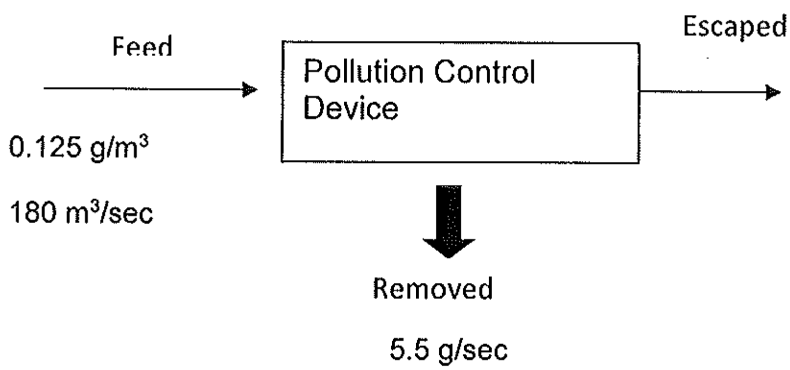
CEE 311 **Homework 1 Solution** **Spring 2019**

MASS BALANCE

1. An air pollution control device is to remove a particulate, which is being emitted at a concentration of 125,000 ug/m^3 at an airflow rate of 180 m^3/sec. The device removes 5.5 g/sec. Calculate the concentration of the emission in g/m^3 and the % recovery of collection.



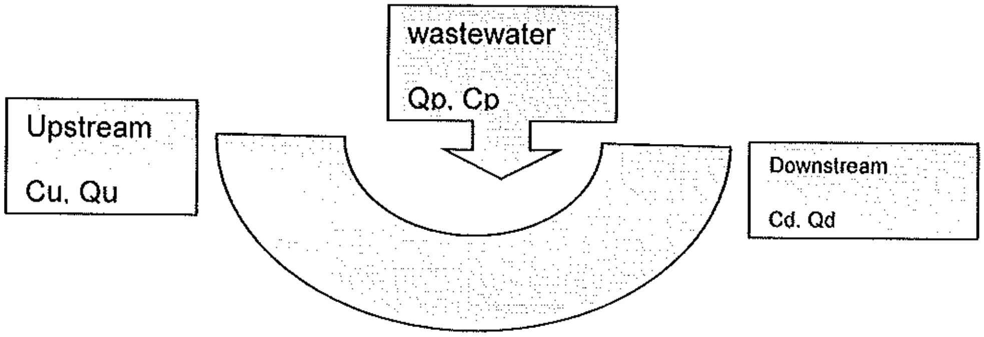
Inflow mass/time = .125*180 = **22.5 g/sec**

Therefore Emission is 22.5-5.5 = 17g/sec

Convert to g/m3 $\frac{17\text{ g}}{\text{sec}} * \frac{\text{sec}}{180\text{ m}^3} * \frac{10^6\text{ ug}}{\text{g}} =$ **94,444.44 g/m^3**

Recovery = (5.5/22.5)*100 = **24.44%**

2.



3b) Present solids concentration downstream =Cd

Given Cu = 2 mg/L Qu = 30 MGD Qp = 20 MGD Cp = 30 mg/L

Known Qd = Qu + Qp = 30 + 20 = 50 MGD

CuQu + CpQp = QdCd or Cd = CuQu + CpQp /Qd

Cd = (20*30 + 30*2)/50MGD = **<u>13.2 mg/L</u>**

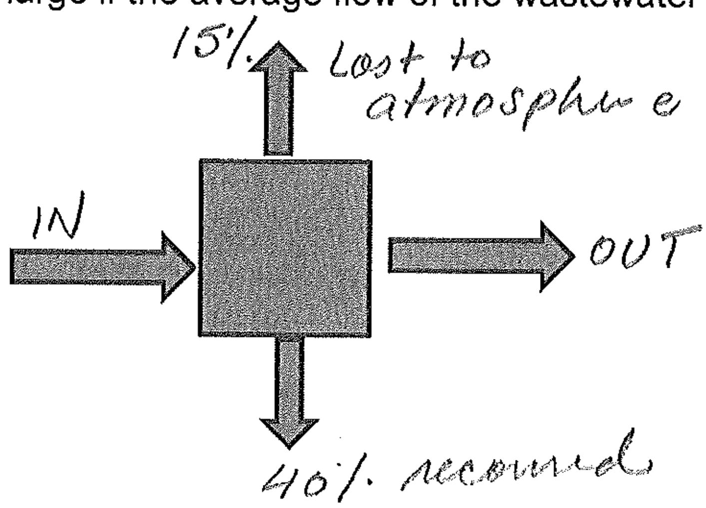
3. A manufacturing process uses 100 kg/month of Solvent S to clean machine parts. Solvent S is volatile and 15% of it is lost to the atmosphere. 40% is recovered for recycling each month. The remainder leaves the plant in wastewater. What is the average concentration in **mg/L** of the solvent in the wastewater discharge if the average flow of the wastewater is 10 m^3/d?

a) 0.15 mg/L

b) 1,500 mg/L

c) 150 mg/L

d) None of the above



∴ OUT = 100 − 15 − 40 = 45%

$$IN = \left[\frac{100\ kg}{month} \cdot \frac{month}{30\ days} \cdot \frac{day}{10\ m^3} \times \frac{10^6\ mg}{kg} \cdot \frac{m^3}{1000\ L}\right] = 334\ mg/L$$

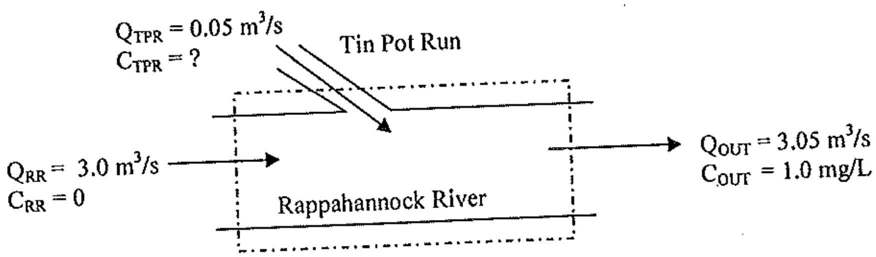
OUT = 45% x 334 mg/L = 150 mg/L

2-5 Mass rate of tracer addition

Given: $Q_{RR} = 3.00\ m^3/s$, $Q_{TPR} = 0.05\ m^3/s$, detection limit = 1.0 mg/L

Solution:

a. Mass balance diagram (NOTE: $Q_{out} = Q_{RR} + Q_{TPR} = 3.05\ m^3/s$)



b. Mass balance equation

$$C_{RR}Q_{RR} + C_{TRP}Q_{TPR} = C_{out}Q_{out}$$

Because C_{RR} in = 0 this equation reduces to:

$$C_{TPR}Q_{TPR} = C_{out}Q_{out}$$

c. Note that the quantity $C_{TPR}Q_{TPR}$ is the mass flow rate of the tracer into TPR and substitute values

$$C_{TPR}Q_{TPR} = \frac{1.0\text{mg}}{\text{L}} \times \frac{3.05\text{m}^3}{\text{s}} \times \frac{1000\text{L}}{\text{m}^3} \times \frac{1\text{kg}}{10^6\text{mg}} \times \frac{86400\text{s}}{\text{d}} = 264\,\text{kg/d}$$

d. Concentration in Tin Pot Run

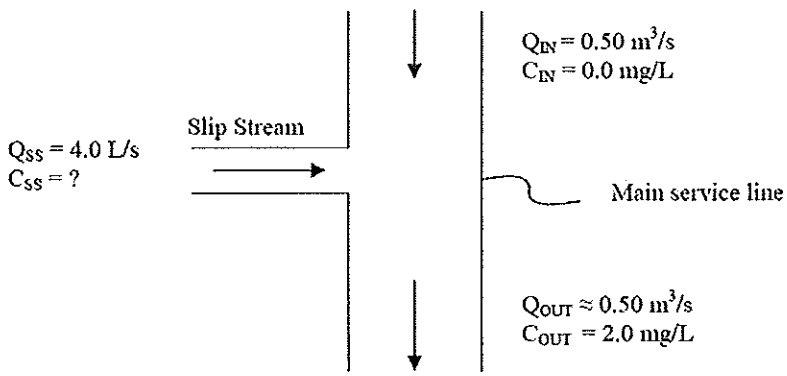
$$C_{TPR} = \frac{C_{TPR}Q_{TPR}}{Q_{TPR}} = \frac{(264\,\text{kg/d})(10^6\,\text{mg/kg})}{(0.05\,\text{m}^3/\text{s})(86400\,\text{s/d})(1000\,\text{L/m}^3)} = 61 \text{ or } 60\ \text{mg/L}$$

2-6 NaOCl pumping rate

Given: NaOCl at 52,000 mg/L
Piping scheme in figure P-2-6
Main service line flow rate = 0.50 m^3/s
Slip stream flow rate 4.0 L/s

Solution:

a. Mass balance at return of slip stream to main service line



b. Calculate C_{SS}

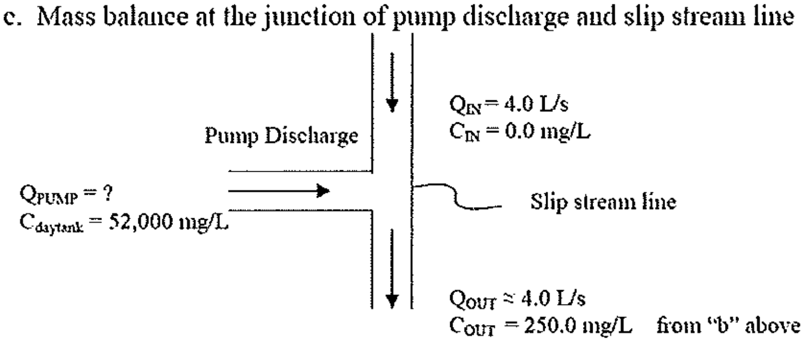
Mass out = Mass in

$$(0.50\ m^3/s)(2.0\ mg/L)(1000\ L/m^3) = (4.0\ L/s)(C_{SS})$$

$$1000\ mg/s = (4.0\ L/s)(C_{SS})$$

$$C_{SS} = \frac{1000\,mg/s}{4.0\,L/s} = 250\,mg/L$$

c. Mass balance at the junction of pump discharge and slip stream line



d. Calculate Q_{PUMP}

Mass in = Mass out

$$(Q_{PUMP})(52{,}000\ mg/L) = (4.0\ L/s)(250\ mg/L)$$

$$Q_{PUMP} = \frac{(4.0\,L/s)(250\,mg/L)}{52{,}000\,mg/L} = 0.0192\,L/s$$