

Answer on Question #73501 – Chemistry – Inorganic Chemistry

Equilibrium involving $\text{SO}_2(\text{g})$, $\text{O}_2(\text{g})$ and $\text{SO}_3(\text{g})$ 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 $\text{SO}_3(\text{g})$ at 900 K?

Solution:

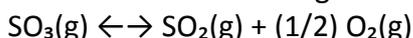


1. Calculate the amount of SO_3 which has reacted away:

$$\Delta n(\text{SO}_3) = n(\text{SO}_3)_{\text{initial}} - n(\text{SO}_3)_{\text{equilibrium}} = 0.0200 \text{ mol} - 0.0142 \text{ mol} = 0.0058 \text{ mol}$$

2. Calculate amount of sulfur dioxide and oxygen.

Dissociation reaction is given by:



So one mole of SO_2 and one half mole of O_2 is formed per mole of SO_3 reacted away.

Hence:

$$n(\text{SO}_2)_{\text{equilibrium}} = \Delta n(\text{SO}_3) = 0.0058 \text{ mol}$$

$$n(\text{O}_2)_{\text{equilibrium}} = (1/2) \cdot \Delta n(\text{SO}_3) = 0.0029 \text{ mol}$$

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)

$$p(\text{SO}_3) = 0.082 \text{ L} \cdot \text{atm} / (\text{K} \cdot \text{mol}) \times 900 \text{ K} \times 0.0142 \text{ mol} / 1.52 \text{ L} = 48.6 \text{ atm/mol} \times 0.0142 \text{ mol} = 0.690 \text{ atm}$$

$$p(\text{SO}_2) = 48.6 \text{ atm/mol} \times 0.0058 \text{ mol} = 0.282 \text{ atm}$$

$$p(\text{O}_2) = 48.6 \text{ atm/mol} \times 0.0029 \text{ mol} = 0.141 \text{ atm}$$

4. Calculate equilibrium constant

According to reaction equation:

$$K_p = p^2(\text{SO}_2) \times p(\text{O}_2) / p^2(\text{SO}_3) = (0.282)^2 \times 0.141 / (0.690)^2 = 0.0235 = 0.024$$

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