

# Sulphur

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## Chemistry project on Sulphur

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3/30/2008



This is a project on Sulphur explaining its characteristics; where we obtain it from and other facts about one of the most important elements on earth. Most of the Sulphur is used in making Sulphuric acid but it has many other uses.

## 1. From where do we get Sulphur?

We get sulphur from places like volcanic areas such as Italy and Japan. We also get sulphur as a compound from Natural gas and crude oil. However, we obtain the largest amount of Sulphur from underground deposits like in Texas, USA.

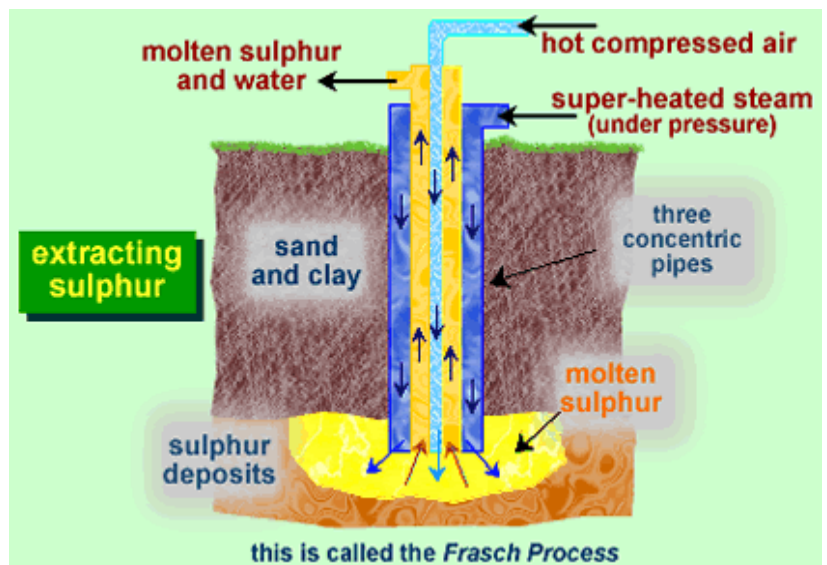
## 2. What is the Frasch process? Describe it in Detail.

The Frasch process is a process that is used to extract sulphur found in underground deposits. This process was first developed by Herman Frasch. This is how the process works:

- Firstly, a hole is dug into the sulphur bed which is several hundred feet.

- Then, a pipe which is 20 metres in diameter is put down; this pipe also contains a piece of engineering called a **Frasch pump**.

- The pump consists of three tubes shown in the diagram; one for super heated steam which is about 170°C, one for hot



- compressed air and one that takes away the molten sulphur that is forced out.

- At the bottom of the whole the sulphur and the steam meet each other and since the melting point of sulphur is 115°C, the steam melts it.

- The hot compressed air forces it up the middle of the tube, all the way up to the surface; the sulphur stays molten because the tube in which it is pushed up is surrounded by tubes which contain super heated steam.

- **The sulphur obtained is 99.5% pure** and can be used right there and then so the sulphur does not need to be purified.

- The sulphur is then stored and re-melted to produce sulphur rock or 'roll' sulphur.



Sulphur crystal

### 3. What are the general properties of Sulphur?

- Sulphur is yellow when solid.
- Sulphur is solid at room temperature.
- Transparency is transparent to translucent.
- Brittle
- Low melting point
- Non-metal
- Insoluble in water
- Does not conduct electricity



### 4. Using Sulphur as an example, what does the word allotrope mean?



in rhombic crystals the S<sub>8</sub> rings fit snugly into each other



in monoclinic crystals the S<sub>8</sub> rings are stacked on top of each other

When we say something has an allotrope we mean that there is an existence of an element in two or more different forms in a physical state. Sulphur is a very good



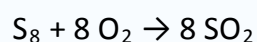
example of this. Solid sulphur has two crystalline forms or allotropes: these are Rhombic and monoclinic sulphur. The difference comes from the way the molecules are packed together. Crystals of the rhombic sulphur are denser and more stable than those of monoclinic sulphur at room temperature.

### 5. What is Sulphur used for?

- Production of Sulphuric acid which is used in batteries and also in the making of paper.
- For the vulcanisation of tires; this makes the car tires stronger i.e. tougher.
- Added in concrete to produce sulphur concrete that is not damaged against acid rain.
- To produce fertilisers

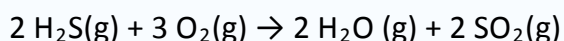
### 6. How is Sulphur dioxide made?

Sulphur dioxide is made by **burning sulphur in air**. The oxygen bonds with the sulphur:



This is the simplest process of making sulphur.

It is also produced by the **combustion of Hydrogen sulphide and organosulphur**:

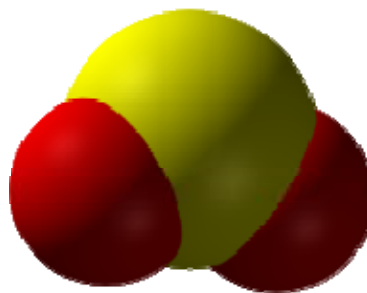


Sulphur dioxide is made whenever **sulphite salts are added to dilute acid**:



### 7. What are the general properties of Sulphur dioxide?

- Ⓐ Colourless
- Ⓐ Gas
- Ⓐ Soluble in water
- Ⓐ Corrosive
- Ⓐ Choking smell
- Ⓐ Heavier than air
- Ⓐ Non-flammable
- Ⓐ Low melting point ( $-72.4^\circ\text{C}$ ), Low boiling point ( $-10^\circ\text{C}$ )



Molecule of sulphur dioxide

### 8. How does Sulphur dioxide act as a bleach?

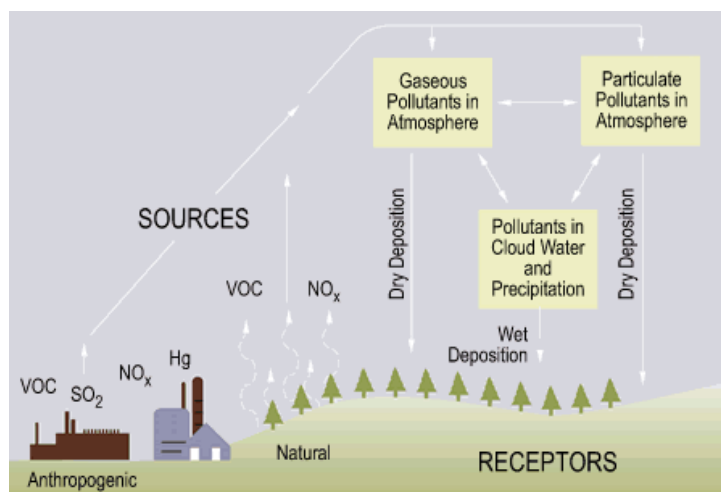
Bleaches remove color. In the presence of water, Sulphur dioxide is able to decolorize substances. Making paper is an excellent example; the sulphur dioxide removes oxygen from the wood pulp and therefore making it lose its brown color and it then becomes white.

### 9. Why, and for what, is sulfur dioxide used as a food preservative?

Sulphur dioxide can kill bacteria that make food go bad. This is why is used as a food preservative for fruit and jam.

### 10. Why is sulphur dioxide considered to be a polluting gas?

If there is high exposure to this gas there is can cause serious health effects including breathing problems (bronchitis), worsening of respiratory and cardiovascular diseases. It also aids in causing acid rain by reacting with water. When



acid rain falls on trees it corrodes the minerals in the soil so the trees cannot grow due to the absence of nutrients. Acid rain seeps into the rivers and lakes and turns the water acidic in doing so, the fishes in the water die because they cannot withstand low level pH. The acid also corrodes very much anything like cement or even steel i.e. construction materials. It corrodes things like limestone and also building and statues. That is why sometimes sulphur is used in cement making so that it does not get corroded by the acid rain.  $\text{SO}_2$  also causes

formation of microscopic acid aerosols, which have serious health implications as well as contributing to climate change. In places where there is a lot of this gas, it causes poor visibility.

### 11. Where does the polluting sulphur come from?

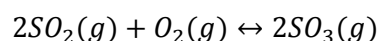
The main polluters are factories which release this gas as a waste produce and also from power plants which release this gas by burning fossil fuels.

### 12. What is the contact process? Describe it in detail.

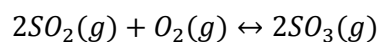
The contact process is the process that is used to make sulphuric acid. This process produces sulphuric acid in high concentration. The main ingredient is sulphur dioxide; the sulphur dioxide is converted into sulphur trioxide.

This sulphur trioxide is then converted into sulphuric acid.

#### Sulphur dioxide and oxygen react to form sulphur trioxide:



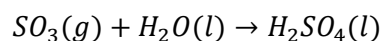
After Sulphur dioxide ( $SO_2$ ) is formed, any impurities are removed as well as untreated oxygen. These gases are heated to about  $450^\circ C$  and pressurized to 2-3 atmospheres. The gas is then fed into a reaction which is catalysed by Vanadium (V) oxide ( $V_2O_5$ ); this catalyses the reaction between Sulphur dioxide and oxygen to produce Sulphur trioxide ( $SO_3$ ).



$\Delta H = -197 \text{ kJ mol}^{-1}$ : We can see that the breakdown of  $SO_3$  is endothermic and the build up is opposite. SO AT HIGH TEMPERATURES THE  $SO_3$  WILL BREAKDOWN.

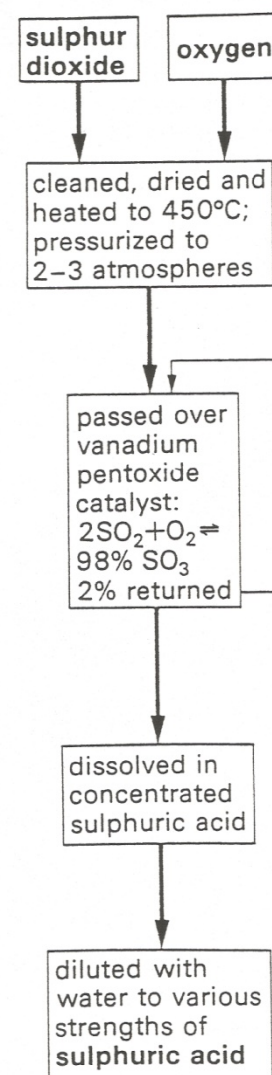
The reaction is reversible so Le Chanticleers principle can be used. At high temperature the Sulphur trioxide breaks down to Sulphur dioxide and oxygen. The contact process uses a temperature between  $400^\circ C$  to  $500^\circ C$ . This temperature is a compromise because the reaction must be high enough for the making of Sulphur dioxide and low enough to prevent its decomposition. The Contact process requires a lot of pressure. This process is economically sustainable because the position of equilibrium is pushed towards the right. Under these circumstances, the amount of Sulphur trioxide produced is 96-98% of Sulphur dioxide and oxygen.

After the synthesis of Sulphur trioxide, it is added to water vapour to produce Sulphuric acid:



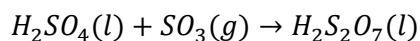
**CAUTION:** This reaction is very dangerous because when Sulphur trioxide is added to water, the reaction produces a thick mist and the reaction itself is very violent.

### The manufacture of sulphuric acid: the Contact Process

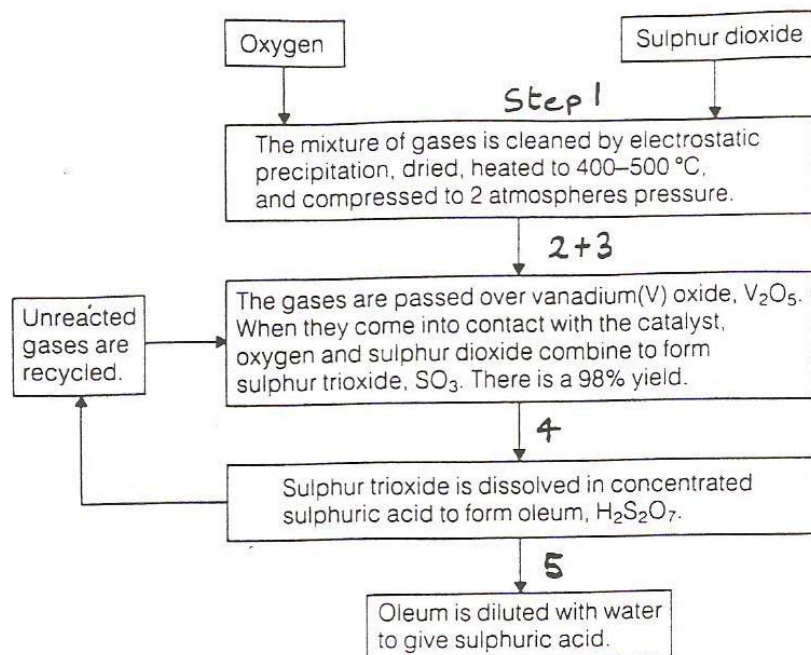
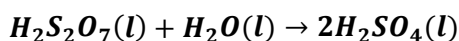




We cannot take in i.e. absorb the mist so what happens is that sulphur trioxide reacts with the concentrated sulphuric acid mist and forms a substance called oleum:



The oleum formed is then added to the correct amount of water to form sulphuric acid. If a lot of water is added, the solution of Sulphuric acid will become dilute, if a little water is added, the solution becomes concentrated:



### 13. What are the chemical properties of concentrated Sulphuric acid?

- Sulphuric acid is very reactive
- It is very corrosive
- It is soluble in water
- Powerful dehydrating agent
- Used as an oxidising agent
- Sulphuric acid can also be used to displace weaker acids from their salts

### 14. What are the chemical properties of dilute sulphuric acid?

- A good electrolyte
- A strong acid, completely ionised by water

### 15. What are the main uses of Sulphuric acid?

- Used in fertilizers
- Used in paints, pigments and dyestuff
- Used in making fibres and plastics
- Used in the manufacture of soaps and detergents

### 16. How is Sulphuric acid used in the manufacture of fertilizers?

Sulphuric acid is added to calcium phosphate to produce phosphoric acid, this is then neutralised by ammonia to produce the fertilizer. Sulphuric acid turns calcium phosphate into fertilizer but has to be neutralised. Superphosphate is another fertiliser that is made by reacting Sulphuric acid and 'rock phosphate'.