

CHAPTER NO. 13

NITROGEN AND OXYGEN

Q1. Write down the introduction and occurrence of Nitrogen and Oxygen?

NITROGEN:

Introduction:

1. Nitrogen was discovered in 1772 by a Scottish Botanist Daniel Rutherford.
2. Nitrogen belongs to group V-A of the periodic table.
3. Nitrogen containing five electrons in its last shell.
4. Nitrogen is the most common gas present in the atmosphere.

OCCURRENCE:

1. Nitrogen is the 10th most abundant element in the earthcrust.
2. Nitrogen occurs in the free state as N₂ gas in the air upto 78% by volume.
3. In the combined state Nitrogen occurs abundantly in earth's crust as nitrates of different elements.

OXYGEN:

Introduction:

1. Oxygen was discovered independently by Scheele in 1772 and J. priestly in 1774.
2. Oxygen belongs to VI-A group of the periodic table.
3. It contains six electrons in its last shell.

OCCURRENCE:

1. Oxygen is the most abundant element on earth.
2. It occurs in nature in the free state as well as in combined state.
3. In the free state oxygen is present as diatomic gas(O₂) in the air upto 21% by volume.

Q2. Write physical properties and chemical properties of Nitrogen?

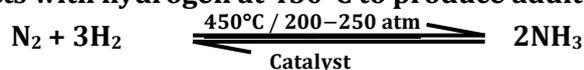
PHYSICAL PROPERTIES OF NITROGEN:

1. Nitrogen is colorless, odorless and tasteless gas.
2. Pure Nitrogen is slightly soluble in water.
3. It is slightly lighter than air.
4. Its boiling point is -196°C and melting point is -210°C.
5. It does not sustain combustion or life.

CHEMICAL PROPERTIES OF NITROGEN:

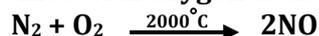
REACTION WITH HYDROGEN:

Nitrogen reacts with hydrogen at 450°C to produce addition product.



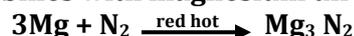
REACTION WITH OXYGEN:

Nitrogen combines with oxygen at about 2000°C to form Nitrogen monoxide or nitric acid (NO)



REACTION WITH MAGNESIUM (RED HOT):

Nitrogen combines with magnesium directly on heating to red hot to form magnesium nitride.



Q3. Write down the industrial preparation of ammonia gas (NH₃) by haber-borch process?

INDUSTRIAL PREPARATION OF AMMONIA GAS (NH₃) BY HABER-BORCH PROCESS:

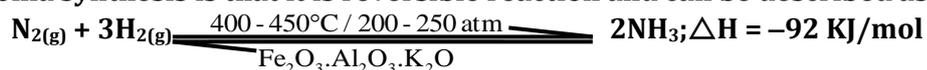
Introduction:

1. On large scale ammonia was manufactured by direct combination of nitrogen and hydrogen.
2. Firtz Haber discovered this process in 1908.
3. For this work Haber won the noble prize in chemistry in 1918.



DETAILED OF PROCESS:

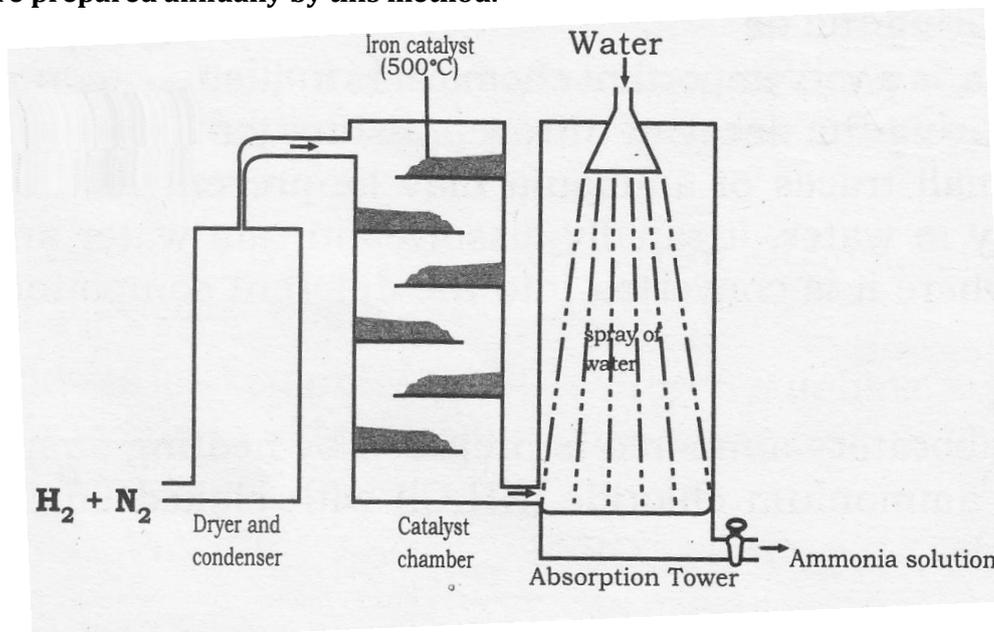
In this process nitrogen and hydrogen in the ratio of 1:3 by volume is allowed to react. The basic problem in ammonia synthesis is that it is reversible reaction and can be described as:



To get maximum yield of ammonia the optimum condition of temperature should be 400 to 450°C and pressure should be 200 to 250 atm.

The appropriate catalyst Fe_2O_3 with small amount of Al_2O_3 , CaO , K_2O are required Ammonia thus obtained is liquefied by cooling.

The unused gases are circulated over catalyst for further formation of ammonia. Millions of tons of ammonia are prepared annually by this method.



Industrial Preparation Of Ammonia Gas (NH_3) By Haber-Borch Process

Q4. Write down the physical properties, chemical properties and uses of ammonia gas (NH_3)?

PHYSICAL PROPERTIES OF AMMONIA GAS (NH_3):

1. Ammonia is colourless gas with a characteristics pungent smell.
2. In large quantity ammonia is poisonous because of its effect on respiratory system.
3. It is highly soluble in water.
4. Its solution is alkaline (basic) as it turns red litmus paper into blue.

CHEMICAL PROPERTIES OF AMMONIA GAS (NH_3):

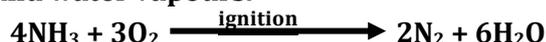
REACTION WITH WATER:

Ammonia is very soluble in water and reacts with water to form ammonium hydroxide.



REACTION WITH OXYGEN:

Ammonia does not burn in air but it burns readily in oxygen with greenish yellow flame to form nitrogen gas and water vapours.



REACTION WITH ACIDS:

Since ammonia is a base, so it reacts with acids to form ammonium salts.



AMMONIA AS A REDUCING AGENTS:

Ammonia is not a strong reducing agent however it reduces heated copper oxide (CuO) to free copper metal with the evolution of N_2 gas and water.



USES OF AMMONIA:

1. Aqueous ammonia is used in softening of temporary hard water.
2. It is used as solvent in laundries for removing grease and oil stains.
3. Liquid ammonia is used as cooling agent in some refrigerators.

- Ammonia is used in the manufacture of nitric acid in Ostwald's method.
- It is also used in the manufacture of sodium carbonate (washing soda) by ammonia Solvay process.

Q5. Write down the industrial preparation of nitric acid(HNO₃) by Ostwald's methods?

INDUSTRIAL PREPARATION OF NITRIC ACID(HNO₃) BY OSTWALD'S METHOD:

INTRODUCTION:

This process was introduced by William Ostwald in 1902.

DETAILED OF PROCESS:

1ST STEP (CATALYST OR CONVERTER CHAMBER):

In this chamber ammonia is allowed to react with oxygen in the presence of platinum (pt) catalyst at 600°C to produce nitric oxide (NO) and stream above 96% of ammonia is converted into nitric oxide.



2nd STEP (COOLING TOWER):

In this chamber nitric oxide is cooled by passing through coolers upto -150°C, then nitric oxide mixed with excess of oxygen in oxidation chamber to produce nitrogen dioxide (NO₂).

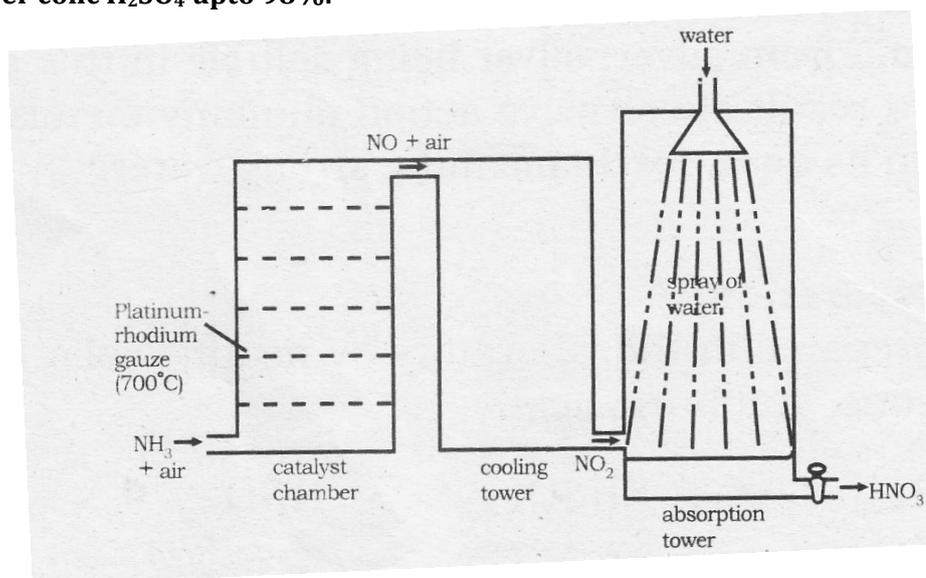


3rd STEP (ABSORPTION TOWER):

In this chamber NO₂ dissolve in water to produce nitric acid (HNO₃) and liberated nitric oxide (NO).



Nitric acid obtained from this process is 68% concentrated which can be concentrated further by passing over conc H₂SO₄ upto 98%.



Industrial Preparation Of Nitric Acid(HNO₃) By Ostwald's Method

Q6. Write down physical properties, chemical properties and uses of nitric acid?

PHYSICAL ROPERTIES OF NITRIC ACID:

- Nitric acid is a colorless fuming liquid with sharp choking smell and has sour taste.
- The boiling point of pure nitric acid is 83°C while its freezing point is -41.6 °C.
- The density of pure nitric acid is 1.52 gm/cm³.
- It is miscible in water in all proportion.

CHEMICAL ROPERTIES OF NITRIC ACID:

AS AN ACID:

It reacts with alkalis (base) metal oxide and metal carbonates to form nitric salts and water.



AS OXIDIZING AGENT:

Nitric acid acts as a powerful oxidizing agent because it is an electron acceptor.

REACTION WITH NON- METALS:**REACTION WITH CARBON:**

Carbon oxidizes to liberate CO₂ gas on heating with conc HNO₃.

**REACTION WITH SULPHUR:**

Sulphur oxidizes first into SO₂ gas and then to sulphuric acid, on heating with conc nitric acid.

**REACTION WITH PHOSPHOROUS:**

Red phosphorous oxidizes to phosphoric acid on heating with conc nitric acid.

**REACTION WITH METAL:****REACTION WITH COPPER:****REACTION WITH LEAD:****REACTION WITH ZINC:****USES OF NITRIC ACID:**

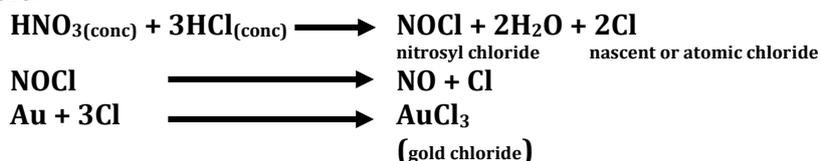
1. Large amount of nitric acid is used in the manufacture of fertilizers. Such as NH₄NO₃, NaNO₃, KNO₃ etc.
2. It is used in the manufacture of smokeless gun powder.
3. It is used in the manufacture of dyes and explosives such as nitroglycerol and trinitrotoluene (T.N.T) which are powerful explosives.
4. It is used in the formation of aqua regia.
5. It is used as laboratory reagent.

Q7. What is aqua regia/ royal water? How it dissolves gold?

AQUA REGIA:

The mixture of conc. HNO₃ and conc. HCl taken in the ratio of 1:3. This mixture is called aqua regia or royal water.

Aqua regia dissolves gold due to liberation of nascent chlorine which forms gold chloride with it, which is soluble.



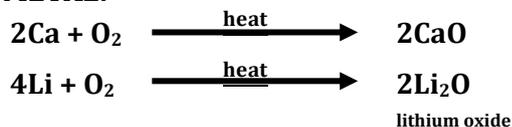
Q8. Write down the physical and chemical properties of oxygen?

PHYSICAL PROPERTIES OF OXYGEN:

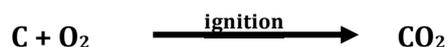
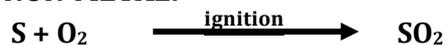
1. Oxygen (O₂) is a colorless, odorless gas and tasteless gas.
2. It is neutral to moist litmus paper.
3. It is slightly soluble in water. However this solubility is of vital importance for the existence of aquatic life.
4. Gaseous oxygen is about 1.1 times denser than air.

CHEMICAL PROPERTIES OF OXYGEN:

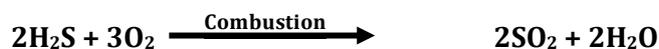
Oxygen reacts with metals non-metal and other compounds directly to form their oxides.

REACTION WITH METAL:

REACTION WITH NON-METAL:



REACTION WITH OTHER COMPOUNDS:



Q9. What are oxides? Write its types and define them with examples?

OXIDES:

The binary compounds of oxygen with metals and non-metals are called as oxides.

Example: CaO, Fe₂O₃, CO₂, H₂O etc.

CLASSIFICATION OF OXIDES:

There are four types of oxides.

1. Normal oxides.
2. Peroxides.
3. Super oxides.
4. Suboxides.

1. NORMAL OXIDES:

Normal oxides are those oxides in which oxygen shows normal oxidation state or valence number -2.

Example: CaO, CO₂, H₂O, SO₂ etc.

2. PEROXIDES:

In these oxides oxygen has an oxidation state or valence number -1.

Example: Na₂O₂, BaO₂, H₂O₂.

3. SUPER OXIDES.

In these oxides, oxygen has an oxidation state or valence number -0.5 or -1/2.

Example: KO₂, RbO₂, CsO₂.

4. SUBOXIDES:

Suboxides have less quantity of oxygen than the normal oxides. They are unstable. Very few suboxides are known.

Example: carbon suboxides (C₃O₂)

Q10. How many types of normal oxides are there? Define them with examples?

NORMAL OXIDES:

CLASSIFICATION OF NORMAL OXIDES:

Normal oxides are further classified into four types on the basis of their chemical characteristics.

- i. Basic oxides
- ii. Acidic oxides
- iii. Amphoteric oxides
- iv. Neutral oxides

I. BASIC OXIDES:

The normal oxides of metals are the examples of basic i. Basic oxides.

Example: Na₂O, PbO, CaO.

II. ACIDIC OXIDES:

The normal oxides of non-metal are generally acidic oxides.

Example: SO₂, CO₂, NO₂.

III. AMPHOTERIC OXIDES:

When oxygen reacts with less electro positive metals just like aluminium, zinc, tin etc to form oxides that possess dual characteristics i.e. acidic as well as basic. These oxides are known as amphoteric oxides.

Example: Al₂O₃, ZnO₂.

IV. NEUTRAL OXIDES:

Neutral oxides are neither acidic or basic. They are neutral to litmus in aqueous solution.

Example: H_2O , NO , CO , N_2O .

Q11. How hydrogen peroxide (H_2O_2) can be prepared in laboratory? Also write its physical properties and uses?

LABORATORY PREPARATION OF HYDROGEN PEROXIDE (H_2O_2):

Hydrogen peroxide is usually prepared in the laboratory by the action of dilute sulphuric acid with barium peroxide (BaO_2). Barium sulphate is insoluble and can be easily removed by filtration and pure H_2O_2 is obtained.



PHYSICAL PROPERTIES OF HYDROGEN PEROXIDE:

1. Pure hydrogen peroxide is pale blue syrupy liquid.
2. It mixes with water to give solution which is slightly acidic.
3. Its boiling point is 150°C and freezing point is -0.9°C .

USES OF HYDROGEN PEROXIDE:

1. Hydrogen peroxide is used as a mild antiseptic in mouth wash as well as for cleaning wounds.
2. Hydrogen peroxide is used as bleaching agent in bleaching delicate materials like silk, wool, feathers and human hairs.
3. Liquid H_2O_2 is used for restoring paintings.
4. Liquid H_2O_2 is used for providing oxygen for burning fuel in space rockets.

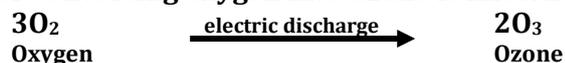
Q12. What is ozone? How ozone can be prepared by oxygen? Write its physical properties and uses?

OZONE:

Ozone is a pale blue poisonous gas with a sharp irritating odour. It is an allotropic form of oxygen with molecular formula O_3 . Ozone was first discovered by Schonbein in 1839.

PREPARATION OF OZONE BY OXYGEN:

Ozone can be prepared from oxygen by passing electric discharge through oxygen gas. The apparatus used for converting oxygen into ozone is known as Ozonizer.



PHYSICAL PROPERTIES OF OZONE:

1. Ozone is a pale blue gas at ordinary condition.
2. Ozone has characteristic smell which is sharp irritating like Cl_2 gas.
3. Ozone is very poisonous gas and produces headache and burning of eyes.
4. It is only slightly soluble in water but dissolves in turpentine oil readily.

USES OF OZONE:

1. Ozone is sometimes used in treatment of domestic water in place of chlorine.
2. It is used as bleaching agent because all oxidizing agents are also good bleaching agents.
3. It is largely used in the preparation of pharmaceutical, synthetic lubricants and other commercially useful organic compounds.

Q13. Why ozone is important component in upper atmosphere?

Ozone is an important component in the upper atmosphere, where, it serves to screen out the ultra violet radiations of sun. In this way ozone protects earth from harmful effects of high energy rays.

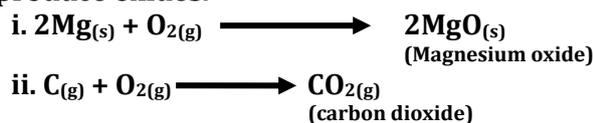
Q14. What is oxidation and reduction reactions explain with different examples?

OXIDATION:

Oxidation can be defined in a number of ways as:

1. OXYGEN AS ADDITION OF OXYGEN:

Oxidation is defined as a reaction in which oxygen combines with other elements or substance to produce oxides.



2. OXIDATION AS REMOVAL OF HYDROGEN:

Oxidation is also the process in which the removal of hydrogen occurs form a compound.



3. OXIDATION AS REMOVAL OR LOSS OF ELECTRONS:

Oxidation is also defined as the process or a reaction which occurs by the loss or removal electrons.



REDUCUTION:

Reduction can be defined in a number of ways.

1. REMOVAL OF OXYGEN FROM A SUBSTANCE:

Reduction means the removal of oxygen from substance.



2. ADDITION OF H₂ (HDYROGEN):

Reduction also means addition of hydrogen in a substance.



3. GAIN OF ELECTRONS:

The process or a reaction in which a substance gains electron is called reduction.



Q15. Write down the differences between oxidation and reduction reactions.

DIFFERENCE BETWEEN OXIDATION AND REDUCTION REACTIONS:

S.No.	OXIDATION	REDUCTION
1.	Addition of oxygen in a substance is called oxidation. $\text{C} + \text{O}_2 \longrightarrow \text{CO}_2$	Removal of oxygen from a substance is known as reduction. $\text{CO}_2 \longrightarrow \text{C} + \text{O}_2$
2.	Removal of hydrogen from a substance is known as oxidation. $2\text{HCl} \longrightarrow \text{H}_2 + \text{Cl}_2$	Addition Of hydrogen in a substance is called reduction. $\text{H}_2 + \text{Cl}_2 \longrightarrow 2\text{HCl}$
3.	Loss of electrons during a reaction is called oxidation. $\text{Na} \longrightarrow \text{Na}^{+} + 1e^{-}$	Gain of electrons during a reaction is called reduction. $\text{Na}^{+} + 1e^{-} \longrightarrow \text{Na}$

Q16. What is redox reaction?

REDOX REACTION:

A redox reaction (oxidation- reduction) is a type of chemical reaction that involves a transfer of electron between two atoms.

It is a reaction in which the oxidation number of a molecule, atom or ion changes by gaining or losing of electron.