

## CHAPTER NO. 14

### SULPHUR AND ITS COMPOUNDS

Q1. Write down the introduction and occurrence of sulphur?

**SULPHUR:**

**INTRODUCTION:**

1. Sulphur is the second member of VI A group of the periodic table.
2. It has periodic symbol "S".
3. Its atomic number is 16.
4. Its atomic mass is 32.

**OCCURRENCE:**

Sulphur is non-metal and makes up about 0.1 % of the earth crust. It is found in the free state in Japan, Newzeland and U.S.A. In the combined state, it is largely found, as sulphides of iron, zinc, lead, copper and mercury and also as sulphates of magnesium, calcium and barium.

Q2. Write down extraction of sulphur by Frasch process? OR How sulphur is extracted by Frasch process? Explain with diagram.

**EXTRACTION F SULPHUR (FRASCH PROCESS):**

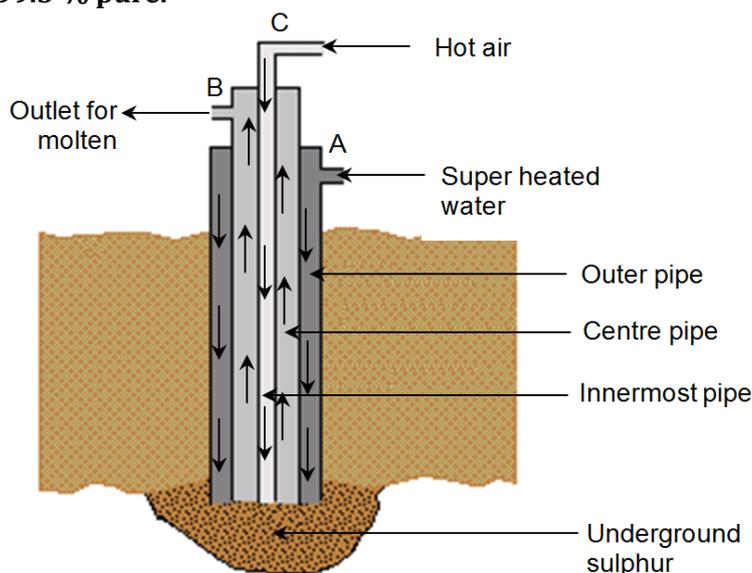
**INTRODUCTION:**

This Method was discovered by Herman Frasch, an American engineer, known as Frasch process.

**DETAILED OF THE PROCESS:**

In this process a hole about 30 cm in diameter is drilled through the soil layers to the sulphur bed. Three concentric iron pipes are sunk into the bore or hole. Super heated water at about 170°C and 100 atmospheric pressure is forced through the outer pipe to the sulphur bed to melt sulphur (m.p =115°C) of the sulphur bed. Hot compressed air at a pressure of 15 atm is then flown down the inner most pipe (5 cm diameter) to force the molten sulphur up through the middle tube or pipe. This sulphur is prevented from solidifying by high temperature of the middle pipe whose temperature is maintained by the heat of the super-heated water in the outer side and also hot compressed air on the inner side.

The molten sulphur is continuously pumped into a receptacle at the surface where it is allowed to solidify in large wooden tanks. The sulphur obtained from this process is about 99.5 % pure.



**EXTRACTION F SULPHUR (FRASCH PROCESS)**

Q3. Write physical and chemical properties of sulphur? Also write its uses?

**PHYSICAL PROPERTIES OF SULPHUR:**

1. Sulphur is a yellow solid.
2. It is insoluble in water but soluble in carbon disulphide (CS<sub>2</sub>).
3. It is bad conductor of heat and electricity.
4. It melts at a temperature between 113°C to 119°C.
5. Its boiling point is about 444°C.

**CHEMICAL PROPERTIES OF SULPHUR:**

**WITH OXYGEN:**

Sulphur burns in oxygen of the air with a bright blue flame to form sulphur dioxide.



**WITH HYDROGEN:**

At high temperature about 600-660°C, sulphur combined with hydrogen slowly to form hydrogen sulphide (H<sub>2</sub>S) gas.



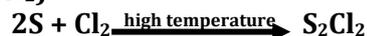
**WITH CARBON:**

Sulphur combined with coke in an electric furnace to form a colourless liquid, carbon disulphides (CS<sub>2</sub>).



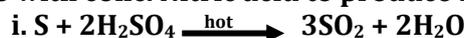
**WITH CHLORINE:**

Sulphur combined with chlorine on heating to high temperature, forming disulphur dichloride (S<sub>2</sub>Cl<sub>2</sub>).



**REACTION WITH ACIDS:**

Sulphur is readily oxidized when warmed conc. Sulphuric acid added it produce SO<sub>2</sub> gas and also with conc. Nitric acid to produce NO<sub>2</sub> gas.



**USES OF SULPHUR:**

1. Sulphur is used in the manufacture of sulphuric acid, sulphur dioxide and carbon disulphide.
2. It is used for the manufacture of calcium and magnesium hydrogen sulphates and also used for bleaching wood-pulp.
3. Sulphur is used in vulcanizing rubber.
4. It helps to kill the fungi and insects.

Q4. How sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) industrially prepared by contact process? Explain in detail.

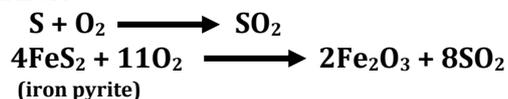
**INDUSTRIAL PREPARATION OF H<sub>2</sub>SO<sub>4</sub> BY CONTACT PROCESS:**

**INTRODUCTION:**

This method was developed in Germany in the early 19<sup>th</sup> century that, came into operation in 1912. Now a days sulphuric acid is mostly manufactured by contact process.

**STAGE NO: 01 (PYRITE BURNER):**

In this method SO<sub>2</sub> is produced mainly by burning sulphur in dry air or iron pyrite in pyrite burner.



**STAGE NO: 02 (DUST REMOVING CHAMBER):**

For removing impurities SO<sub>2</sub> is passed through special dust chamber where solid particles are settle down.

**STAGE NO: 03 (WASHING AND SCRUBING CHAMBER):**

Then SO<sub>2</sub> is passed through scrubbing chamber where heat is injected from the top of the chamber and solid particles form droplets with steam and settle down.

**STAGE NO: 04 (DRYING CHAMBER):**

For removing moisture from SO<sub>2</sub>. The mixture of SO<sub>2</sub> and air is pass through drying tower where concentrated H<sub>2</sub>SO<sub>4</sub> is sprayed from the top.

**STAGE NO: 05: (CONTACT TOWER CATALYST CHAMBER):**

In this chamber SO<sub>2</sub> is oxidized into SO<sub>3</sub> in the presence of catalyst V<sub>2</sub>O<sub>5</sub>.



The reaction is exothermic and reversible so obtained maximum amount of SO<sub>3</sub>, three conditions are necessary;

- i. Low temperature.      ii. High pressure      iii. Excess of air (O<sub>2</sub>)

**STAGE NO: 06: ABSORPTION TOWER:**

In this stage sulphur trioxide (SO<sub>3</sub>) is absorb with concentrated H<sub>2</sub>SO<sub>4</sub> producing a very thick liquid called Oleum (H<sub>2</sub>S<sub>2</sub>O<sub>7</sub>).



Oleum is then diluted with appropriate amount of water to get H<sub>2</sub>SO<sub>4</sub> of desired concentrated.



Sulphuric acid is obtained by this process is about 100% pure.

Q5. Write down the physical properties, chemical properties and used of H<sub>2</sub>SO<sub>4</sub> ?

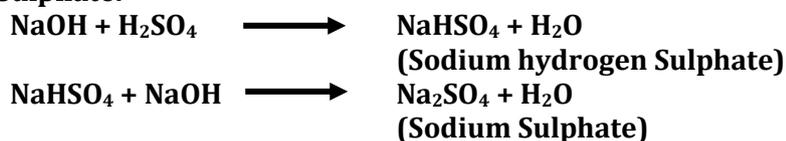
**PHYSICAL PROPERTIES OF SULPHURIC ACID:**

1. Pure concentrated sulphuric acid is a colourless, odourless, viscous oily liquid, often known as oil of vitrol.
2. Its melting point is 10.5°C while its boiling point is 338°C.
3. Concentrated H<sub>2</sub>SO<sub>4</sub> (98.3%) has specific gravity about 1.84.
4. It is corrosive and is hygroscopic as it absorbs water vapours from the surrounding and becomes dilute.

**CHEMICAL REACTION OF H<sub>2</sub>SO<sub>4</sub>:**

• **AS AN ACID:**

Sulphuric acid reacts with alkalis (bases) to give two types of salts. Hydrogen Sulphate and Sulphate.



• **AS AN OXIDIZING AGENT:**

i. **OXIDATION OF METAL:**

less electropositive metals like Zn, Fe Al react with dilute sulphuric to liberate H<sub>2</sub> gas and forming their sulphates



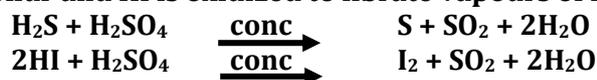
## ii. OXIDATION OF NON-METALS:

Hot concentrated sulphuric acid oxidizes some non-metals like C, S and P into their oxides and oxyacids.



## OXIDATION OF OTHER COMPOUNDS;

Concentrated sulphuric acid oxidizes hydrogen sulphide ( $\text{H}_2\text{S}$ ) which is oxidized to sulphur and HI is oxidized to liberate vapours of  $\text{I}_2$ .



## USES OF SULPHURIC ACID:

1. It is used in the manufacture of fertilizers.
2. It is used in the refining of metals by the process of electrolysis.
3. It is used in the manufacture of paints and pigments.
4. It is used in the steel pickling and cleaning.
5. It is used in the motor batteries.
6. It is used for refining of petroleum.

Q6. Write down the names of allotropic forms of sulphur and also write their structure and properties with diagram.

## SULPHUR AND ITS ALLOTROPIC FORM:

Sulphur exist in several allotropic forms out of which three forms are as under:

1. Rhombic sulphur ( $\alpha$ -sulphur)
2. Monoclinic sulphur ( $\beta$  or prismatic sulphur)
3. Plastic sulphur ( $\gamma$ - Sulphur)

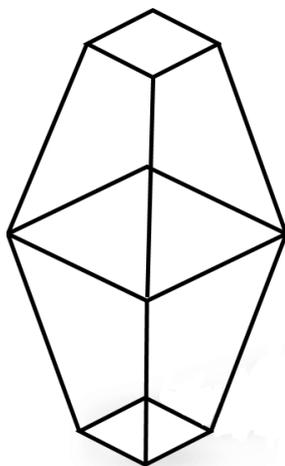
## RHOMBIC SULPHUR ( $\alpha$ -SULPHUR):

### STRUCTURE:

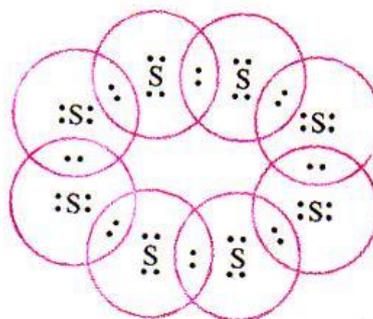
Rhombic sulphur consist of  $\text{S}_8$  molecules. These  $\text{S}_8$  molecules consist of eight sulphur atoms bound to each other through single covalent bond.

### PROPERTIES:

1. It is obtained as pale-yellow crystals given lemon yellow powder.
2. Its melting point is  $113^\circ\text{C}$ .
3. Its density is  $2.08 \text{ gm/cm}^3$ .
4. It is insoluble in water but dissolve in carbon disulphide( $\text{CS}_2$ ) and benzene.



Crystal of Rhombic Sulphur



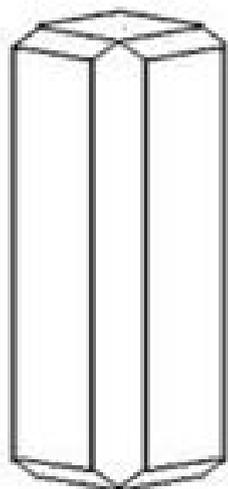
Structure of  $\text{S}_8$  Molecules

**MONOCLINIC SULPHUR ( $\beta$  OR PRISMATIC SULPHUR):  
STRUCTURE:**

Monoclinic sulphur also consists of sulphur atoms of  $S_8$  molecules. The only difference is the shapes of the crystals. The monoclinic sulphur the  $S_8$  molecules unit together to give long needle-shaped crystal.

**PROPERTIES:**

1. It consists of dark yellow transparent needle like crystals.
2. Its melting point is  $119^\circ\text{C}$ .
3. Its density is  $1.96 \text{ gm/cm}^3$ .
4. It is soluble in carbon disulphide ( $\text{CS}_2$ ) but insoluble in water.



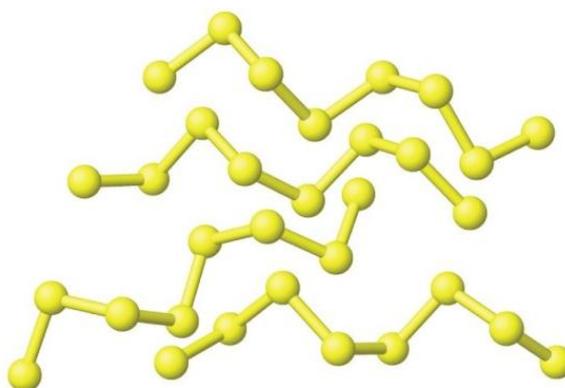
**Crystal of Monoclinic Sulphur**

**PLASTIC SULPHUR ( $\gamma$ -SULPHUR):  
STRUCTURE:**

Plastic sulphur is a super cooled form of sulphur. It is the non-crystalline allotrope of sulphur.

**PROPERTIES:**

1. It has zig-zag arrangement of sulphur atoms.
2. Its density is  $1.92 \text{ gm/cm}^3$ .
3. It is unstable at all temperature.
4. Its melting point is  $141^\circ\text{C}$ .



**Model of Plastic Sulphur**