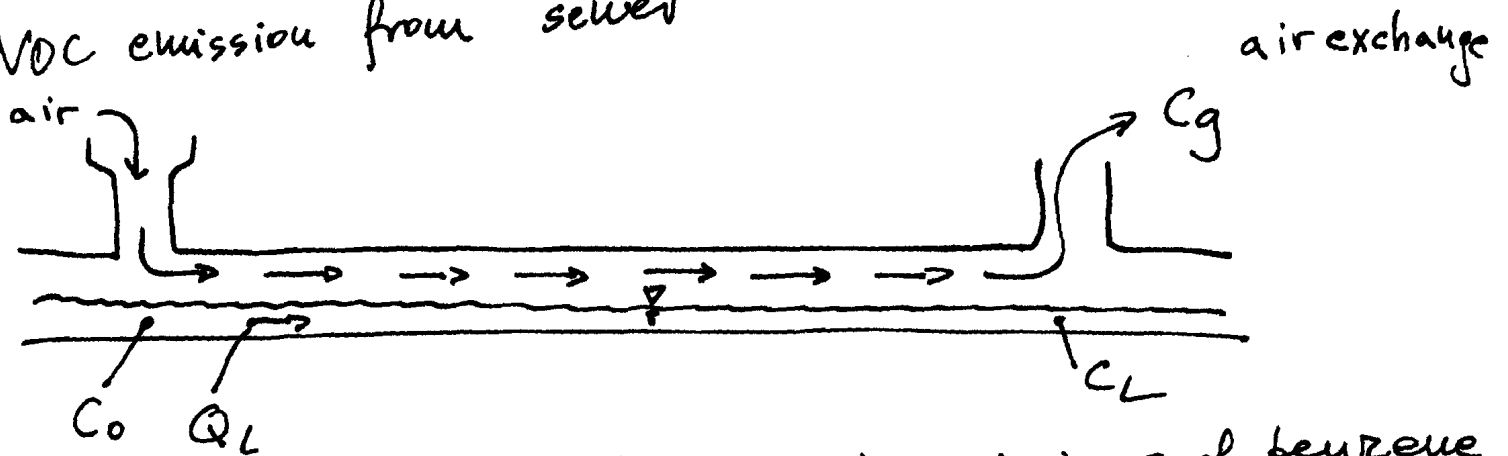


①

Homework solution

VOC emission from sewer



- determine stripping efficiency & emissions of benzene
- assume exhaust gas is at equilibrium with adjacent (underlying) water at the exhaust
- $H_c = 0.25 \text{ m}^3 \text{ liq} / \text{m}^3 \text{ gas}$ (for benzene @ room temp.)
- $C_o = 500 \text{ mg/L}$
- $Q_L = 0.05 \text{ m}^3/\text{s}$
- $Q_{\text{air}} = 0.05 \text{ m}^3/\text{s}$

$$\text{Emissions} = E = Q_{\text{air}} C_g = Q_{\text{air}} C_L H_c \quad (\text{at equilibrium})$$

↓ unknown

Removal of benzene from liquid:

$$\begin{aligned} Q_L C_o &= Q_L C_L + Q_{\text{air}} C_g \\ \text{---} &= Q_L C_L + Q_{\text{air}} C_L H_c \\ \text{---} &= C_L (Q_L + Q_{\text{air}} H_c) \end{aligned}$$

$$C_L = \left\{ \frac{Q_L}{Q_L + Q_{\text{air}} H_c} \right\} C_o$$

$$E = \left\{ \frac{1}{1 + \frac{Q_{\text{air}} H_c}{Q_L}} \right\} C_o Q_{\text{air}} H_c$$

$$\left\{ 1 + \frac{0.05 \frac{\text{m}^3_{\text{air}}/\text{s} \times 0.25 \frac{\text{m}^3_{\text{liq}}}{\text{m}^3_{\text{air}}}}{0.05 \frac{\text{m}^3_{\text{liq}}/\text{s}}{}} \right\} 500,000 \frac{\text{m}^3_{\text{liq}}}{\text{s}} \times 0.25 \frac{\text{m}^3_{\text{liq}}}{\text{m}^3_{\text{air}}} \times \frac{1}{9} \times \frac{1}{\text{m}^3_{\text{air}}}$$

$$5,000 \frac{\text{m}^3}{\text{s}} = 5 \frac{9}{5} \times \frac{3600 \text{s}}{\text{hr}} \times \frac{24 \text{hr}}{\text{day}} \times 365 \text{ days/year}$$

$$\boxed{160 \text{ metric tons/year}}$$

ipping efficiency

$$= \frac{Q_L}{Q_{\text{air}} H_c} = 4$$

$$\text{mass inflow} = Q_L C_0 = 800 \text{ metric tons/year}$$

$$S = \frac{160 \text{ (lost to gas-phase)}}{800 \text{ (mass in inflow)}} = \frac{1}{5} = \underline{\underline{20\%}}$$