Answer on Question #73501 – Chemistry – Inorganic Chemistry

Equilibrium involving SO_2(g), O_2(g) and SO_3(g) is important in sulfuric acid production. When a 0.0200 mol sample of SO_3 is introduced into an evacuated 1.52 L vessel at 900 K, 0.0142 mol, SO_3 is found to be present at equilibrium. Calculate the value of K_p for the dissociation of SO_3(g) at 900 K?

Solution:

$$2SO_3(g) \rightarrow 2SO_2(g) + O_2(g)$$

1. Calculate the amount of SO_3 which has reacted away:
   $\Delta n(SO_3) = n(SO_3)_{initial} - n(SO_3)_{equilibrium} = 0.0200$ mol – 0.0142 mol = 0.0058 mol
2. Calculate amount of sulfur dioxide and oxygen.
   Dissociation reaction is given by:
   $SO_3(g) \leftarrow\rightarrow SO_2(g) + (1/2)\ O_2(g)$
   So one mole of SO_2 and one half mole of O_2 is formed per mole of SO_3 reacted away.
   Hence:
   $n(SO_2)_{equilibrium} = \Delta n(SO_3) = 0.0058$ mol
   $n(O_2)_{equilibrium} = (1/2)\cdot\Delta n(SO_3) = 0.0029$ mol
3. Calculate equilibrium partial pressures.
   Assuming ideal gas mixture partial pressures are given by
   $p(i) = n(i)\cdot R\cdot T/V$
   (R - universal gas constant, T - absolute temperature , V - Volume)
   $p(SO_3) = 0.082$ L·atm/(K·mol) × 900 K × 0.0142 mol / 1.52 L = 48.6 atm/mol × 0.0142 mol = 0.690 atm
   $p(SO_2) = 48.6$ atm/mol × 0.0058 mol = 0.282 atm
   $p(O_2) = 48.6$ atm/mol × 0.0029 mol = 0.141 atm
4. Calculate equilibrium constant
   According to reaction equation:
   $K_p = p^2(SO_2) \times p(O_2) / p^2(SO_3) = (0.282)^2 \times 0.141 / (0.690)^2 = 0.0235 = 0.024$

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