

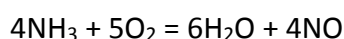
Answer on Question # 55088 – Chemistry – General Chemistry

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 80.4 g of each reactant?

Solution

The first step reaction of Ostwald process:



Given masses of reactants:

$$m(\text{NH}_3) = 80.4\text{g}$$

$$m(\text{O}_2) = 80.4\text{g}$$

Calculated molar masses:

$$M(\text{NH}_3) = 17 \text{ g/mol}$$

$$M(\text{O}_2) = 32 \text{ g/mol}$$

$$M(\text{H}_2\text{O}) = 18 \text{ g/mol}$$

Amounts of reactants:

$$n = m/M$$

$$n(\text{NH}_3) = 80.4/17 = 4.73 \text{ mol}$$

$$n(\text{O}_2) = 80.4/32 = 2.51 \text{ mol}$$

It is obviously (according to the chemical reaction coefficients) that 4 moles of NH₃ react with 5 moles of O₂ completely. But we have 4.73 and 2.51 moles respectively, so NH₃ is in abundance. So, all calculations will be made using the amount of oxygen.

5 moles of O₂ give 6 moles of H₂O

$$2.51 \text{ moles of O}_2 \text{ give } x \text{ moles of H}_2\text{O} \quad x = 2.51 \times 6/5 = 3.01 \text{ mol}$$

The mass of water formed is $m = nM = 3.01 \times 18 = 54.2 \text{ g}$

Answer: 54.2 g