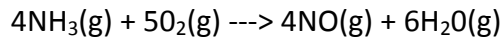


Answer on Question #46523 - Chemistry – Inorganic Chemistry

Question

The Ostwald process is used commercially to produce nitric acid, which is, in turn, used in many modern chemical processes. In the first step of the Ostwald process, ammonia is reacted with oxygen gas to produce nitric oxide and water. What is the maximum mass of H₂O that can be produced by combining 86.4 g of each reactant?



Answer:

Number of moles equals:

$$n = \frac{m}{M}$$

m – Mass of the substance, g.

M – Molar mass of the substance, g/mol.

Molar masses of the reactants equal:

$$M(\text{NH}_3) = 17 \text{ g/mol}, \quad M(\text{O}_2) = 32 \text{ g/mol}$$

Number of moles of the reactants are:

$$n(\text{NH}_3) = \frac{m(\text{NH}_3)}{M(\text{NH}_3)} = \frac{86.4}{17} = 5.08 \text{ mol}$$

$$n(\text{O}_2) = \frac{m(\text{O}_2)}{M(\text{O}_2)} = \frac{86.4}{32} = 2.7 \text{ mol}$$

Then we make a proportion:

4 moles of NH₃ react with 5 moles of O₂

5.08 moles of NH₃ – x moles of O₂

$$x = \frac{5.08 \cdot 5}{4} = 6.35 \text{ moles of O}_2 \text{ should react with 5.08 moles of NH}_3$$

We have only 2.7 moles of oxygen, therefore it is the limiting reactant.

We need to make another proportion to calculate the maximum mass of H₂O that can be produced by combining 86.4 g of each reactant:

5 moles of O₂ produce 6 moles of H₂O

2.7 moles of O₂ – x moles of H₂O

$$x = \frac{2.7 \cdot 6}{5} = 3.24 \text{ moles of } H_2O \text{ could be produced}$$

The mass of H₂O equals:

$$m(H_2O) = n(H_2O) \cdot M(H_2O) = 3.24 \cdot 18 = 58.32 \text{ g}$$

Answer: 58.32 g of H₂O