ROWAN UNIVERSITY
CHEMICAL ENGINEERING - 0906-314

SPRING
RO-1

REVERSE OSMOSIS HW

(ADAPTATION OF 12-02.)

TABLE 12-2

i) CELLULOSE-3 ACETATE, DOW, HOLLOW FIBER $\%R = 97$

$J_w = 200\ L/m^2 d$

$\Delta P = 28\ bar$

$C_f = 0.3\%\ NaCl = 3000\ mg/l$

$T = 35°C$

$0.97 = 1 - \frac{C_p}{C_f}$

$\therefore C_p = 90\ mg/l$

$J_w = A_w(\Delta P - \Delta \pi)$

$A_w = \frac{J_w}{\Delta P - \Delta \pi}$

$$A_w = \frac{\left(200\ l/m^2 d\right)\left(\frac{1\ kg}{l}\right)\left(\frac{1000\ g}{kg}\right)\left(\frac{day}{24\ hr}\right)\left(\frac{hr}{3600\ sec}\right)}{\left[(28\ bar)\left(\frac{0.9869\ atm}{bar}\right) - \left(0.0114\ \frac{psi}{mg/l}\right)\left(\frac{atm}{14.7\ psi}\right)(3000 - 90\ mg/l)\right]}$$

$$A_w = \frac{2.3148\ g/m^2 sec}{(27.6332\ atm - 2.2567\ atm)}$$

$$A_w = 9.12 \times 10^{-2}\ g/m^2 \cdot sec \cdot atm \quad \leftarrow$$

$$J_s = J_w \frac{C_p}{C_w}$$

$$J_s = B_s \Delta C_s$$

$$B_s = \frac{J_s}{\Delta C_s} = \frac{\left(2.3148\ g/m^2 sec\right)\left(\frac{90\ mg/l}{10^6\ mg/l}\right)}{(3000 - 90\ mg/l)\left(\frac{g}{1000\ mg}\right)\left(\frac{1000\ l}{m^3}\right)}$$

$$B_s = 7.16 \times 10^{-8}\ m/sec \quad \leftarrow$$

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ii) UOP, COMPOSITE, SPIRAL WOUND

$\%R = 99.2$, $J_w = 600\ l/m^2 d$

$\Delta P = 63$ bar, $45°C$, $C_f = 3.5\%\ NaCl = 35{,}000\ mg/l$

$$0.992 = 1 - \frac{C_p}{C_f}$$

$$C_p = 280 \text{ mg/l}$$

$$A_w = \frac{J_w}{\Delta P - \Delta \pi}$$

$$A_w = \frac{\left(600 \frac{l}{m^2 d}\right)\left(\frac{1 kg}{l}\right)\left(\frac{1000 g}{kg}\right)\left(\frac{day}{24 hr}\right)\left(\frac{hr}{3600 sec}\right)}{\left[(63 bar)\left(0.9869 \frac{atm}{bar}\right) - \left(\frac{0.0114 psi}{mg/l}\right)\left(\frac{atm}{14.7 psi}\right)(35,000 - 280 mg/l)\right]}$$

$$A_w = \frac{6.9444 \text{ g/m}^2\text{-sec}}{62.1747 \text{ atm} - 26.9257 \text{ atm}}$$

$$A_w = 0.197 \text{ g/m}^2 \text{ sec atm} \leftarrow$$

$$J_s = B_s \Delta C_s \;;$$

$$B_s = \frac{J_s}{\Delta C_s} = \frac{\left(6.9444 \text{ g/m}^2\text{-sec}\right)\left(\frac{280 mg/l}{10^6 mg/l}\right)}{(35,000 - 280 mg/l)\left(\frac{g}{1000 mg}\right)\left(\frac{1000 l}{m^3}\right)}$$

$B_s = 5.60 \times 10^{-8}$ m/sec ←

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iii) TORAY, COMPOSITE, SPIRAL WOUND

$\%R = 99.7$

$J_w = 700\ l/m^2 day$

$\Delta P = 400$ bar

$C_F = 0.25\%\ NaCl = 2500$ mg/l

40 °C

$$A_w = \frac{J_w}{\Delta P - \Delta \pi}$$

$$R = 1 - \frac{C_p}{C_f}$$

$$0.997 = 1 - \frac{C_p}{2500\ mg/l}$$

$$C_p = 7.5\ mg/l$$

$$A_w = \frac{\left(700 \frac{l}{m^2 d}\right)\left(\frac{1\ kg}{l}\right)\left(\frac{1000 g}{kg}\right)\left(\frac{day}{24\ hr}\right)\left(\frac{hr}{3600\ sec}\right)}{\left[(400\ bar)\left(0.9869 \frac{atm}{bar}\right) - \left(0.0114 \frac{psi}{mg/l}\right)\left(\frac{atm}{14.7\ psi}\right)(2500 - 7.5\ mg/l)\right]}$$

$$A_w = \frac{8.1019\ g/m^2 sec}{(394.76\ atm - 1.933\ atm)} =$$

$$A_w = 2.062 \times 10^{-2}\ g/m^2\text{-sec-atm} \longleftarrow$$

$$B_s = \frac{J_s}{\Delta C_s} = \frac{(8.1019\ g/m^2 sec)\left(\frac{7.5\ mg/l}{10^6\ mg/l}\right)}{(2500 - 7.5\ mg/l)\left(\frac{g}{1000\ mg}\right)\left(\frac{1000\ l}{m^3}\right)}$$

$$B_s = 2.438 \times 10^{-8}\ m/sec \longleftarrow$$

(NOTE ΔP IS TOO LARGE FOR PRACTICAL RO APPLICATIONS. I THINK THERE IS AN ERROR IN TEXT AND ΔP IS REALLY 40 bar)