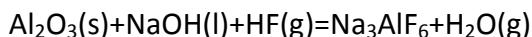


Answer on Question #40495, Chemistry, Other

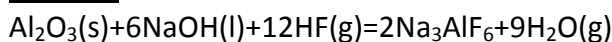
Task:

Cryolite, $\text{Na}_3\text{AlF}_6(\text{s})$ an ore used in the production of aluminium, can be synthesised using aluminium oxide.



- 1) Balance the equation
- 2) If 15.2 kilograms of $\text{Al}_2\text{O}_3(\text{s})$, 57.4 kilograms of $\text{NaOH}(\text{l})$ and 57.4 kilograms of HF gas react completely, how many kilograms of cryolite will be produced?
- 3) Which reactants will be in excess?
- 4) What is the total mass of the excess reactants left over after the reaction is complete?

Answer:



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

where m-mass, grams;

M-molar mass, gram/mol.

$$M(\text{Al}_2\text{O}_3) = 101.96 \text{ g/mol}$$

$$M(\text{NaOH}) = 39.996 \text{ g/mol}$$

$$M(\text{HF}) = 20.007 \text{ g/mol}$$

$$M(\text{Na}_3\text{AlF}_6) = 209.95 \text{ g/mol}$$

$$v(\text{Al}_2\text{O}_3) = \frac{15200}{101.96} = 149.08 \text{ moles}$$

$$v(\text{NaOH}) = \frac{57400}{39.996} = 1435.1 \text{ moles}$$

$$v(\text{HF}) = \frac{57400}{20.007} = 2869.0 \text{ moles}$$

Let's calculate the amount of Na_3AlF_6 , that can be produced from the indicated amount of each reactant:

$$v(\text{Na}_3\text{AlF}_6) = 2 \cdot v(\text{Al}_2\text{O}_3) = 2 \cdot 149.08 = 298.16 \text{ moles}$$

$$v(\text{Na}_3\text{AlF}_6) = \frac{v(\text{NaOH})}{6} \cdot 2 = \frac{1435.1}{6} \cdot 2 = 478.37 \text{ moles}$$

$$v(\text{Na}_3\text{AlF}_6) = \frac{v(\text{HF})}{12} \cdot 2 = \frac{2869.0}{12} \cdot 2 = 478.17 \text{ moles}$$

As we can see from the previous calculations, the amount of Al_2O_3 is the determining factor.

All other reactants (NaOH, HF) will be in excess.

That is why, the maximum mass of Na_3AlF_6 that can be produced is equal to:

$$m(\text{Na}_3\text{AlF}_6) = v(\text{Na}_3\text{AlF}_6) \cdot M(\text{Na}_3\text{AlF}_6)$$

$$m(\text{Na}_3\text{AlF}_6) = 298.16 \cdot 209.95 = 62599 \text{ g} = 62.599 \text{ kg}$$

NaOH and HF will be in excess. Let's calculate this excess:

$$m(\text{NaOH})_{\text{ex}} = \frac{478.37 - 298.16}{2} \cdot 6 \cdot 39.996 = 21623 \text{ g} = 21.623 \text{ kg}$$

$$m(\text{HF})_{\text{ex}} = \frac{478.17 - 298.16}{2} \cdot 12 \cdot 20.007 = 21609 \text{ g} = 21.609 \text{ kg}$$

The total mass of the excess reactants leftover after the reaction is complete will be:

$$m(\text{NaOH})_{\text{ex}} + m(\text{HF})_{\text{ex}} = 21.623 \text{ kg} + 21.609 \text{ kg} = 43.232 \text{ kg}$$