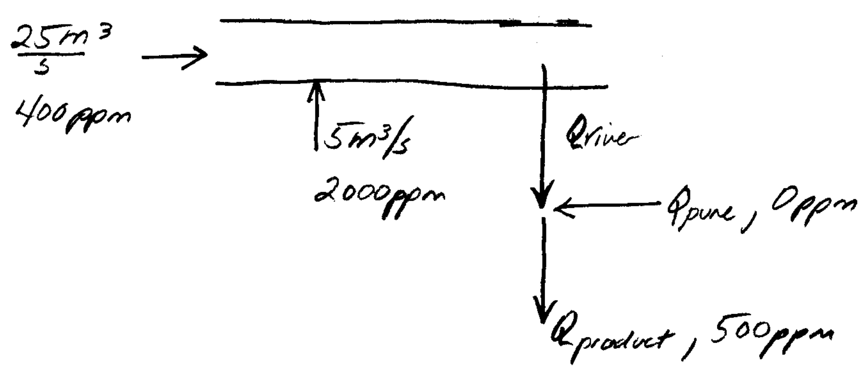
A river with 400ppm salt and upstream flow $25 m^3/s$ recieves an agricultural discharge $Q = 5 m^3/s$ with 2000mg/L salt. Downstream, after mixing a city draws water and blends with salt free water to produce a product water with 500ppm salt. What is the mixture ratio of pure water to river water?



① Determine concentration downstream of ag. source

$$C_1 Q_1 + C_2 Q_2 = \bar{C}(Q_1 + Q_2)$$

$$\frac{(400)(25) + (2000)(5)}{30} = \bar{C} = 666.67 \text{ppm}$$

② Determine mixing ratio

$$\bar{C} Q_R + 0 Q_{pure} = C_{product}(Q_R + Q_{pure})$$

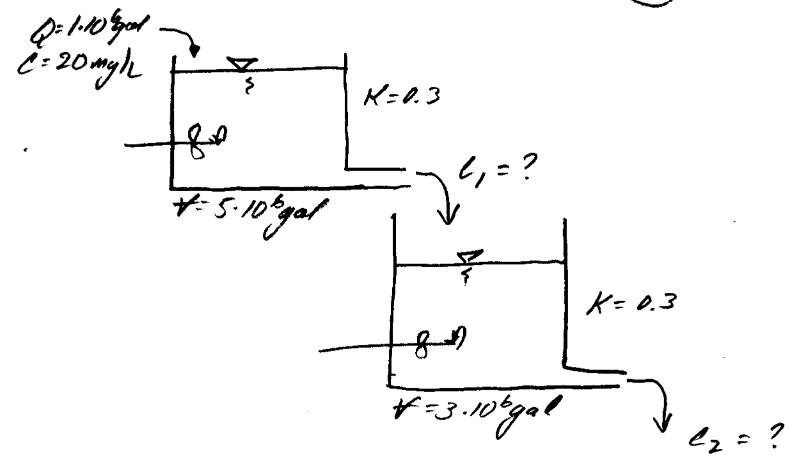
$$\frac{\bar{C}}{C_{product}} = \frac{Q_R + Q_{pure}}{Q_R} = \frac{Q_R}{Q_R} + \frac{Q_{pure}}{Q_R} = 1 + \frac{Q_{pure}}{Q_R}$$

$$\frac{666.67}{500} = 1.333 \quad \therefore \quad \frac{Q_{pure}}{Q_R} = 1.333 - 1 = 0.333$$

CIVE 1331 Problem 1.9

A two pond system is fed by a stream Q = 1 MGD, BOD = 20.0 mg/L. The decay rate for BOD is 0.3/day. $\forall$ pond 1 is $5 \cdot 10^6$ gal; $\forall$ pond 2 is $3 \cdot 10^6$ gal.

Find BOD concentration leaving each pond



$$\left(\frac{dm}{dt}\right)_{in} - \left(\frac{dm}{dt}\right)_{out} = \left(\frac{dm}{dt}\right)_{acc.}^{\nearrow 0} + \left(\frac{dm}{dt}\right)_{tran}$$

Assume complete mixing
assume equilibrium

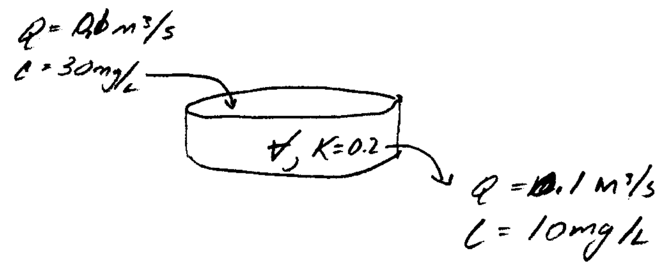
IN	OUT	TRAN		
$Q_0 C_0$	$- Q_0 C_1$	$- K C_1 \forall_1$	$= 0$	(first reactor)
$Q_0 C_1$	$- Q_0 C_2$	$- K C_2 \forall_2$	$= 0$	(second reactor)

Solve for C_1 & C_2

$$C_1 (Q_0 + K\forall_1) = Q_0 C_0 \quad \therefore \quad C_1 = \frac{Q_0 C_0}{Q_0 + K\forall_1} = 8 \text{ mg/L}$$

$$C_2 (Q_0 + K\forall_2) = Q_0 C_1 \qquad C_2 = \frac{Q_0 C_1}{Q_0 + K\forall_2} = 4.21 \text{ mg/L}$$

A lagoon to take $Q = 0.1 m^3/s$ of nonconservative pollutant at $C = 30 mg/L$, first order decay rate 0.2/day must produce an effluent with $C \leq 10 mg/L$. How large must the lagoon be sized?



$$\left(\frac{dm}{dt}\right)_{in} - \left(\frac{dm}{dt}\right)_{out} = \left(\frac{dm}{dt}\right)_{acc} + \left(\frac{dm}{dt}\right)_{tran}$$

Assume equilibrium & complete mixing

$$Q_0 C_0 - K C_1 \forall - Q_0 C_1 = 0$$

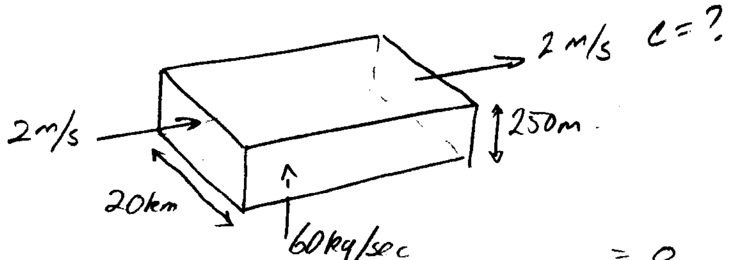
Solve for $\forall$

$$\frac{Q_0 C_0 - Q_0 C_1}{K C_1} = \forall$$

$$* \quad \frac{(0.1)(30) - (0.1)(10)}{(0.2/d)(10)} = ~~1 m^3~~ \quad 86400 m^3$$

↑ 0.2/86400 sec

A simple air pollution model is a box model that assumes complete mixing and no dispersion except in direction of prevailing wind.
Consider a town having an inversion at 250m, 20km width of dispersion. What is the concentration of CO if emmission rate is 60 kg/s.



$$\left(\frac{dm}{dt}\right)_{in} - \left(\frac{dm}{dt}\right)_{out} = \left(\frac{dm}{dt}\right)_{acc} + \left(\frac{dm}{dt}\right)_{tran}$$

$\left(\frac{dm}{dt}\right)_{acc}$ = 0 equilibrium; $\left(\frac{dm}{dt}\right)_{tran}$ = 0 conservation

$$Q_{in} C_{in} - Q_{out} C_{out} = 0$$

$$Q_{in} C_{in} = 60\ kg/sec$$

$$Q_{out} = (2 m/sec)(250 m)(20{,}000 m) = 10{,}000{,}000\ m^3/sec$$

$$C_{out} = \frac{60\ kg/sec}{10{,}000{,}000\ m^3/sec} = 6.0 \cdot 10^{-6}\ kg/m^3 - CO$$