EGEE 470
Quiz #1

Read these statements carefully and indicate whether they are true (T) or false (F). For partial credit (if your answer is incorrect), summarize how you arrived at your conclusion.

T (35%) If the efficiency of a CATA bus is 8 miles per gallon and it travels 50,000 miles in a year, its annual emissions of CO₂ do not exceed 3 tons. (Assume that "clean natural gas" = CH₄ and, if necessary, make other reasonable assumptions.)

\[ \text{44 g CO}_2 \quad 128 \text{ g CH}_4 \quad \text{1 mol} \quad \text{3.8 L} \quad \text{1 gal} \quad \frac{8 \text{ mi}}{\text{ yr}} \quad \frac{1 \text{ ton}}{16 \text{ g}} \]

\[ ? = \frac{0.05 \text{ t}}{x} \]

\[ \text{OK?} \]

F (30%) If the concentration of CO at 350 K and 1.5 atm is 100 micrograms/m³, it exceeds the NAAQS standard of 35 ppm.

\[ P_v = RT \Rightarrow \frac{P_v}{n} = \frac{RT}{P} = \frac{(0.08206 \text{ L atm/mol K})(350)}{1.5} = 19.2 \text{ L atm/mol} \]

\[ \frac{100 \times 8 \text{ g CO}}{100 \text{ m}^3} = 8 \text{ g CO} \text{ m}^{-3} \]

\[ \frac{8 \text{ g CO}}{100 \text{ m}^3} = (3.6 \times 10^{-6} \text{ mol CO}) \]

\[ \text{actual (not 51g)} \]

\[ 19.2 \frac{\text{L atm}}{\text{mol CO}} \times \frac{1}{10^{-6} \text{ mol CO}} = 0.047 \text{ ppm} \]

F (35%) If the equilibrium constant for the formation of nitric oxide (0.5N₂ + 0.5SO₂ = NO) is 0.01, the equilibrium conversion of N₂ exceeds 0.5%.

\[ K = \frac{a_{NO}}{a_{N}_2 \cdot a_{O}_2} = 0.01 \]

\[ t=0: \text{ i i o 2} \]

\[ t=oo: \text{ l x l x 2 x 2} \]

\[ \Rightarrow 0.01 = \frac{x}{(1-x)^2} \Rightarrow x = 0.498\% \approx 0.5\% \]

\[ \text{Conv. N}_2 = \frac{1 - (1-x)}{1} = x \]

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\begin{align*}
\text{gal} & = \frac{44 \text{ g CO}_2}{28 \text{ g C}} \times \frac{16 \text{ g CH}_4}{1 \text{ mol}} \times \frac{3.6 \text{ m}^3 \text{ (STP)}}{1 \text{ gal}} \\
& = \frac{16 \text{ g CH}_4}{16 \text{ g C}} \times \frac{0.0224 \text{ m}^3 \text{ (STP)}}{1 \text{ gal}} \\
& \approx \frac{1 \text{ t CO}_2}{16 \text{ g}} \\
& \approx 2.8 \frac{\text{ t CO}_2}{\text{ t}}
\end{align*}
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