

## Sulphur

Sulphur is a non-metallic element. It does not conduct heat or electricity. It is brittle yellow solid, melts at 112 degrees and boils at 444 degrees Celsius. It exists in two allotropic forms; rhombic and monoclinic.

Sulphur is trapped between rock layers in volcanic regions; in Sicily, Poland, Japan and USA.

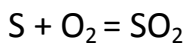
### Sources of sulphur:

- Found in underground sulphur beds
- Natural gas and petroleum contain sulphur compounds. These have to be removed and are an important source of sulphur.
- Metal sulphides, such as Zinc Blende can be used to get sulphur.

### Sulphur Dioxide:

Sulphur dioxide  $\text{SO}_2$  is a colourless gas with a pungent smell. It is formed when sulphur is burnt in air.

Sulphur + Oxygen = Sulphur Dioxide



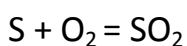
### Uses of sulphur dioxide:

- In the manufacture of sulphuric acid
- As a bleaching agent in the manufacture of wood pulp, this is used in paper industry.
- As a food preservative. It prevents the growth of bacteria when added in small quantities to food.

### Manufacture of sulphuric acid:

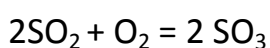
1) Sulphur is burnt in air to produce Sulphur Dioxide

Sulphur + Oxygen = Sulphur Dioxide



2) A mixture of sulphur dioxide and oxygen is heated to 450 degrees and then passed over a catalyst of vanadium (V) oxide,  $\text{V}_2\text{O}_5$ , to produce sulphur dioxide.

Sulphur dioxide + Oxygen = Sulphur Trioxide



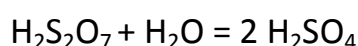
3) The sulphur trioxide formed is not dissolved directly in water because the reaction is too exothermic. Instead, it is dissolved in concentrated sulphuric acid to form fuming sulphuric acid, called oleum,  $\text{H}_2\text{S}_2\text{O}_7$ .

Sulphur trioxide + Sulphuric acid = Oleum (fuming sulphuric acid)



Oleum can be then carefully diluted with water to form concentrated sulphuric acid.

Oleum + Water = Sulphuric Acid



An optimum temperature is used because the forward reaction is exothermic, so there has to be a compromise between the yield and the rate.

Uses of sulphuric acid:

Sulphuric acid is very important industrially. It is commonly used as a raw material in the manufacture of many products such as fertilizers, paints, detergents, plastics, batteries and man-made fibres.

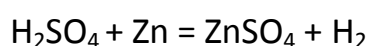
It is also used as a dehydrating agent as it removes water from wet gases bubbled through it. It can also remove water from other compounds.

Properties of sulphuric acid:

Dilute sulphuric acid reacts with metals and their oxides, hydroxides and carbonates in a typical acid fashion:

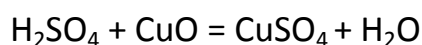
1) With metals above hydrogen in the reactivity series, it gives a salt called sulphate and hydrogen.

Sulphuric acid + zinc = Zinc Sulphate + Hydrogen



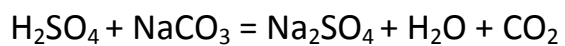
2) With bases (metal oxides and hydroxides) it gives a metal sulphate + water.

Sulphuric acid + copper (II) oxide = Copper sulphate + water



3) With metal carbonates or metal hydrogen carbonates it gives a metal sulphate + water + Carbon Dioxide.

Sulphuric acid + sodium carbonate = sodium sulphate + water + carbon dioxide



Or

Sulphuric acid + sodium hydrogen carbonate = sodium sulphate + water + carbon dioxide



4) It produces  $\text{H}^+$  ions in aqueous solutions.

