

Sulphur/sulphuric acid

- Number one bulk chemical
- Majorly used in fertilizer
- Dyeing industry
- Ore processing industry
- Sulphur is taken from pyrite(FeS_2)
- $2\text{H}_2\text{S} + \text{SO}_2 \rightarrow 3\text{S} + 2\text{H}_2\text{O}$ (most of the sulphur comes from petrol refinery)
- Lead Chamber Process \rightarrow Contact Process (improvisation of technology)

Lead Chamber Process

- $\text{S}_8 + \text{H}_2\text{O} + \text{O}_2 \rightarrow \text{H}_2\text{SO}_4 + \text{H}_2\text{S}$
- Steps in Lead chamber process
- Combustion of Pyrite ore to Produce SO_2
- $\text{SO}_2 \rightarrow (\text{in water}) \rightarrow \text{SO}_2(\text{aq})$
- $\text{N}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_2 + \text{HNO}_3$
- $\text{SO}_2 + \text{HNO}_2 + \text{HNO}_3 \rightarrow \text{H}_2\text{SO}_4 + \text{NO} + \text{NO}_2$
- Happens in open furnaces
- $\text{NO} + \text{O}_2 \rightarrow \text{NO}_2$ (slow/Rate limiting step \rightarrow challenge for lead chamber process)
- NO_2 works as catalyst
- Since it is in same phase as reactants (Gaseous) it is homogenous catalyst
- Less amount of sulphuric acid produced (75%) since the concentrated acid reacts with lead chamber and causes corrosion of the chamber.

Contact Process

- V_2O_5 is used as a catalyst
- Since it is in solid phase, it is a heterogeneous catalyst
- $\text{SO}_2 + \text{O}_2 \rightleftharpoons \text{SO}_3$ (Rate limiting step)
- Steps involved
- Combustion – Generate steam out of heat produced from this combustion reaction
- Air is used instead of pure oxygen because It is cheaper and if we use pure oxygen temperature would substantially increase therefore in air nitrogen acts as diluting agent
- The above reaction is equilibrium limited reaction
- For ex according to curve we would expect 98% conversion but since outlet temperature is high than inlet temperature the conversion decreases
- To fix this the gases are passed to multiple bed reactors
- Sufficient cooling between these subsequent bed reactors ensures 98-99% conversion
- Vent gases – SO_3 , N_2 ,
- Since even 99% conversion is not enough, SO_3 after passing through third bed catalyst is passed through absorption tower where it is absorbed in water

- This sudden removal of SO_3 increases the rate of reaction and the conversion curve shifts upward thus more conversion can be obtained

Block Diagram for Contact Process

Contact process:

