Answer on the question #63249, Chemistry / General Chemistry

Question:

Chapter 13 (13.93)

Fish need at least 4 ppm dissolved O2 for survival.

1)What is this concentration in mol/L?

2)What partial pressure of O2 above the water is needed to obtain this concentration at 10 ◦C? (The Henry's law constant for O2 at this temperature is 1.71×10−3mol/L · atm.)

Solution:

1) 4 ppm of O_2 means that there are 4 molecules of O_2 (N_{O_2}) per million molecules of water (N_{H_2O}) :

$$ppm(O_2) = \frac{N_{O_2}}{N_{H_2O}} \cdot 10^6 = \frac{n_{O_2}}{n_{H_2O}} \cdot 10^6 = \frac{n_{O_2} \cdot M_{H_2O}}{d_{H_2O} \cdot V_{H_2O}} \cdot 10^6 = c_{O_2} \frac{M_{H_2O}}{d_{H_2O}} \cdot 10^6$$

where n_{O_2} and n_{H_2O} are the number of the moles of oxygen and water, respectively ; M_{H_2O} and d_{H_2O} are molar mass and density of water, respectively.
We deduce the concentration of oxygen in water then :

$$c_{O_2} = \frac{d_{H_2O} \cdot ppm(O_2)}{M_{H_2O} \cdot 10^6} = \frac{1000\ (g\ L^{-1}) \cdot 4(ppm)}{18.01528\ (g\ mol^{-1}) \cdot 10^6} = 2.22 \cdot 10^{-4}(mol\ L^{-1})$$

2) Henry solubility is :

$$H_s = \frac{c}{p}$$

$$p = \frac{c}{H_s} = \frac{2.22 \cdot 10^{-4}(mol\ L^{-1})}{1.71 \cdot 10^{-3}(mol\ L^{-1} atm^{-1})} = 0.13\ (atm)$$

Answer : 1) $2.22 \cdot 10^{-4}(mol\ L^{-1})$, 2) $0.13\ (atm)$