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?

$4NH_3(g) + 5O_2(g) \dashrightarrow 4NO(g) + 6H_2O(g)$

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:

$M(NH_3) = 17$ g/mol, $M(O_2) = 32$ g/mol

Number of moles of the reactants are:

$$n(NH_3) = \frac{m(NH_3)}{M(NH_{3)}} = \frac{86.4}{17} = 5.08\ mol$$

$$n(O_2) = \frac{m(O_2)}{M(O_{2)}} = \frac{86.4}{32} = 2.7\ mol$$

Then we make a proportion:

4 moles of NH_3 react with 5 moles of O_2

5.08 moles of NH_3 – *x* moles of O_2

$$x = \frac{5.08 \cdot 5}{4} = 6.35\ moles\ of\ O_2\ should\ react\ with\ 5.08\ moles\ of\ NH_3$$

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 H_2O that can be produced by combining 86.4 g of each reactant:

5 moles of O_2 produce 6 moles of H_2O

2.7 moles of O_2 – *x* moles of H_2O

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

The mass of H_2O equals:

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

Answer: 58.32 g of H_2O