Josh Whitehead
ChEn 5103

HW8

1) $P_o = P_i - \frac{C_4 F L Q^2}{D^5}$

$C_4 = 2 \frac{atm\ s^2}{cm^2}$
$D = 2\ cm$
$L = 50\ cm$
$f = 0.0005$
$P_i = 2\ atm$
$Q = \frac{2L}{min} = \frac{2}{60}\frac{L}{sec} \cdot \frac{1000\ cm^3}{1L}$

$\therefore P_o = 0.264\ atm$

b) $\Delta P_M = \frac{P_i + P_o}{2} - P_f$

$P_f = 1\ atm$

$\therefore \Delta P_M = 0.132\ atm$

c) $J = k \ln\left(\frac{C_M}{C_B}\right)$

$k = 5 \frac{cm}{sec}$

$C_G = 100 \frac{g}{L}$
$C_B = 30 \frac{mg}{L} = \frac{0.03 g}{L}$

$\therefore J = 40.6 \frac{cm}{sec}$

d) $J = \frac{\Delta P_M}{R_G + R_M} \rightarrow R_G = \frac{\Delta P_M}{J} - R_M$

$R_M = 0.002 \frac{atm\ cm^2 s}{cm^3}$

$\therefore R_G = 0.0013 \frac{atm\ cm^2 s}{cm^3}$

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2.) $u_0 = \frac{D_p^2}{18\mu}(\rho_s - \rho_f)g$

$D_p = 150\,\mu m = 0.015\,cm$

$\mu = 1$ centipoise

$\rho_s = 1.02 \frac{g}{cm^3}$

$\rho_f = 1\ g/cm^3$

$g = 980 \frac{cm}{sec^2}$

$\therefore$

$u_0 = 2.82 \times 10^{-4} \frac{cm}{sec}$

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3) $\frac{dr}{dt} = \frac{D^2}{18\mu}(\rho_s - \rho_f)\omega^2 r$

$\rightarrow \int \frac{dr}{r} = \int \frac{D^2}{18\mu}(\rho_s - \rho_f)\omega^2 dt$

$\rightarrow \ln\left(\frac{r_1}{r_0}\right) = \frac{D^2}{18\mu}(\rho_s - \rho_f)\omega^2 t$

$r_1 = 15$ cm
$r_0 = 5$ cm

$\omega = 2\pi N$

$N = 500 \frac{1}{min} \cdot \frac{1}{60 sec}$

$D = 10 \mu m = 0.0010$ cm
$\mu = 1$ cP
$\rho_s = 1.05 \frac{g}{cm^3}$
$\rho_f = 0.997 g/cm^3$

$$t = \frac{\ln\left(\frac{r_1}{r_0}\right)}{\frac{D^2}{18\mu}(\rho_s - \rho_f)\omega^2} = 1.361 \times 10^5 sec$$

$= 37.8$ hrs