epsilon)\,\mu_g^{'}}{D_p G_0} + 1.75\right) \\ &= \left(\frac{1-0.73}{(0.73)^3}\right)\left(\frac{\left(707\ \frac{\text{lbm}}{\text{hr-ft}^2}\right)^2}{(0.0207\ \text{ft})\left(32.2\ \frac{\text{ft-lbm}}{\text{lbf-sec}^2}\right) \times \left(0.075\ \frac{\text{lbm}}{\text{ft}^3}\right)\left(3600\ \frac{\text{sec}}{\text{hr}}\right)^2}\right) \\ &\quad \times \left(\frac{(150)\,(1-0.73)\left(0.044\ \frac{\text{lbm}}{\text{ft-hr}}\right)}{(0.0207\ \text{ft})\left(707\ \frac{\text{lbm}}{\text{hr-ft}^2}\right)} + 1.75\right) \\ &= 1.00\ \text{psf/ft}\end{aligned}$$

The answer is (B).