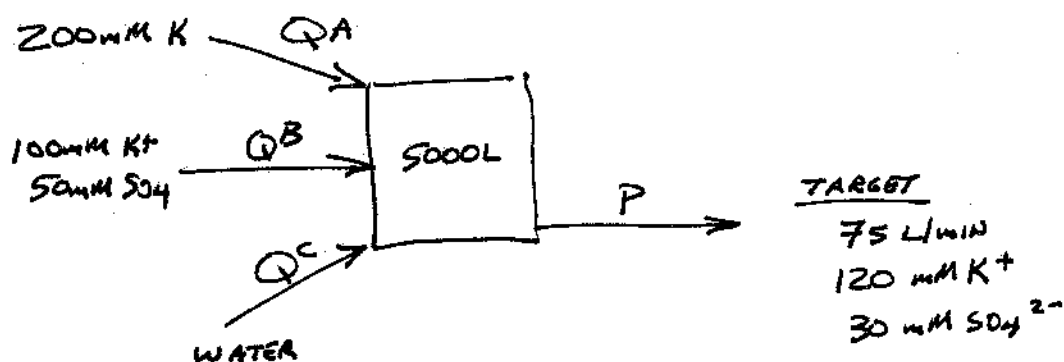


②



a) SO_4 BALANCE

$$\text{ACC} = \text{IN} - \text{OUT} + \text{GEN}$$

$$0 = Q_B(50) - 75(30)$$

$$Q_B = 45 \text{ L/min}$$

NOTE
50mM K_2SO_4
CONTAINS
100mM K

K BALANCE

$$\text{ACC} = \text{IN} - \text{OUT} + \text{GEN}$$

$$0 = Q_A(200) + Q_B(100) - 75(120)$$

$$0 = Q_A(200) + 45(100) - 75(120)$$

$$Q_A = 22.5 \text{ L/min}$$

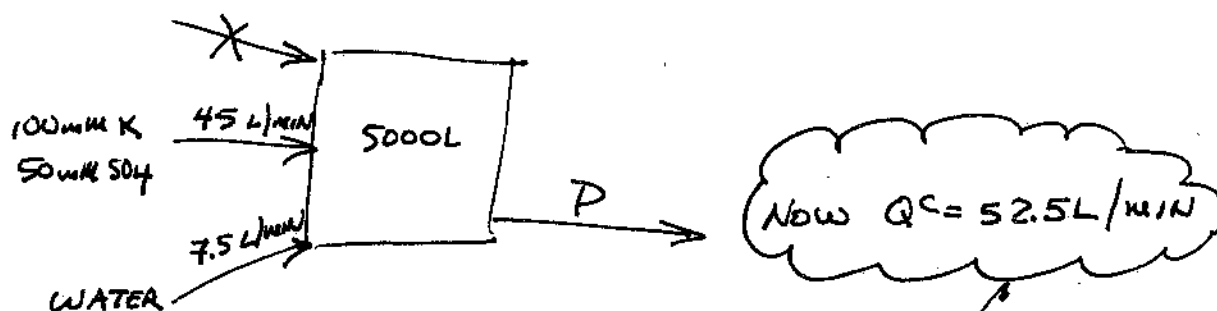
WATER BALANCE
(OVERALL)

$$0 = Q_A + Q_B + Q_C - 75$$

$$0 = 22.5 + 45 + Q_C - 75$$

$$Q_C = 7.5 \text{ L/min}$$

b)



K BALANCE

$$\text{ACC} = \text{IN} - \text{OUT} + \text{GEN}$$

$$\frac{d(c_K V)}{dt} = (100)(45) - 52.5 c_K$$

$$5000 \frac{dc_K}{dt} = 4500 - 52.5 c_K$$

$$\frac{dc_K}{dt} = 0.9 - 0.0105 c_K$$

$$\int_{120}^{c_K} \frac{dc_K}{0.9 - 0.0105 c_K} = \int_0^t dt$$

NOTE INITIAL
CONC IS
120mM

$$-\frac{1}{0.0105} \ln \left[\frac{0.9 - 0.0105 C_K}{0.9 - 0.0105(120)} \right] = t$$

$$\text{OR} \quad -95.24 \ln \left[\frac{0.0105 C_K - 0.9}{0.36} \right] = t$$

$$\text{i) } 90 \text{ mM?} \quad -95.24 \ln \left[\frac{0.0105(90) - 0.9}{0.36} \right] = t \quad \underline{t = 198 \text{ MIN}}$$

$$\text{ii) } 80 \text{ mM?} \quad -95.24 \ln \left[\frac{0.0105(80) - 0.9}{0.36} \right] = t \quad \underline{t = \text{DOES NOT OCCUR!}}$$

NOTE: NEW STEADY-STATE WOULD BE 85.7 mM K

iii) SULFATE BALANCE $ACC = IN - OUT + GEN$

$$\frac{d(c_s V)}{dt} = (45)(50) - 52.5 c_s$$

$$\frac{dc_s}{dt} = 0.45 - 0.0105 c_s$$

$$\int_{30}^{c_s} \frac{dc}{0.45 - 0.0105 c_s} = \int_0^{198} dt = 198$$

NOTE INITIAL CONC IS 30 mM

$$-\frac{1}{0.0105} \ln \left[\frac{0.45 - 0.0105 c_s}{0.45 - 0.0105(30)} \right] = 198$$

$$0.45 - 0.0105 c_s = (0.135)(0.12506)$$

$$\underline{c_s = 41.2 \text{ mM}}$$

NOTE: NEW STEADY-STATE WOULD BE 42.9 mM SO₄