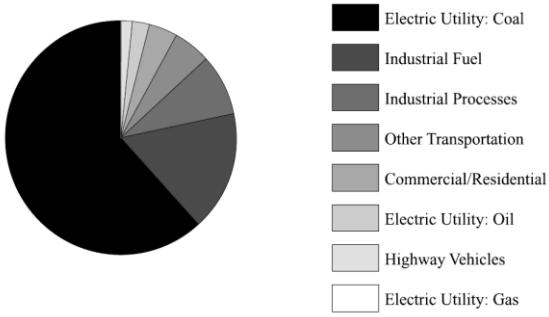
CONTROL OF SULPHUR OXIDES

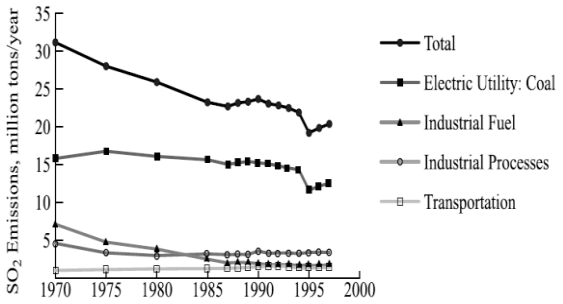
INTRODUCTION

- SO_2, a common component of air pollution.
- Negative effects on flora and fauna in natural environments.
- Extent to which SO_x emissions harm human health depends on :
  - ground-level ambient concentrations,
  - the number of people exposed,
  - the duration of exposure.
- Industrial sources of sulphur oxides should have emergency management plans .
- Traditionally, ground-level ambient concentrations of sulphur dioxide were reduced by emitting gases through tall stacks .

SOURCES OF SULFUR OXIDE



SO_x EMISSION TREND



NECCESSITY OF CONTROL EMISSION OF SO_x

- Fuels, that contained sulphur will mostly form sulphur dioxide

$$S + O_2 = SO_2$$

- SO_2 is a colourless gas possessing a pungent and irritating odour at higher concentration above 300 ppm .

- It can react photochemically in the atmosphere to form sulphur trioxide, sulphuric acid .

- SO_3 , may also exist in the form of vapour, and readily combine with water to form H_2SO_4.
- The major concern SO_2 and SO_3 in the atmosphere is their ability to form H_2SO_4 , which declines the pH of rain water to result in the occurrence of acid rain .
- By looking all harmful effects on human health as well as vegetation and materials, it is damn necessary to control the emission of sulphur content in environment.

APPROACHES FOR LIMITING EMISSIONS

- ❑ CHOICE OF FUEL
- ❑ FUEL CLEANING
- ❑ PROCESS MODIFICATION
- ❑ SELECTION OF TECHNOLOGY & MODIFICATION
- ❑ EMISSION CONTROL TECHNOLOGIES
- ❑ MONITERING

APPROACHES FOR LIMITING EMISSIONS

❑ **CHOICE OF FUEL** : an effective means of reducing Sox emissions is to burn low-sulphur fuel such as natural gas, low-sulphur oil, or low-sulphur coal .

❑ **FUEL CLEANING** : The most significant option for reducing the sulphur content of fuel is called beneficiation. Coal beneficiation can remove 50% of pyretic sulphur and 20–30% of total sulphur, also removes ash responsible for particulate emissions .

❑ **SELECTION OF TECHNOLOGY AND MODIFICATION** : Processes using fluidized-bed combustion (FBC) & lime or dolomite bed in the combustion chamber reduce air emissions of sulphur oxides.

❑ **EMISSION CONTROL TECHNOLOGIES :**

➢ Sorbent injection involves adding an alkali compound to the coal combustion gases for reaction with the sulphur dioxide.

➢ Flue gas desulfurization may be carried out using either of two basic FGD systems: regenerable and throwaway .

❑ **MONITERING** : Three types of SOx monitoring systems are continuous stack monitoring, spot sampling, and surrogate monitoring .

CONTROL OPTIONS

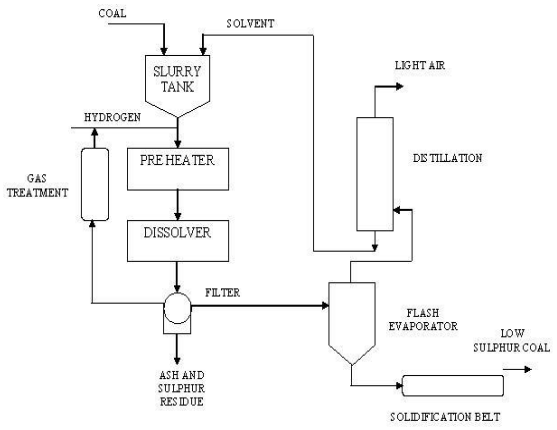
- Extraction of sulphur from fuel
  - Hydrodesulphurization of Coal
  - Coal Gasification
  - Desulphurization of fuel oil
  - fuel oil gasification
- Sulphur reduction during Combustion
- Desulphurization of flue gases

EXTRACTION OF SULPHUR FROM FUEL

- The removal of sulphur from transportation fuels is an important aspect of the nation.
- Theoretically attractive route
- Sulphur present in two form
  - INORGANIC
  - ORGANIC
- Practically all **INORGANIC** sulphur exists in the coal as iron disulphide (FeS_2), i.e. In the form of PYRITES and MARCASITES.
- washing can reduce pyrites sulphur content by 30%, but such methods result in a loss of combustible matter and may add 20% or more to the cost of coal.
- organic sulphur present in the form of CYSTIN, THIOLS, SULPHIDES and some CYCLIC compounds, uniformly bound with most of the carbonaceous material and can be removed only by chemical processing.

HYDRODESULPHURIZATION OF COAL

- Hydrodesulphurization of coal using a solvent extraction process can remove both the organic sulphur as well as its inorganic forms.
- In this process, finally ground coal is slurried with anthracene oil; a small amount of hydrogen (about 0.5%) is added to avoid depolymerisation, and the slurry is heated at high temperature (450° C) in order to dissolve the coal.



COAL GASIFICATION

- Gasification, is a simpler process compared to hydrodesulphurization
- proven technology for removal of both ORGANIC and INORGANIC Sulphur
- India has abundant coal reserves and coal gasification provides an attractive and economically viable alternative for our energy need.
- Coal gas is composed of CO & H_2
- produced by heating coal with steam in presence of oxygen
- the O_2 aids the combustion process during burning of the coal to attain sufficiently high temperature in order to sustain the rate of reaction at a reasonable rate.

COAL GASIFICATION

- Basic reactions

$$Coal \rightarrow C + CH_4 + H_2 + C_xH_y$$

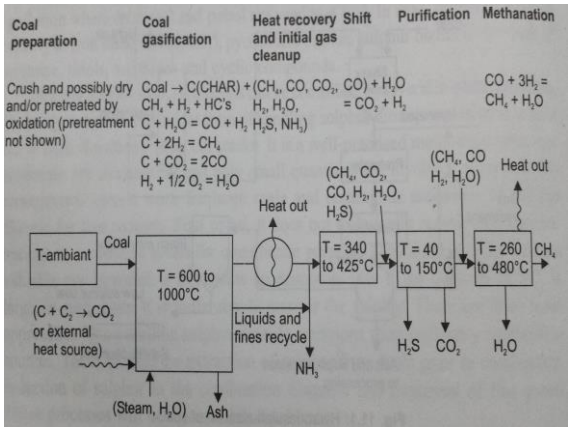
$$C + O_2 \rightarrow CO$$

$$C + H_2O \rightarrow CO + H_2$$

$$C + 2H_2 \rightarrow CH_4$$

$$C + CO_2 \rightarrow 2CO$$

$$H_2 + \tfrac{1}{2} O_2 \rightarrow H_2O$$



DESULPHURIZATION OF FUEL OILS

FUEL OIL GASIFICATION

- The carbon to hydrogen ratio in fuel oil is lower than that in coal and, hence the gasification of fuels is much easier .
- It involves catalytic steam cracking where the hydrocarbon reacts with the steam over a nickel catalyst at temperature of 700-1000° C and at atmospheric pressure to form carbon monoxide, methane and hydrogen.
- The sulphur in the fuel is converted in to hydrogen sulphide which is then separated by means of ethanolamine.
- The hydrogen sulphide is finally converted in to sulphur in a claus system plant.

SULPHUR REDUCTION DURING COMBUSTION