4.4

$$t_f = \frac{\mu \alpha \rho_c}{2\Delta P}\left(\frac{V_f}{A}\right)^2 + \frac{\mu R_m}{\Delta P}\left(\frac{V_f}{A}\right)$$

$R_m$ IS GIVEN SO ASSUME NOT NEGLIGIBLE

$A = 200 m^2 = 2 \times 10^6 cm^2$

$\Delta P = 75 kPa = 7.5 \times 10^5 g/cm s^2$

$\mu = 5.0 cP = 0.05 g/cm s$

$\alpha = 1 \times 10^{11} cm/g$

$R_m = 1 \times 10^8 cm^{-1}$

$\rho_c = 15 g/L = 0.015 g/cm^3$

$t_c = 45 s$

$t_f = 10 s$

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a) FIND RATE OF FILTRATION (VOLUME/TIME)

NOTE $V_f$ IS VOLUME/CYCLE!

$$10 = \frac{(0.05)(1\times10^{11})(0.015)}{2(7.5\times10^5)(2\times10^6)^2} V_f^2 + \frac{(0.05)(1\times10^8)}{(7.5\times10^5)(2\times10^6)} V_f$$

$$0 = 1.25\times10^{-11} V_f^2 + 3.33\times10^{-6} V_f - 10$$

SOLVE QUADRATIC...

$$V_f = \frac{-3.33\times10^{-6} + \sqrt{(3.33\times10^{-6})^2 - 4(1.25\times10^{-11})(-10)}}{2(1.25\times10^{-11})}$$

$V_f = 771{,}000 cm^3/cycle$

$= 771$ LITERS/CYCLE

THIS IS NOT ANSWER!

LET $Q$ = FILTRATION RATE

$$Q t_c = V_f$$

$$Q = \left(\frac{771\ L}{CYCLE}\right)\left(\frac{CYCLE}{45s}\right) = \underline{\underline{17.1\ LITERS/S}}$$

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b) How significant is $R_m$?

METHOD #1 — let $R_m = 0$ & compare filtration rate

$$1.25\times10^{-11} V_f^{\,2} = 10$$

$$V_f = 894{,}000\ cm^3/CYCLE$$

$$Q = \underline{19.9\ LITERS/S}$$

→ FILTRATION RATE WOULD BE 16% GREATER IF MEDIUM HAD NO RESISTANCE.

METHOD #1

$$R_m = 1\times10^{8}\ cm^{-1}$$

$$R_c = \alpha \rho_c \frac{V_f}{A} = (1\times10^{11})(0.015)\frac{771000}{2\times10^{6}}$$

$$R_c = 5.79\times10^{8}\ cm^{-1}$$

$$\text{FRACTION OF RESISTANCE BECAUSE OF } R_m = \frac{R_m}{R_c + R_m} = \frac{1}{6.79} = \underline{0.147}$$

→ MEDIUM IS 15% OF TOTAL RESISTANCE