Assignment 2 – Follow up

Q3: What is the mixing ratio of 250 μg/m³ of acrolein (MW = 56.1 g mol^{-1}) in ppb$_v$ at 17°C and 1.0 atm?

$250\ \mu g / m^3$ ← mass ← volume

mixing ratio

$\frac{mol}{mol}$ or $\frac{Vol}{Vol}$ or $\frac{P}{P}$

$$250\ \mu g\ \text{acrolein} \times \frac{1\ mol}{56.1\ g} \times \frac{1\ g}{10^6\ \mu g} = 4.46 \times 10^{-6}\ mol$$

$1\ m^3$ air

$$n_{air} = \frac{P \cdot V}{R \cdot T} = \frac{(1.0\ atm)(10^3\ L)}{(0.08206\ \frac{L \cdot atm}{mol\ K})(290 K)} = 42.0\ mol$$

$$\therefore \text{mixing ratio} = \frac{4.46 \times 10^{-6}\ mol}{42.0\ mol} = 1.06 \times 10^{-7}$$

or 106 ppb$_v$

Q6: Write an expression for the residence time (τ) of OH in the troposphere, if the following reactions represent the dominant loss processes.

OH + CO → H + CO_2	k_{CO}
OH + CH_4 → H_2O + CH_3	k_{CH4}

$$\tau_{OH} = \frac{\text{stock of OH}}{\text{flux of OH}} = \frac{[OH]}{k_{CO}[OH][CO] + k_{CH_4}[OH][CH_4]}$$

$$= \frac{1}{\underbrace{k_{CO}[CO]}_{k'_{CO}} + \underbrace{k_{CH_4}[CH_4]}_{k'_{CH4}}}$$

$$= \frac{1}{\sum k}$$

where k is 1st order rate constant /s

Q7: What is the rate expression for the production of OH from the reaction below?

O(^{1}D) + **H_2O** → **2 OH** k_3

rate OH prod^n = 2 × rate H_2O loss

or 2 × rate O('D) loss

$$\frac{d[OH]}{dt} = -\frac{2\,d[O'D]}{dt} = -\frac{2\,d[H_2O]}{dt}$$

'rate of reaction' defined as rate for 1 mol of reactant as written (ie. $\frac{d[O'D]}{dt}$ or $\frac{d[H_2O]}{dt}$)

∴ Rate of OH prod^n = $2\,k_3[O('D)][H_2O]$

Q8: What is the total mass of CFC-12 (MW = 121 g mol^{-1}) in Earth's atmosphere if global average concentration is given by 400 ppt$_v$?

$$\frac{400}{10^{12}} \times (\#\text{ mols air in atmos}) \times MW_{CFC-12}$$

MW_{CFC-12} ← 121 g/mol

\# mols air in atmos ↑ mass of atmos × $\frac{1}{MW_{air}}$

mass of atmos ↑ 5.27×10^{18} kg (Appendix or Data sheet)

MW_{air} ↑ 0.02896 $\frac{kg}{mol}$ (Appendix or Data sheet)

∴ mass CFC-12 = 8.7×10^{12} g or 8.7×10^{9} kg