Potassium carbonate reacts with nitric acid to form potassium nitrate, water and carbon dioxide gas. When 5.00 g of potassium carbonate reacts with 35.5 mL of 1.75 M nitric acid solution, 0.695 L of carbon dioxide gas is formed at 25 °C and 745 torr. What is the percent yield of the reaction?

Solution:

Balanced equation:

$K_2CO_3 + 2HNO_3 = 2KNO_3 + CO_2 + H_2O$;

Let's calculate number of moles of potassium carbonate:

$n(K_2CO_3)=\frac{m(K_2CO_3)}{M(K_2CO_3)}=\frac{5\ g}{138\ g/mol} = 0.036232\ mol$

At the same time we have $n(HNO_3)$ = 1.75 M * 0.0355 L = 0.062125 moles of nitric acid.

For complete transformation of potassium carbonate into reaction products, we need double amount of nitric acid (according to stoichiometric coefficients) :

$n(HNO_3)=2*n(K_2CO_3)=0.036232$ mol *2=0.072464 moles

However, we have only 0.062125 moles of nitric acid, which means, that potassium carbonate is in excess. Therefore, we must calculate volume of carbon dioxide according to number of moles of nitric acid:

$n(CO_2)=\frac{1}{2}(HNO_3)=0.5 * 0.062125$ mol = 0.0310625 mol;

According to ideal gas law:

PV=nRT

(where P – total pressure, V – volume of gas, n – total number of moles, R – universal gas constant, T – temperature in Kelvins).

Therefore, mentioned above amount of moles of CO_2 should occupy volume (at 25 °C and 745 Torr) equal to:

$V=\frac{nRT}{P}=\frac{0.0310625\ mol*62.363\frac{L*Torr}{K*mol}*298\ K}{745\ Torr}$= 0.775 L

Now we can calculate percent yield:

$Yield=\frac{0.695\ L}{0.775\ L} * 100\% = 0.8967 * 100\% = 89.67\%$

Answer:

The percent yield of reaction is equal to 89.67%.