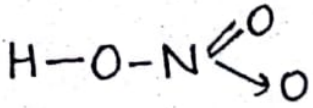
Nitric Acid (HNO_3)



Laboratory preparation.

Reactants: Distilling a mixture of potassium or sodium nitrate with conc. sulphuric acid.

Reactions:-

$$KNO_3 + H_2SO_4 \xrightarrow{<200^\circ C} KHSO_4 + HNO_3$$

(H_2SO_4: Conc; $KHSO_4$: Potassium bisulphate)

$$NaNO_3 + H_2SO_4 \xrightarrow{<200^\circ C} NaHSO_4 + HNO_3$$

($NaHSO_4$: Sodium bisulphate.)

Collection: Vapours of nitric acid are condensed to a light yellow liquid.

The yellow colour is due to the dissolution of NO_2 gas.

$$4HNO_3 \longrightarrow 2H_2O + 4NO_2 + O_2.$$

Note:- The yellow colour is removed by passing dry air of CO_2 in it.

Note:- (i) Entire apparatus should be made up of glass because nitric acid is highly corrosive in nature and will damage, wood, metal, rubber etc.

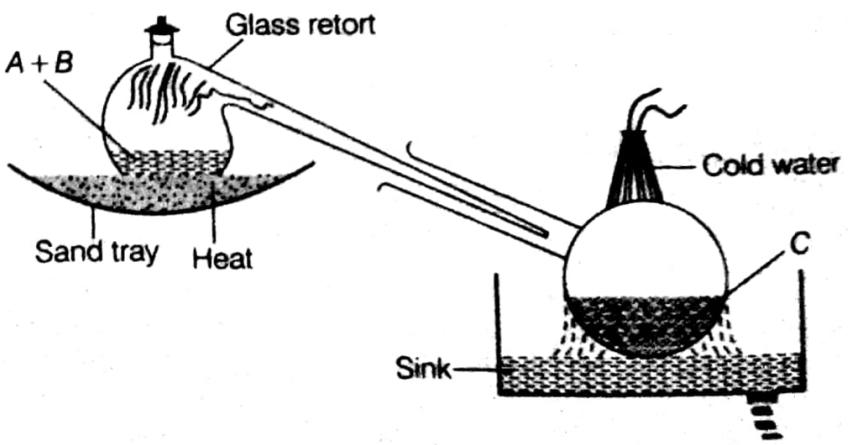
(ii) Above 200°c, the nitric acid decomposes into H_2O NO_2 and O_2 as it is very unstable to heat.

(iii) Sodium sulphate or potassium sulphate will be formed which forms a crust over the mixture thus, restricting the release of nitric acid vapours.

A - conc. H_2SO_4

B - KNO_3

C - HNO_3



Laboratory preparation of nitric acid

Manufacturing of Nitric Acid. (Ostwald Process)

(1) Oxidation of ammonia into nitrogen monoxide

$$4NH_3 + 5O_2 \xrightarrow[800^\circ C]{Pt} 4NO + 6H_2O + Heat$$

(2) Oxidation of Nitric Oxide.

$$2NO + O_2 \xrightarrow{50^\circ C} 2NO_2(g)$$

(3) Absorption of NO_2 in water.

$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$$

Chemical Properties

1) Pure nitric acid is colourless and unstable and decomposes slightly even at ordinary temp and in the presence of sunlight.

$$4HNO_3 \xrightarrow[\text{Sunlight}]{\Delta} 4NO_2 + 2H_2O + O_2$$

(Brown colour)

(2) It is a strong monobasic acid.

$$HNO_3 \rightleftharpoons H^+ + NO_3^-$$

Turns blue litmus to red,
Methyl orange to pink and
Phenolphthalein remains colourless.

(3) Reaction with alkalines:

Neutralises alkalies to form salt and water.

$$Na_2O + 2HNO_3 \rightarrow 2NaNO_3 + H_2O$$

$$Fe(OH)_3 + 3HNO_3 \rightarrow Fe(NO_3)_3 + 3H_2O$$

Reaction with carbonates and bicarbonates:

These reacts with dil HNO_3 to give salt, water, carbon dioxide.

$$Na_2CO_3 + 2HNO_3 \longrightarrow 2NaNO_3 + H_2O + CO_2\uparrow$$

$$NaHCO_3 + HNO_3 \longrightarrow NaNO_3 + H_2O + CO_2\uparrow$$

(4) Oxidising Properties.

Oxidising Properties are due to nascent oxygen which HNO_3 gives on decomposition.

$$2HNO_3 \text{ (conc)} \longrightarrow 2NO_2 + H_2O + [O]$$

$$2HNO_3 \text{ (dil)} \longrightarrow 2NO + H_2O + 3[O]$$

(i) Action on Non-Metals.

$$C + 4HNO_3 \longrightarrow CO_2 + 2H_2O + 4NO_2$$

$$S + 6HNO_3 \rightarrow H_2SO_4 + 2H_2O + 6NO_2$$

$$P_4 + 20HNO_3 \rightarrow 4H_3PO_4 + 4H_2O + 20NO_2$$

Action on Metals

→ Cold and dil HNO_3 acid oxidises metal to their nitrates and librate nitric oxide (NO)

$$3Cu + 8HNO_3 \xrightarrow{\text{(cold \& dil)}} 3Cu(NO_3)_2 + 4H_2O + 2NO.$$

$$3Zn + 8HNO_3 \xrightarrow{\text{(cold \& dil)}} 3Zn(NO_3)_2 + 4H_2O + 2NO$$

→ Conc. HNO_3 oxidises metals to their nitrates and librate nitrogen dixide.

$$Cu + 4HNO_3 \xrightarrow{\text{(conc)}} Cu(NO_3)_2 + 2H_2O + 2NO_2$$

$$Zn + 4HNO_3 \longrightarrow Zn(NO_3)_2 + 2H_2O + 2NO_2$$

Note: (i) HNO_3 reacts with all metals except Gold and Platinum.

(ii) Metals like Fe, Al, Co & Ni become inert when treated with pure conc. HNO_3. because of the extremely thin layer of insoluble metallic oxide which stops reaction

(iii) Very dil HNO_3 reacts with Mg & Mn metals

$$Mg + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2$$

$$Mn + 2HNO_3 \longrightarrow Mn(NO_3)_2 + H_2$$

Questions

(1) Why Iron is rendered passive with fuming nitric acid?

Ans:- Iron forms coating of its oxide and nitrate which stops further reaction.

(2) What happens when Ferric hydroxide reacts with HNO_3?

Ans:- $Fe(OH)_3 + 3HNO_3 \rightarrow Fe(NO_3)_3 + 3H_2O$

(3) Illustrate acidic nature of nitric acid

Ans:- $CaCO_3 + \underset{\text{Dil}}{2HNO_3} \rightarrow Ca(NO_3)_2 + H_2O + CO_2$

(4) Comple the reaction:- $NH_4NO_3 \xrightarrow{\Delta} N_2O(g) + \underbrace{2H_2O}_{\text{(Vap)}}$

(Ammonium nitrate)

Ans.

(5) Why dil. HNO_3 acid is different from other acids when it reacts with metals?

Ans:- HNO_3 is strong oxidising agent, so hydrogen gas is not liberated when metal react with nitric acid.

(6) Why does pure nitric acid take on a yellowish brown colour when exposed to light?

Ans:- Because it decomposes at room temp to form reddish brown nitrogen dioxide.

(7) Name the catalyst which is used in the first step of manufacturing of nitric acid catalytic oxidation.

Ans:- Platinum (Pt)

(8) What is Aqua Regia?

Ans:- Aqua regia contains one part volume of conc. nitric acid and three parts by volume of conc. hydrochloric acid.