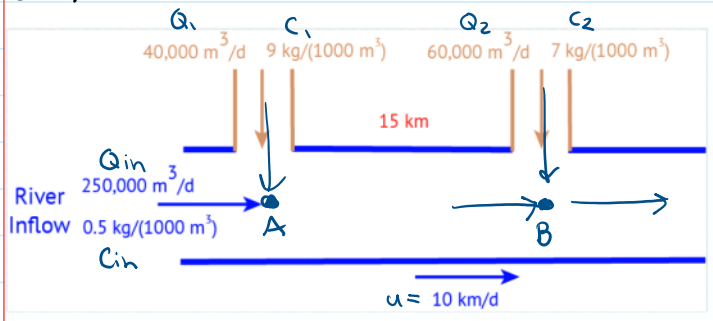
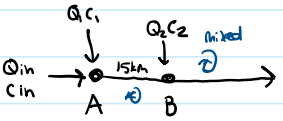
HW2

Tuesday, September 17, 2024 1:43 AM

Q1)



$k = -0.36\ d^{-1}$



$$0 = V\frac{dC}{dt} = Q_{in}C_{in} - Q_{out}C_{out} - kCV$$

↑ steady state

$$\frac{V}{Q} = t$$

Mix Point A $\longrightarrow Q_{mixA} = Q_{in} + Q_1 = 290{,}000\ m^3/d$

$$C_{mixA} = \frac{Q_{in}C_{in} + Q_1C_1}{Q_{mixA}} = \boxed{1.672\ \frac{kg}{1000m^3} = C_{mixA}}$$

$$M_{mixA} = \left(290000\ \frac{m^3}{d}\right)\left(1.672\ \frac{kg}{1000m^3}\right) = 484.88\ \frac{kg}{d}$$

Point A → B (decay) $Q_{out} = Q_A$ since no flows being added

Reference: in BEE 2510, we modeled flow in stream as a PFR, representing decay as $\frac{C_{out}}{C_{in}} = e^{-kt}$ or $C_{out} = C_{in}e^{-kt}$

derivation

$$\frac{dM}{dt} = kM$$

$$dM = kMdt$$

$$\int \frac{dM}{M} = \int k\,dt$$

$$\exp\left(\ln|M| = kt + M_0\right)$$

$$M = M_0 e^{kt} \leftarrow t = \frac{V}{Q} = \frac{x}{u}$$

$$M = M_0 e^{kx/u} = 484.88\ \frac{kg}{d} e^{(-0.36\ d^{-1})(15km)/(10km/d)} = 282.56\ \frac{kg}{d} = M_{decay}$$

↑ M_{mixA}

Mix Point B

$$Q_{mixB} = Q_{out} + Q_2 = 290000\ m^3/d + 60{,}000\ m^3/d = 350{,}000\ m^3/d$$

Mix Point B

$$Q_{mixB} = Q_{out} + Q_2 = 290{,}000\ m^3/d + 60{,}000\ m^3/d = 350{,}000\ m^3/d$$

$$M_{mixB} = M_{decay} + \underbrace{M_2}_{Q_2C_2} = 282.56\ \frac{kg}{d} + \left(60000\ \frac{m^3}{d} \cdot \frac{7kg}{1000m^3}\right) = 702.56\ \frac{kg}{d}$$

$$C_{mixB} = \frac{M_{mixB}}{Q_{mixB}} = 0.002007\ \frac{kg}{m^3} = \boxed{2.0073\ kg/1000m^3} < 2.5\ kg/1000m^3$$

↑ also the maximum CRUD Conc. in the stream (because no more entry points and only decay in our model).

After Point B

$$M_{downstream} = M_{mix\,B}\ e^{kx/u}$$

or

$$C_{downstream} = C_{mix\,B}\ e^{kx/u}$$

Therefore, yes our modeled system is in compliance with the regulatory limit