Air Pollution Control

Techniques Without Using Emission Control Devices

- Process Change
  - modification of an existing process or the introduction of a new process



- Wind, Geothermal, Hydroelectric, or Solar Unit instead of Fossil fired Unit.



Techniques Without Using Emission Control Devices

- Change in Fuel
  - Use of Low Sulfur Fuel, instead of High Sulfur fuel.
- Good Operating Practices
  - Good Housekeeping
  - Maintenance
- Plant Shutdown / Relocation



Methods For Air Pollution Control

PARTICULATE

- Gravity Collector
- Cyclone separator
- Electrostatic Precipitators
- Fabric Filter
- Scrubbers

GASES

- Adsorption Towers
- Thermal Incineration
- Catalytic Combustion



PARTICULATE MATTER CONTROL



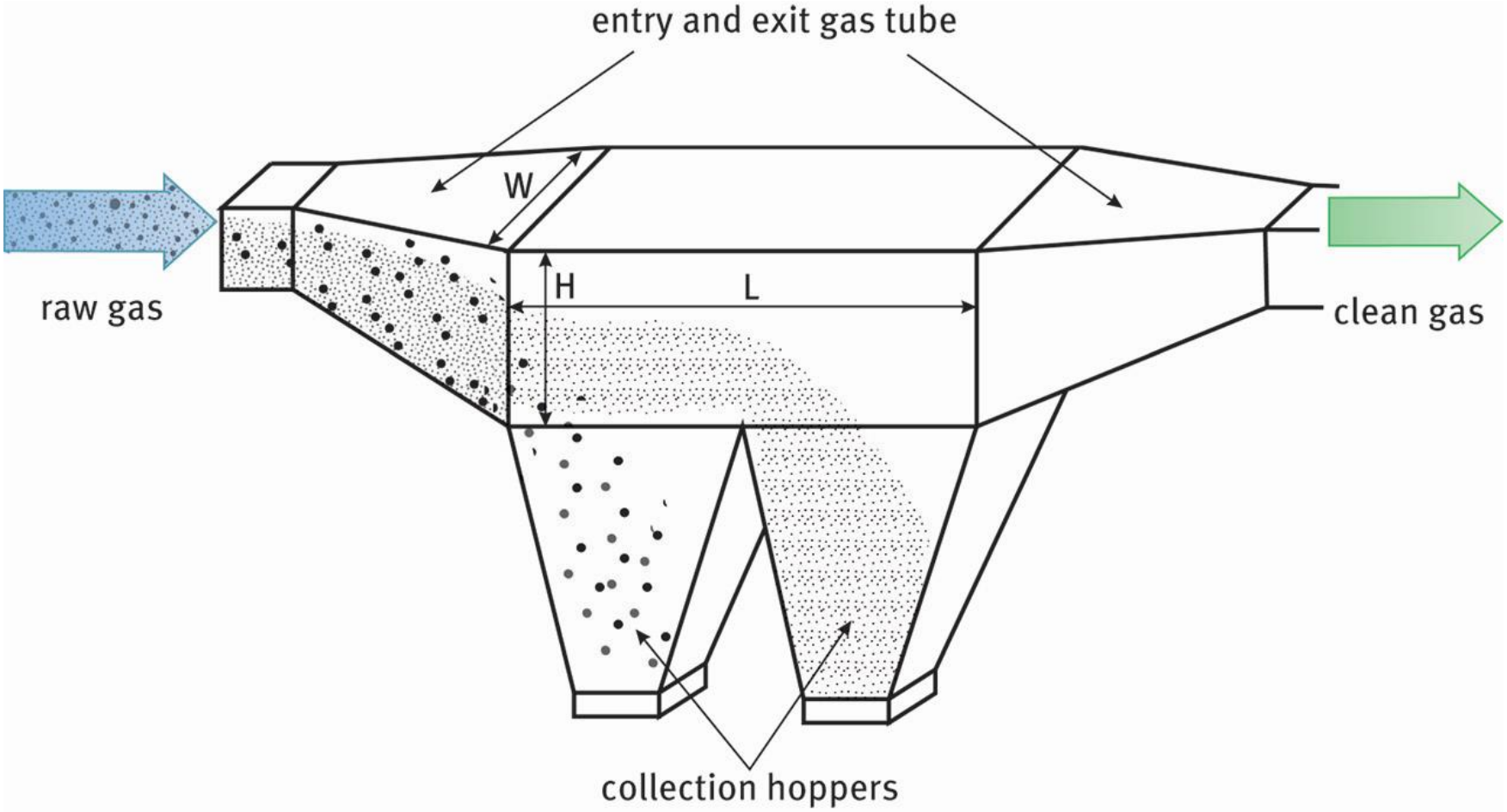
Industrial Sources of Particulate Emissions

- Iron & Steel Mills, the blast furnaces, steel making furnaces.
- Petroleum Refineries, the catalyst regenerators, air-blown asphalt stills, and sludge burners.
- Portland cement industry
- Asphalt batching plants
- Production of sulfuric acid
- Production of phosphoric acid
- Soap and Synthetic detergent manufacturing
- Glass & glass fiber industry
- Instant coffee plants

GRAVITY COLLECTOR

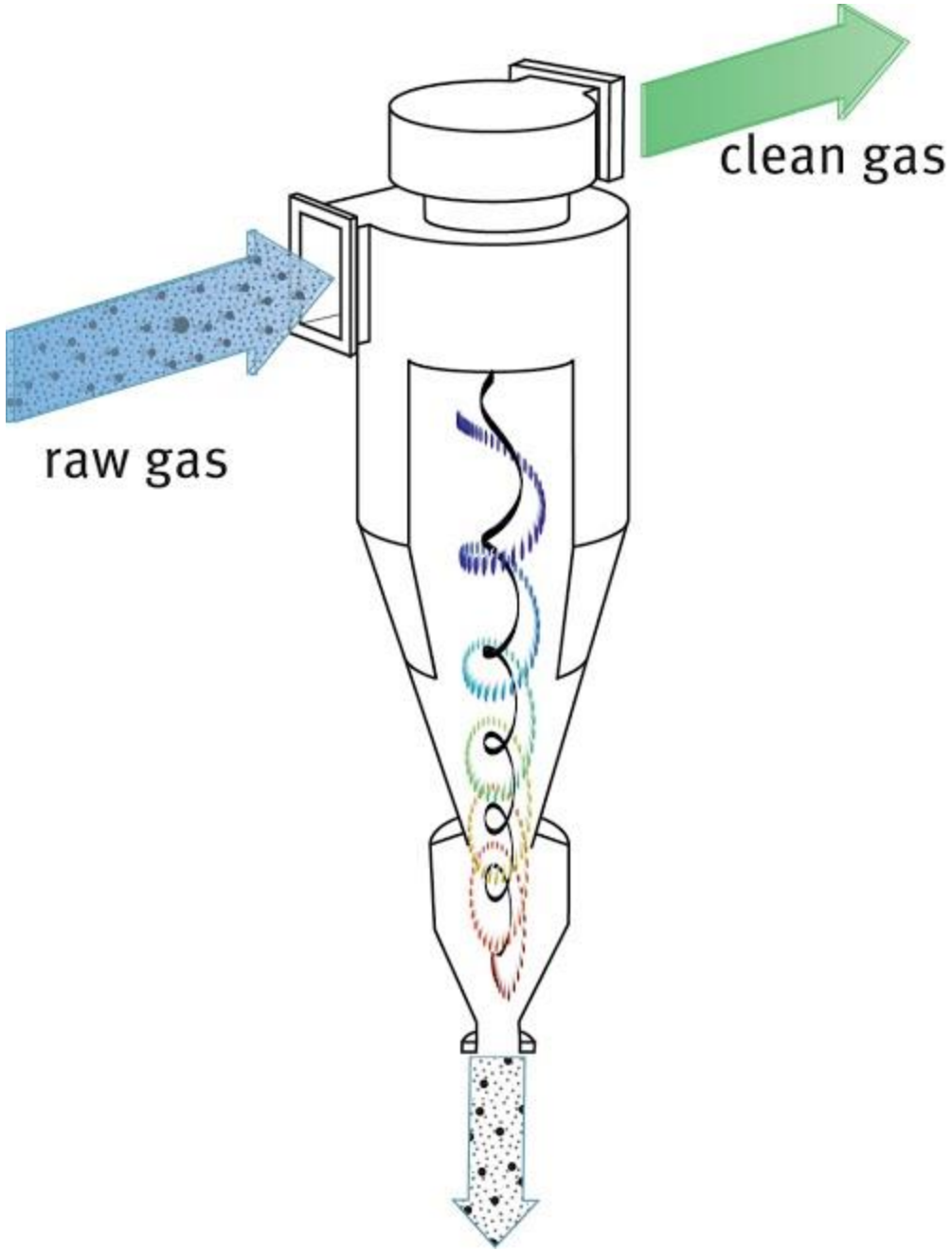
- Used to remove particles with size greater than 50 µm.
- Velocity of flue gas reduced in large chamber.
- Particles settle under gravitational force.




entry and exit gas tube
W
H
L
raw gas
clean gas
collection hoppers

Cyclone separator

- Centrifugal force is utilized to separate the particulate matter.
- It can remove 10 to 50 µm particle size.
- Control gas borne particulates from industries like cement, feed and grain processing, food and beverage processing, mineral processing, paper and textile industries and wood working industries.
- Used in recovery of catalyst ducts in petroleum industry and reduction of fly ash emission.

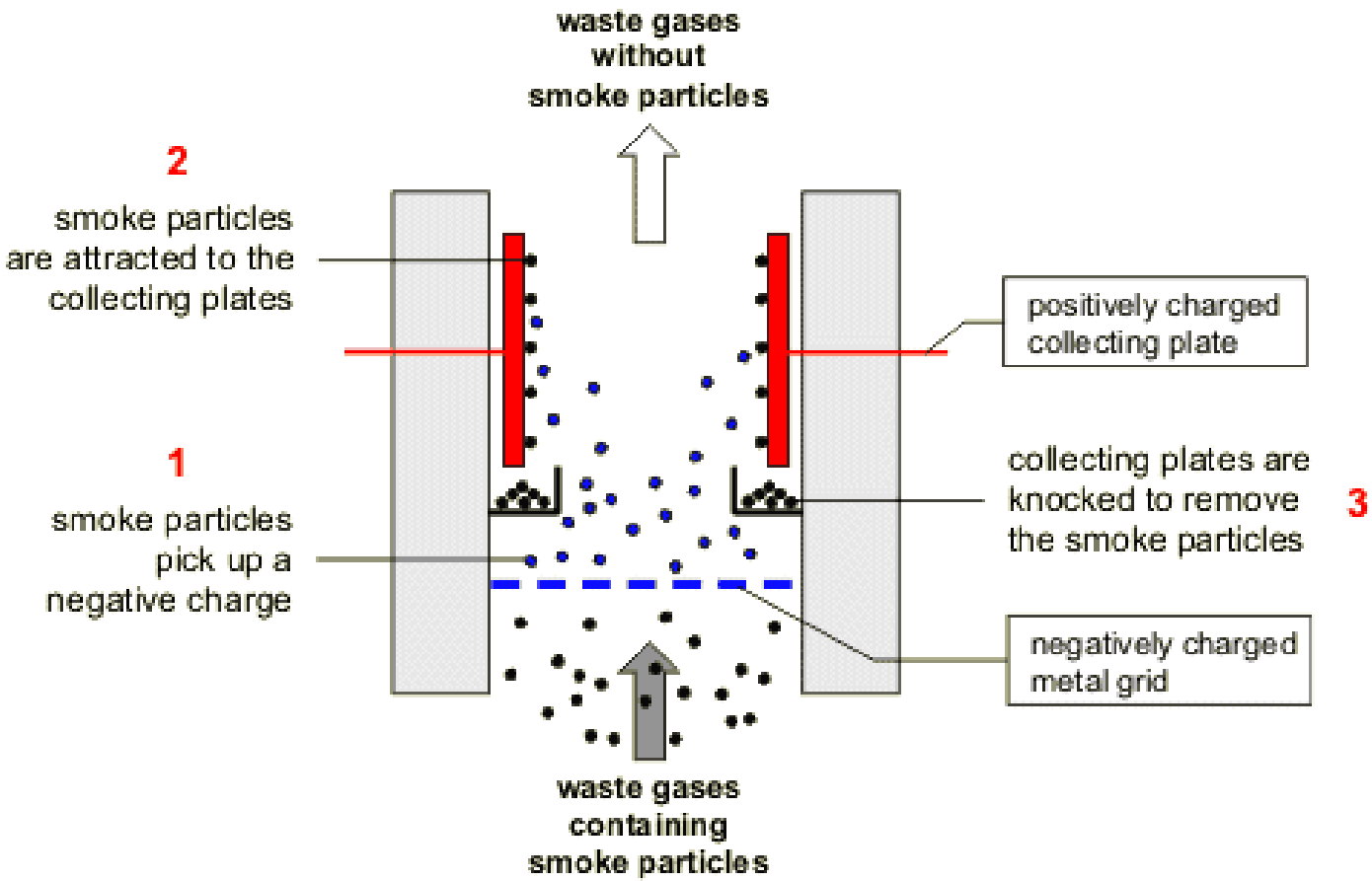

clean gas
raw gas

Electrostatic precipitators

- Works on the principle of electrical charging of particulate Matter (-ve) and collecting it in a (+ve) charged surface.
- 99% efficiency.
- Can remove particle size range of 0.1 µm to 1 µm.

Application

- Cement factories, Pulp and paper mills, Steel plants, Non- ferrous metal industry, Chemical industry, Petroleum industry, Carbon black industry, Electric power industry

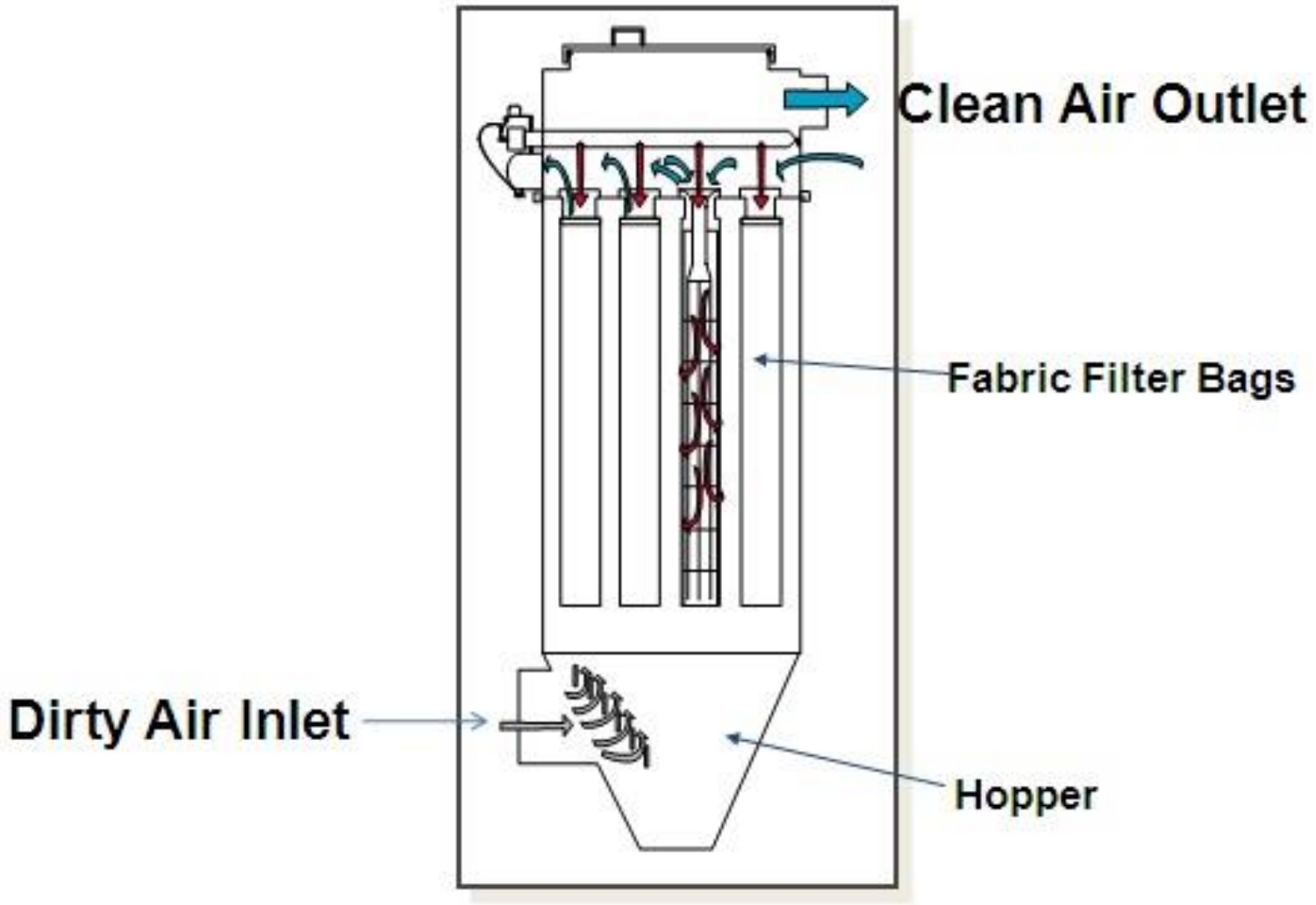

waste gases without smoke particles
2
smoke particles are attracted to the collecting plates
positively charged collecting plate
1
smoke particles pick up a negative charge
collecting plates are knocked to remove the smoke particles
3
negatively charged metal grid
waste gases containing smoke particles

Fabric filters

- Flue gas is allowed to pass through a woven fabric, which filters out particulate matter.
- Small particles are retained on the fabric.
- Consists of numerous vertical bags 120-400 mm dia and 2-10 m long.
- Remove particles up to 1 µm.
- Its efficiency up to 99%.

Application

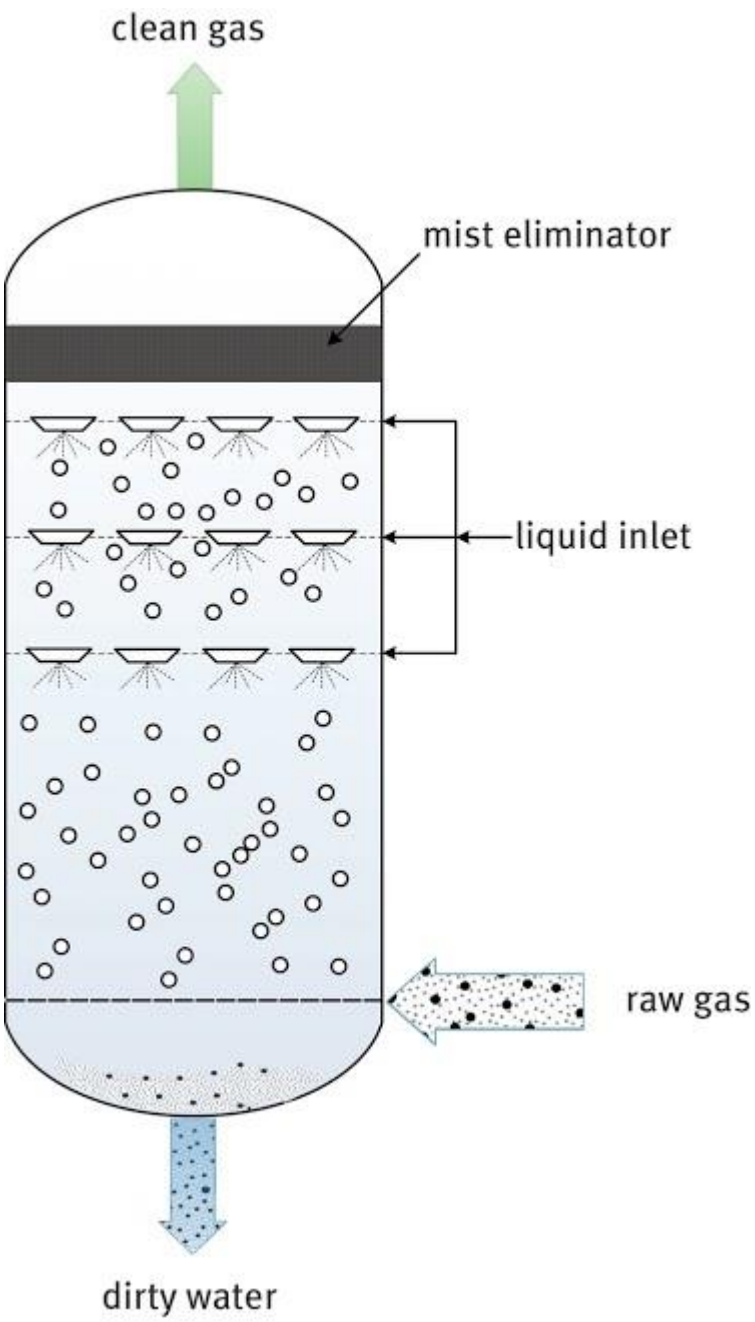
- Metallurgical industry, Foundries, Cement industry, Chalk and lime, Brick works, Ceramic industry, Flour mills


Clean Air Outlet
Fabric Filter Bags
Dirty Air Inlet
Hopper

Scrubbers

- Particulate matters are incorporated into liquid droplets and removed from the gas stream.
- Flue gas made to push up against a down falling water current.
- Particulate matter mix up with water thus falls down and gets removed.




clean gas
mist eliminator
liquid inlet
raw gas
dirty water

Control of gaseous contaminants



Absorption

- Effluent gas passed through absorbers (scrubbers), which contain liquid absorbent.
- Absorbents used to remove SO_2, H_2S, SO_3, F and oxides of nitrogen.

Gaseous pollutants	Common absorbents used in solution form
SO_2	Dimethylaniline, ammonium sulphite, ammonium sulphate, sodium sulphide, calcium sulphite, alkaline water,
H_2S	NaOH and phenol mix (3:2), tripottasium phosphate, sodium alamine, sodium thioarsenate, soda ash
HF	Water, NaOH
NOX	Water, aqueous nitric acid

Adsorption

- Surface phenomenon, require large solid surface
- Adsorption towers use adsorbents to remove the impurities from the gas stream.
- The impurities bind either physically or chemically to the adsorbing material.
- The impurities can be recovered by regenerating the adsorbent.
- Adsorption towers can remove low concentrations of impurities from the flue gas stream.

Gaseous pollutants	Adsorbents used in solid form
SO_2	Pulverized limestone or dolomite, alkalized alumina
H_2S	Iron oxide
HF	Lump limestone, porous sodium fluoride pellets
NOX	Silica gel
Organic solvent vapours	Activated carbon



COMBUSTION

- Flame or catalytic combustion
- Fume and vapor incinerators
- After burners
- Flares, either with steam injection or venturi flare



CONTROL OF SO_X EMISSIONS

Change to Low Sulfur Fuel

- Natural Gas
- Liquefied Natural Gas
- Low Sulfur Oil
- Low Sulfur Coal



(CONTD.)

- Use Flue Gas Desulfurization Systems
- Use Alternative Energy Sources, such as Hydro-Power or Nuclear-Power



Flue Gas Desulfurization Systems



Hydro-Power Generation

Control of NO_X Emissions

- NOx control can be achieved by:
  - Fuel Denitrogenation
  - Combustion Modification
  - Modification of operating conditions
  - Tail-end control equipment
    - Selective Catalytic Reduction
    - Selective Non - Catalytic Reduction
    - Electron Beam Radiation
    - Staged Combustion

Control of CO_2 Emissions

- Reducing energy consumption, increasing the efficiency of energy conversion
- Switching to less carbon intensive fuels
- Increasing the use of renewable sources
- Sequestering CO_2 through biological, chemical, or physical processes



Control Technologies for Mercury Emissions

- Currently installed control devices for SO_2, NO_X, and particulates, in a power plant, remove some of the mercury before releasing from the stack

- *Activated Carbon Injection:*

Particles of activated carbon are injected into the exit gas flow, downstream of the boiler. The mercury attaches to the carbon particles and is removed in a particle control device

- *Thief process for the removal of mercury from flue gas:*

It is a process which extracts partially burned coal from a pulverized coal-fired combustor using a suction pipe, or "thief," and injects the resulting sorbent into the flue gas to capture the mercury.