Chapter 9B. Nitric acid

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Solution 1:

Nitric acid is formed in atmosphere during lightning discharge. Nitrogen in atmosphere combine with oxygen to form nitric acid.

Solution 2:

(i) Gas produced in air during lightning is Nitric Oxide.
(ii) Hydrogen gas is obtained by treating manganese with 1% nitric acid.
(iii) Salt referred to as Chile saltpeter is $NaNO_3$.
(iv) Salt used in laboratory to prepare nitric acid is $KNO_3/NaNO_3$.
(v) Products obtained by catalytic oxidation of ammonia are NO, water& heat.
(vi) Products obtained by heating concentrated nitric acid are NO_2, water & O_2.
(vii) Copper nitrate is blue coloured, cobalt nitrate is coloured.

Solution 3:

(a) Aqua fortis: It is the other name for nitric acid , it is also known as 'strong water'. It was called so because earlier this was the only liquid which could dissolve many metals including silver.

(b) Aqua Regia: It is a mixture of concentrated nitric acid and concentrated hydrochloric acid in proportionof 1:3(by volume).

(c) Fuming nitric acid: It contains NO_2 dissolved in concentrated HNO_3.It is obtained by distilling concentrated HNO_3 with little starch.

(d) Decrepitation: It is the breaking of a substance usually accompanied by the emission of a crackling sound. An example for a substance which decrepitates on heating is lead nitrate $(Pb(NO_3)_2$

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Solution 4:

(a) In laboratory, nitric acid is prepared by heating a mixture of concentrated sulphuric acid and potassium or sodium nitrate with conc. H_2SO_4 at 200^0C.

$KNO_3+H_2SO_4 \rightarrow KHSO_4+HNO_3$

(b) Concentrated sulphuric acid is non-volatile and produce volatile nitric acid.

(c) The temperature is maintained at 200°C in the above reaction to awoid following problems:

- Nitric acid would decompose at high temperature.
- Potassium or sodium sulphate is formed which will stick to the walls of glass and cannot be removed be easily.
- The glass apparatus may break at high temperature.

(d) No, concentrated HCl cannot be used in the place of concentrated H_2SO_4 because HCl is more volatile than HNO_3 and hence nitric acid vapours will carry HCl vapours.

Solution 5:

(a). **Ostwald process** is used for used for the manufacture of nitric acid.

(b). Reactants required for Ostwald process are ammonia and oxygen of air.

(c). In ostwald process ammonia gas and air are taken in 1:10 ratio.

(d). Pt gauge is used as a catalyst in ostwald process.

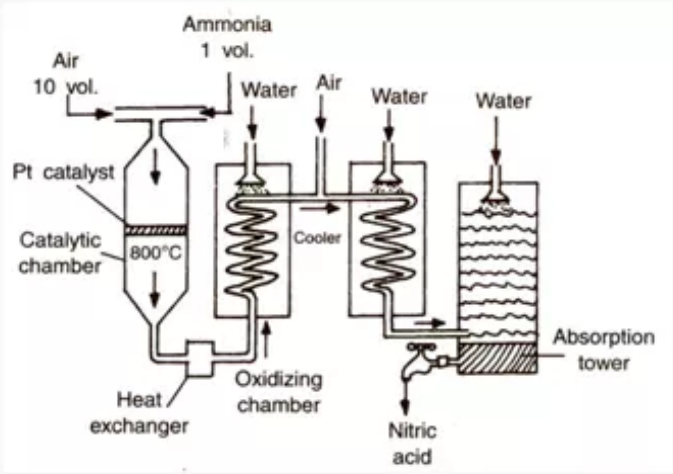
(e). Oxygen is the oxidizing agent which converts ammonia to nitric acid.

(f). $4NH_3 + 5O_2 \xrightarrow[800\,^oC]{Platinum\ gauge} 4NO + 6H_2O + Heat$

$2NO + O_2 \xrightarrow{50\,^oC} 2NO_2$

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

Solution 6:



Ostwald process-

The nitric acid is manufactured by Ostwald process. In ostwald process ammonia gas and air are taken in 1:10 ratio. Pt gauge is used as a catalyst in ostwald process. Following steps are involved in Ostwald's process for the manufacture of nitric acid.

1. Oxidation of ammonia in catalytic chamber.

$$4NH_3 + 5O_2 \xrightarrow[800\,^oC]{Platinum\ gauge} 4NO + 6H_2O + Heat$$

2. Oxidation of nitric acid in oxidation chamber.

$$2NO + O_2 \xrightarrow{50\,^oC} 2NO_2$$

3. Absorption of nitrogen dioxide in water.

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

Solution 7:

(a) Nitric acid cannot be concentrated beyond 68% by the distillation of a dilute solution of HNO_3 because it forms an azeotropic mixture i.e. at 121°C it boils without any change in its concentration of the mixture with water.

(b) 98 % nitric acid is obtained by distilling 68% nitric acid with conc. H_2SO_4 under reduced pressure. The function of H_2SO_4 is to absorb water.

Solution 8:

Three equations to prove acidic nature of nitric acid are-

(a) Reaction with basic oxide-

$CaO + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$

(b) Reaction with carbonates and hydrogen carbonates-

$Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + H_2O(l) + CO_2$

$NaHCO_3 + HNO_3 \rightarrow NaNO_3 + H_2O + CO_2$

(c) Reaction with metallic sulphites-

$Na_2SO_3 + 2HNO_3 \rightarrow 2NaNO_3 + SO_2 + H_2O$

Solution 9:

Uses of nitric acid are-

(i) Nitric acid is used in the purification of silver, gold, platinum etc. because impurities of other metals are dissolved in it.

(ii) Nitric acid is used as an oxidiser in rocket fuel because it can supply large amount of oxygen.

(iii) Nitric acid is used in the manufacture of dyes, perfumes, drugs etc. from coal tar products since nitrobenzene is one of the raw materials of it which is manufactured from nitric acid.

Solution 10:

(a) Brown ring test-

Nitric acid in a test tube is taken and then and then freshly prepared ferrous sulphate solution is added. Concentrated H_2SO_4 is then added carefully down the sides of the test tube, dark brown ring is formed at the junction of two layers.

$6\,FeSO_4 + 3H_2SO_4 + 2HNO_3 \rightarrow 3Fe_2(SO_4)_3 + 2NO + 4H_2O$

$FeSO_4 + NO + 5H_2O \rightarrow [Fe(NO)(H_2O)_5]SO_4$

Hydrated nitrosoferrous

Sulphate(brown ring)

(b) Freshly prepared ferrous sulphate solution is used in the ring test otherwise Ferrous sulphate undergoes aerial oxidation and converts to ferric sulphate

(c) If the test tube is disturbed brown ring will disappear because the complex formed will get dissolved in the layers of the liquid.

Solution 11:

(a) In laboratory preparation of nitric acid all the apparatus including cork should be made up of glass because nitric acid vapours are highly corrosive in nature and corrodes cork, rubber etc.

(b) Commercial nitric acid is yellow in colour because of presence of nitrogen dioxide but when it is diluted with water, it turns colourless because nitrogen dioxide get dissolved in water.

(c) Aluminum does not react with nitric acid of any concentration because of the formation of extremely thin, unreactive, protective layer of insoluble metallic oxide on the surface of aluminium which stops further reaction.

(d) Concentrated nitric acid renders iron passive because of the formation of extremely thin, unreactive, protective layer of insoluble metallic oxide on the surface which stops further reaction.

(e) Nitric acid is used in the purification of gold because impurities of other metals are dissolved in it.

(f)

$$3HCl + HNO_3 \longrightarrow 2H_2O + NOCl + 2[Cl]$$

Gold in Aqua regia:

$$Au + 4[Cl] \longrightarrow AuCl_3$$

Platinum in Aqua regia:

$$Pt + 4[Cl] \longrightarrow PtCl_4$$

(g) Nitric acid usually do not yield hydrogen gas with metals, instead it reacts with metals and form respective nitrates , nitric oxide and water.

(h) Lightning is a blessing as it is the natural source of synthesis of nitric acid.

(i) Concentrated nitric acid is brown in colour due to the presence of nitrogen dioxide formed by heating the acid.

(j) Concentrated nitric acid is a stronger oxidizing agent due to nascent oxygen which it gives on decomposition.

$$2HNO_3 \rightarrow H_2O + 2NO_2 + [O]$$

(Conc.) nascent oxygen

$$2HNO_3 \rightarrow H_2O + 2NO + 3[O]$$

(Dilute) nascent oxygen

Solution 12:

Two tests for nitric acid are-

(i) Brown ring test-

Nitric acid in a test tube is taken and then and then freshly prepared ferrous sulphate solution is added. Concentrated H_2SO_4 is then added carefully down the sides of the test tube, dark brown ring is formed at the junction of two layers.

$$6\,FeSO_4 + 3H_2SO_4 + 2HNO_3 \rightarrow 3Fe_2(SO_4)_3 + 2NO + 4H_2O$$

$$FeSO_4 + NO + 5H_2O \rightarrow [Fe(NO)(H_2O)_5]SO_4$$

Hydrated nitrosoferrous Sulphate(brown ring)

(ii) Nitric acid on heating gives brown fumes of nitrogen dioxide.

$$4HNO_3 \xrightarrow{\Delta} 2H_2O + 4NO_2 + O_2$$

Brown fumes

Solution 13:

(a) Action of concentrated nitric acid on copper-

$$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$

(Conc.)

(b) $$2\,AgNO_3 \xrightarrow{\Delta} 2\,Ag + O_2 + 2\,NO_2$$

Solution 14:

(a) When sodium hydrogen carbonate is added to nitric acid, formation of sodium nitrate, water and carbon dioxide will occur.

$$NaHCO_3 + HNO_3 \rightarrow NaNO_3 + H_2O + CO_2$$

(b) When cupric oxide reacts with nitric acid formation of copper nitrate and water will occur.

$$CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$$

(c) When zinc reacts with dilute nitric acid formation of zinc nitrate, water and nitric oxide will occur.

$$3Zn + 8HNO_3 \rightarrow 3Zn(NO_3)_2 + 4H_2O + 2NO$$

(d) When concentrated nitric acid is heated formation of nitrogen dioxide will occur-

$$4HNO_3 \xrightarrow{\Delta} 2H_2O + 4NO_2 + O_2$$

Solution 15:

Aqua –regia is a mixture of Conc. Nitric acid and conc. Hydrochloric acid in 1:3.

$$3HCl + HNO_3 \longrightarrow 2H_2O + NOCl + 2[Cl]$$

Solution 16:

(i) Reddish brown fumes of nitrogen dioxide are observed

(ii) When hydrogen sulphide is bubbled through conc.HNO_3 formation of sulphur,nitric oxide and water will occur.

$$3\,H_2S + 2HNO_3 \rightarrow 3S + 2NO + 4H_2O$$

(iii) When conc. HNO_3 drops on the skin of a person it reacts with the protein of the skin and forms a yellow compound called xanthoproteic acid, hence skin becomes yellow. Excess of conc. HNO_3 causes blisters on the skin and is highly corrosive.

(iv) When scrap zinc is heated with conc. HNO_3 formation of zinc nitrate, water and nitrogen dioxide will occur.

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

Solution 17:

(a) When sulphur is added to hot and conc. HNO_3 formation of oxide or oxy-acid will occur.

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

(b) Nitric acid act as oxidizing agent and oxidizes iodide to iodine.

$$HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-$$

$$KI \rightarrow I^- + K^+$$

$$2I^- \xrightarrow{-2e^-} I_2$$

$$2HNO_3 + H_2O + 2KI \rightarrow NO_3^- + I_2 + 2KNO_3 + H_3O^+$$

(c) Nitric acid ionizes in water to form free hydronium ions and nitrate ions.

$$HNO_3 + H_2O \rightleftharpoons H_3O^+ + NO_3^-$$

(d) When nitric acid is added to washing soda carbon dioxide will form which when passed through a freshly prepared lime water, turns lime water milky.

$$Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + H_2O(l) + CO_2$$

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

(e) When limestone reacts with nitric acid-

$$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O(l) + CO_2$$

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Solution 18:

(i) $C + 4HNO_3 \longrightarrow 2H_2O + 4NO_2 + CO_2$

(ii) $3SO_2 + 2HNO_3 + 2H_2O \longrightarrow 3H_2SO_4 + 2NO$

(iii) $3Fe + 8HNO_3\,(conc.) \longrightarrow 3Fe(NO)_3 + 4H_2O + 2NO$

(iv) $FeSO_4 + NO + 5H_2O \longrightarrow [Fe(NO)(H_2O)_5]SO_4$

(v) $Pt + HNO_3 + HCl \longrightarrow PtCl_4$

(vi) $2HNO_3 + 6FeSO_4 + 3H_2SO_4 \longrightarrow 3Fe_2(SO_4)_3 + 2NO + 4H_2O$

Solution 19:

Dilute nitric acid	Dilute hydrochloric acid
1. On reacting copper metal with nitric acid brown fumes of nitrogen dioxide. $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$	1. On treating copper metal with HCl We don't observe any reaction.
2. Brown ring test: Nitric acid in a test tube is taken and then and then freshly prepared ferrous sulphate solution is added. Concentrated H_2SO_4 is then added carefully down the sides of the test tube, dark brown ring is formed at the junction of two layers. $6\,FeSO_4 + 3H_2SO_4 + 2HNO_3 \rightarrow 3Fe_2(SO_4)_3 + 2NO + 4H_2O$ $FeSO_4 + NO + 5H_2O \rightarrow [Fe(NO)(H_2O)_5]SO_4$ Hydrated nitrosoferrous Sulphate(brown ring)	2. No brown ring test is observed in the case of hydrochloric acid.

Solution 1991-1:

Gold will dissolve only in aqua regia i.e., a mixture of conc. hydrochloric acid and conc. nitric acid in 1:3 but copper will dissolve in nitric acid.

To separate gold from a mixture of gold and platinum add some nitric acid to the mixture, gold will remain undissolved hence can be filtered.

Solution 1991-2:

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

Solution 1991-3:

Balanced equation: $Cu + 4HNO_3 \xrightarrow{\Delta} Cu(NO_3)_2 + 2NO_2 + 2H_2O$

Word equation: copper + nitric acid $\xrightarrow{\Delta}$ copper nitrate + nitrogen dioxide + water

Solution 1992-1:

In the laboratory preparation of nitric acid, the mixture of concentrated sulphuric acid and sodium nitrate should not be heated very strongly, above 200°C because a higher temperature can cause following problems:

1. Nitric acid would decompose to form nitrogen dioxide.
2. Sodium sulphate is formed which may stick to the glass and cannot be removed easily
3. The glass apparatus may break.

Solution 1992-2:

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

Solution 1992-3:

Commercial nitric acid is yellow in colour because of presence of nitrogen dioxide but when it is diluted with water, it turns colourless because nitrogen dioxide gets dissolved in water.

Brown ring test can be used to test nitric acid:

Brown ring test: Nitric acid in a test tube is taken and then and then freshly prepared ferrous sulphate solution is added. Concentrated H_2SO_4 is then added carefully down the sides of the test tube, dark brown ring is formed at the junction of two layers.

$$6\,FeSO_4 + 3H_2SO_4 + 2HNO_3 \rightarrow 3Fe_2(SO_4)_3 + 2NO + 4H_2O$$

$$FeSO_4 + NO + 5H_2O \rightarrow [Fe(NO)(H_2O)_5]SO_4$$

Hydrated nitrosoferrous Sulphate(brown ring)

Solution 1992-4:

Oxidation of ammonia in catalytic chamber.

$$4NH_3 + 5O_2 \xrightarrow[800°C]{\text{Platinum gauge}} 4NO + 6H_2O + \text{Heat}$$

Solution 1994-1:

Copper is heated with nitric acid, they react together to produce nitrogen dioxide.

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

Solution1994-2:

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

Solution 1994-3:

The nitric acid is manufactured by Ostwald process. In ostwald process ammonia gas and air are taken in 1:10 ratio. Temperature is maintained at 800°C I the catalytic chamber, as the reaction is exothermic so the heat evolved maintains the temperature in the catalytic chamber.

Solution 1994-4:

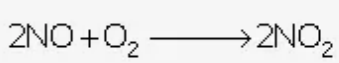
$$KNO_3 + H_2SO_4 \xrightarrow{200^oC} KHSO_4 + HNO_3$$

Solution 1995-1:

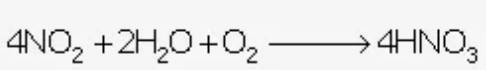
During a thunderstorm, the rainwater contains nitric acid. The nitric acid is formed as a result of three chemical reactions which is described as follows:

1. During lightning discharge , nitrogen in atmosphere combines with oxygen to form nitric oxide.

2. Nitric oxide is further oxidized to nitrogen dioxide.



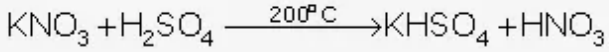
3. Nitrogen dioxide dissolves in moisture or rain water to from nitric acid.



Solution 1997-1:

Lead nitrate is a soluble salt . On heating lead nitrate the following reaction occurs:

Preparation of nitric acid from potassium nitrate:



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Solution 1998-1:

Solution 1999-1:

When concentrated nitric acid is added to copper brown fumes of nitrogen dioxide are observed.

Solution 2000-1:

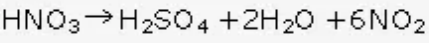
When concentrated nitric acid is added to copper brown fumes of nitrogen dioxide are observed.

Solution 2001-1:

1. Nitrogen dioxide
2. Ammonia gas

Solution 2001-2:

(i) concentrated

(ii) 

Solution 2001-3:

(i) $Na_2CO + 2HNO_3 \longrightarrow 2NaNO_3 + H_2O + CO_2$

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

Solution 2002-1:

For laboratory preparation of nitric acid potassium nitrate or sodium nitrate and conc. Sulphuric acid is required.

Solution 2002-2:

Yellowish brown colour of nitric acid is due to the presence of nitrogen dioxide formed due to thermal decomposition of nitric acid.

Solution 2002-3:

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

(ii) $CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$

Solution 2002-4:

Platinum glaze is used as catalyst in the manufacture for nitric acid

Solution 2003-1:

The apparatus used is made up of glass as nitric acid is highly corrosive in nature.

Solution 2003-2:

$KNO_3 + H_2SO_4 \xrightarrow{200^oC} KHSO_4 + HNO_3$

Solution 2005-1:

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

Solution 2005-2:

(i) Dilute nitric acid is generally considered to be a typical acid except for its reaction with metals, nitric acid did not evolve hydrogen gas on reacting with any metal, other than manganese and magnesium.

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

(iii) In a glass apparatus nitric acid gets decomposed by sunlight .Yellowish brown colour of nitric acid is due to the presence of nitrogen dioxide formed due to thermal decomposition of nitric acid.

Solution 2006-1:

(i) Nitric acid is highly corrosive in nature and corrodes cork, rubber, etc.

(ii) Nitric acid ionizes in water to form free hydronium ions and nitrate ions. This shows that nitric acid is aidic in nature.

Solution 2007-1:

(i) A =sulphuric acid, B=potassium nitrate , C= nitric acid

(ii) $4HNO_3 \longrightarrow 4NO_2 + 2H_2O + O_2$

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

Solution 2007-2:

If nitric acid is kept in a bottle for long time then it will become brown in colour.

Solution 2008-1:

$AlN + 3H_2O \rightarrow Al(OH)_3 + NH_3$

Solution 2008-2:

Name of process	Inputs	Catalyst	Equation for catalysed reaction	Output
Haber Process	Hydrogen +	Iron	$N_2(g) + 3H_2(g) \underset{}{\overset{Fe,\ Al_2O_3}{\rightleftharpoons}} 2NH_3(g)$	Ammonia
Ostwald process	Ammonia + Air	Platinum	$4NH_3 + 5O_2 \xrightarrow[800^0C]{\text{Platinum gauge}} 4NO + 6H_2O + \text{Heat}$	Nitric acid

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Solution 2009-1:

oxygen gas is evolved on heating sodium nitrate.