# Manufacture of sulphuric acid by contact process

**Sulphuric acid is an important chemical which is widely used. It is also known as king of chemicals. It is manufactured by contact process.**

Principle:

1. Production of sulphur dioxide:

Sulphur dioxide gas can be prepared either by burning sulphur or roasting of iron pyrites.

$$S + O_2 \longrightarrow SO_2$$

$$4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2$$

2. Oxidation of SO2 to SO3

Sulphur dioxide is oxidesed to sulphur trioxide in presence of catalyst vanadium pentaoxide at about 450 °C and 2 atm pressure

+

$$2SO_2 + O_2 \underset{}{\overset{V_2O_5,\ 450^0C,\ 2atm}{\rightleftharpoons}} 2SO_3 + \text{heat energy}$$

3. Absorption of SO3 by conc. Sulphuric acid: Sulphur trioxide is allowed to absorb in 98% where by pyrosulphuric acid (H2S2O7), also called oleum is formed along with some trisulphuric acid (H2S3O10 )

$$SO_3 + H_2SO_4 \longrightarrow H_2S_2O_7 \quad \text{Major product}$$

$$SO_3 + 2H_2SO_4 \longrightarrow H_2S_3O_{10} + H_2O$$

## Conditions for optimum yield of sulphuric acid:

### 1. Temperature:

Low temperature favours the reaction. The optimum temperature is 450 ℃ for higher yield of SO3 gas.

### 2. Pressure:

Since the reaction is accompanied by the decrease in volume, high pressure is the effective condition for the formation of SO3. Therefore, an optimum pressure of about 2 atm is applied.

### 3. Concentration:

High concentration of SO2 or O2 Both is used for more production of SO3

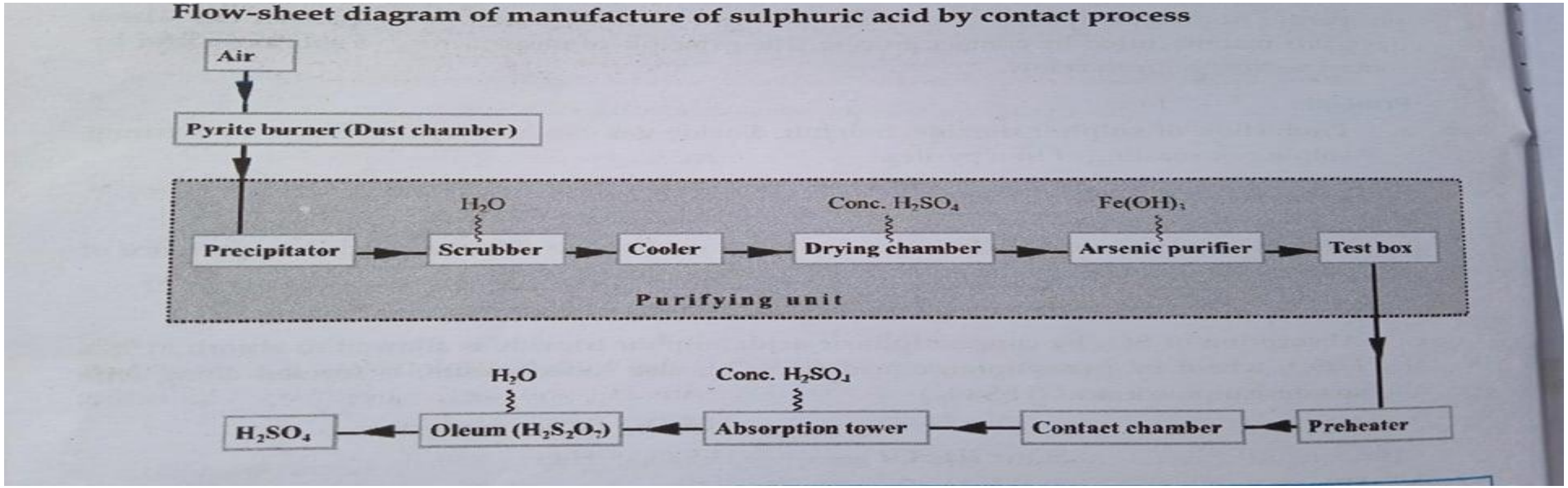
### 4. Catalyst:

Vanadium pentaoxide is used as catalyst to increase the rate of formation of SO3

### 5. Purity of gas:

Pure gas (SO2 and O2 ) should be admitted for reaction.

**Flow-sheet diagram of manufacture of sulphuric acid by contact process**



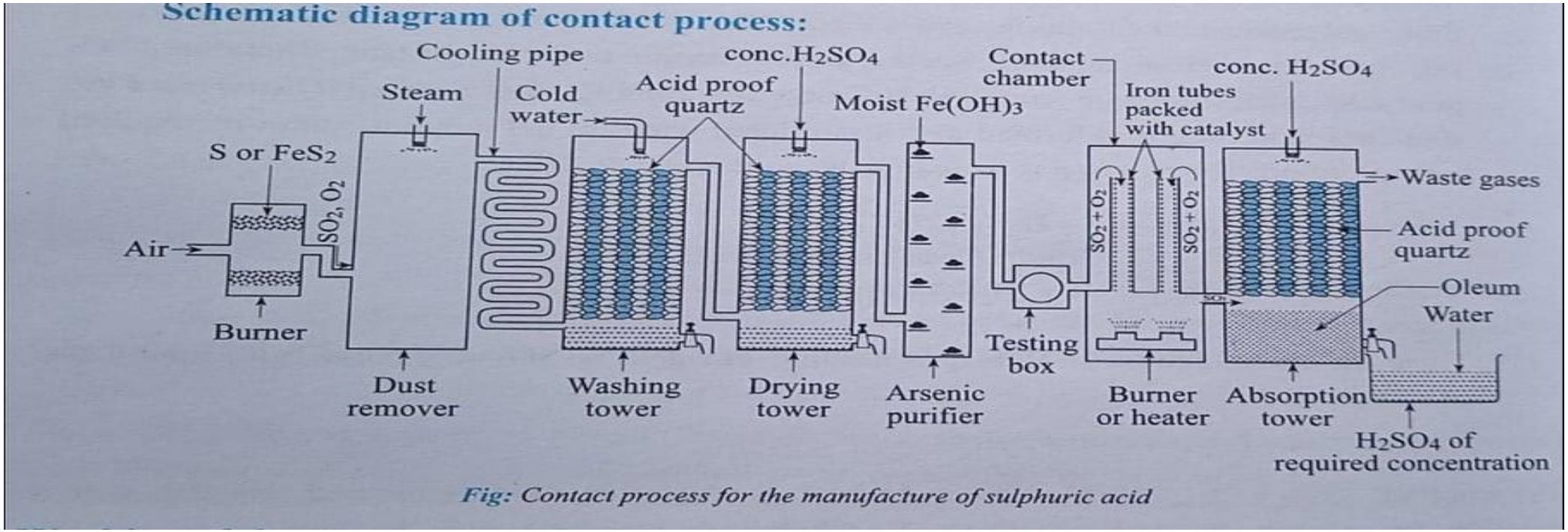



*Fig: Contact process for the manufacture of sulphuric acid*

Deatil of the process



1. **Pyrite burner**

Sulphur dioxide is obtained by burning sulphur or iron pyrite in a burner made of fire bricks.

2. **Purification unit**

The sulphur dioxide obtained may contain different impurities like a dust particle, arsenic oxide ($As_2O_3$), unoxidizedsulphur which needs to be removed before oxidation of $SO_2$ into $SO_3$. For this, the gases are allowed to pass through the following purification units. These, otherwise cause the poisonings of the catalyst.

i. **Electrical dust precipitator**

Dust particles present in the gas precipitate under the influence of high potential differences between metallic conductors fitted in the chamber.

ii. **Steam purification tower**

The mixture of gases is then passed through a *steam purification tower* from the top of which steam is allowed to come in, it makes dust particles settle down.

iii. **Cooler**

The gases coming out of the chamber are passed through a *cooler*. The gases get cooled down

iv. **Washing tower (scrubber)**

The cooled gas is then passed into a tower called *scrubber* which is packed with quartz and water is sprayed from the top. Here gases become free from acid, mist, and water-soluble impurities with the help of down flowing shower of water.

v. **Drying tower**

The outgoing gases from the scrubber are passed into the next tower which is packed with quartz. It is sprayed from the top with conc. $H_2SO_4$ and the upgoing gases become free from moisture as conc. $H_2SO_4$ acts as a dehydrating agent.

vi. **Arsenic purifier**

It contains gelatinous *ferric hydroxide* precipitate kept in shelves which removes arsenic impurities, $As_2O_3$ present in the gases. Otherwise, this impurity poisons the catalytic activity of $V_2O_5$.

vii. **Testing box**

A strong beam of light is passed in the testing box and viewed through a hole perpendicular to the path of light. Solid particles present make the path of light visible due to scattering phenomena (*Tyndall effect*). Gases, if found free from suspended particles, are sent to the contact tower otherwise, they need recycling via the *purifying unit*.

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3. **Preheater**

The purified mixture of $SO_2$ and $O_2$ is then heated at the optimum temperature of 450°C. Then the gases are passed tothe contact tower.

4. **Contact tower**

Various designs of contact towers are available but the most used is *Badische tower*. It is an iron chamber with iron tubes packed with catalyst $V_2O_5$. The gases from the preheater enter the contact tower and get oxidized to sulphur trioxide. Since the reaction is exothermic and the heat evolved is used for heating the gases in the preheater.

5. **Absorption tower**

This tower is packed with quartz (or *acid-proof stone*) in which 90% conc. $H_2SO_4$ is sprayed from the top of the tower. *Oleum* is obtained after absorbing $SO_3$ by conc. $H_2SO_4$. Oleum is then added with a calculated amount of water to give sulphuric acid of the desired concentration.

## 4. Manufacture of sodium hydroxide by Diaphragm cell

hydroxide in Nelson Diaphragm cell are: