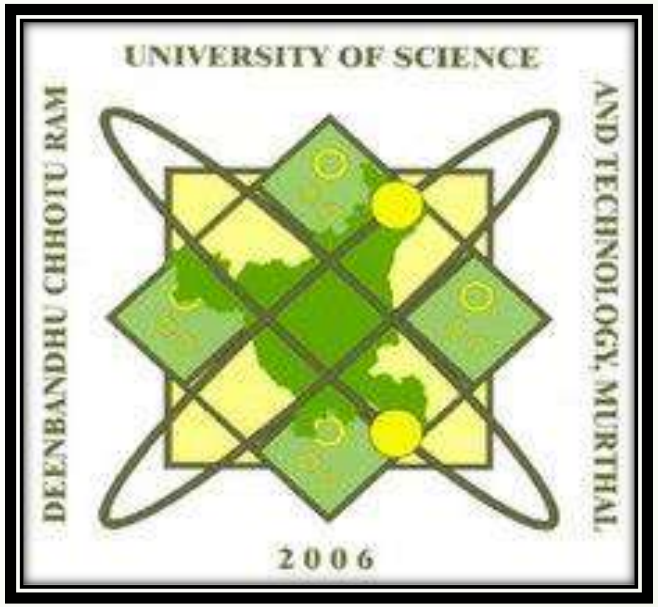
# PRESENTATION ON AIR POLLUTANTS AND CONTROL MEASURES

# M.SC.(CEES) 2ND YEAR

# ROLL NO. : 2200155600 1




- SUBMITTED TO: DR. SUDESH
- SUBMITTED BY: HIMANI

# INTRODUCTION

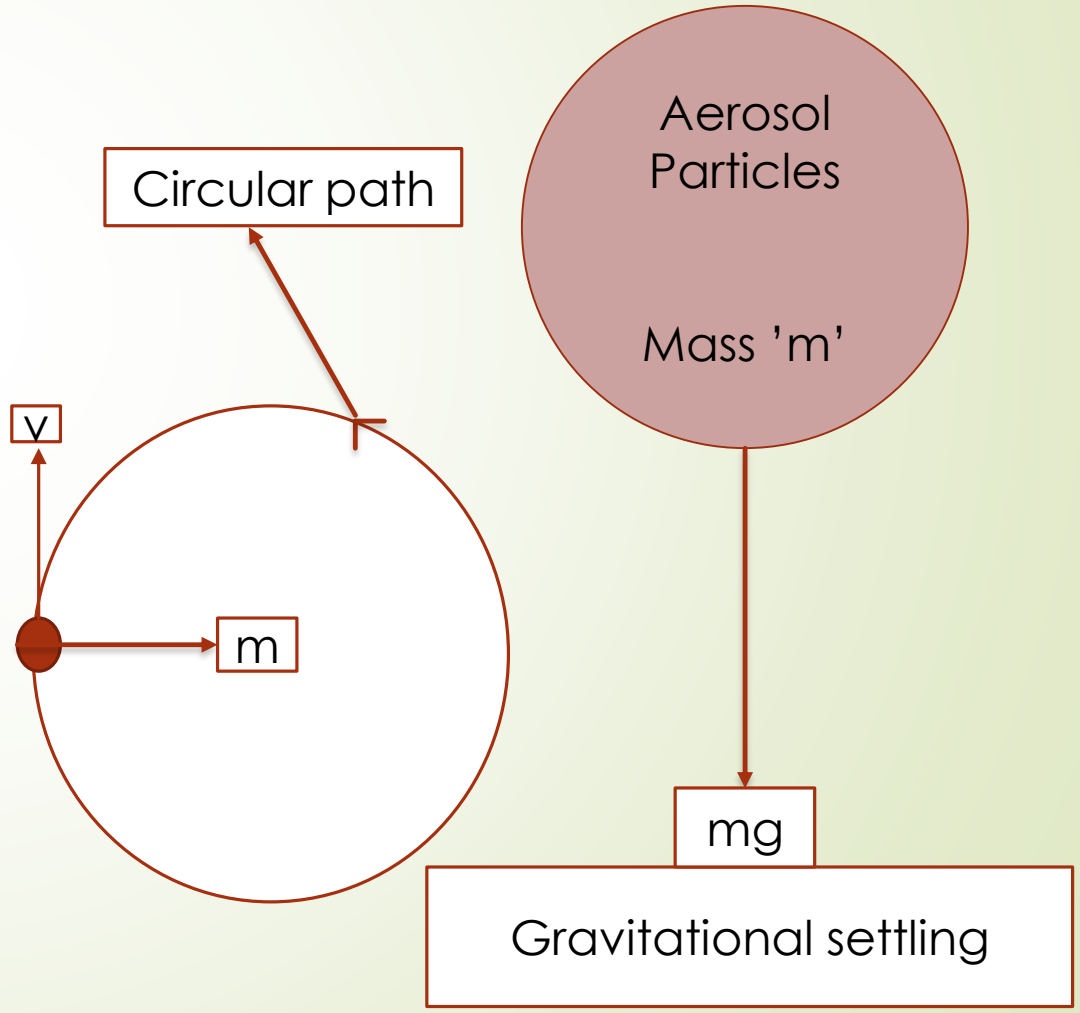
- To control air pollution, the most effective methods are reduction at the source. One of these methods is by the application of control equipment/ device.
- Appropriate air cleaning devices are required to collect the particulate pollutants.
- Particulate pollutants are a mixture of solid particles and liquid droplets found suspended in air and many of which can be hazardous. Control devices are installed at the respective source to control particulate pollutants.
- Devices that remove particles from gas streams relay on one or more of the pollutants removal mechanisms.

# PARTICULATE MATTER POLLUTANT

- Particulate matter is the sum of all solid and liquid particles suspended in air, many of which are hazardous. This complex mixture contains for instance dust, pollen, soot, smoke, and liquid droplets.
- Temperature and chemical composition of gases to be cleaned from particulants before the selection of proper control device. Information on the physical form of the suspended material, its abrasive properties, size and shape, chemical composition and electrical sensitivity is required for this selection.

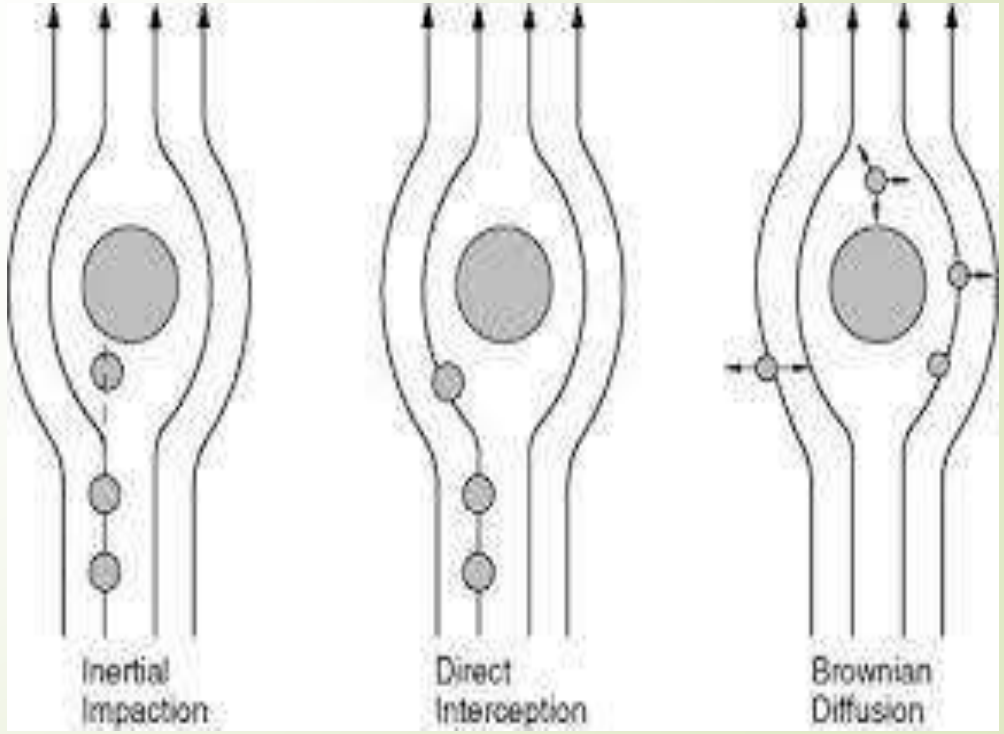
# MECHANISM OF REMOVAL

- **GRAVITATIONAL SETTLING** the particles containing gas stream is introduced into a device or chamber where the particle settle under gravity.
- **CENTRIFUGAL IMPACTION** the gas is allowed to follow a circular path which cause the particulate to impact on the outer periphery of device.
- **DIRECT INTERCEPTION** the particles having less inertia, barely follow the gas streamlines around the fiber and get intercepted by the fibers.



# MECHANISM OF REMOVAL

- **ELECTROSTATIC ATTRACTION:** The particle - containing gas stream is introduced into a device in which the particles are charged and then subjected to an electric field which causes them to migrate to one of the surfaces of the device, where they are held and collected.
- **INERTIAL DEPOSITION:** When a gas stream changes direction as it follows around an object in its path, suspended particles tend to keep moving in their original direction due to their inertia.
- **BROWNIAN DIFFUSION:** Particles suspended in a gas are always in Brownian motion. when the gas stream follows around obstacles, the natural random motion of the particles will bring them into contact with the obstacles, where they are adhere and are collected



# TYPES OF CONTROL DEVICES

- Settling chambers
- Cyclones
- Filters
- Electrostatic precipitators
- Scrubber's or wet collectors

# SETTLING CHAMBERS

- This is the simplest type of equipment used for the collection of solid particles. These are long chambers in which velocity of gas lower down & solid particles settle under influence of gravity.
- They are also called free cleaners because they reduce the inlet loading at the initial stages.

# IMPORTANT ASPECTS

- The gas velocity must be sufficiently low (less than about 3m/s to prevent re-enterai ment of the settled particles less than 0 5m/s for good results).
- Recently is improved if the height to be travelled by the particle is less.
- Horizontal trays or shelves are incorporated in the chamber that trace are fitted about 1-3 cm height intervals.
- The increase in efficient efficiency obtained by the insertion of horizontal trace is directly proportional to the number of trace.
- The minimum particle size which can be removed after is installation of traces about 10 um.
- Used to remove particulates about 40 mm in diameter however find particles such as carbon black and various metallurgical fumes from agglomerates with enough mass to permit collection.
- Setting chambers are used dividedly to remove large solids particulates from natural draft furnaces kilns and extra.
- Also used in process industries like food and metallurgical industries as the first step in dust control.
- Widely used as pre cleaners for high efficiency collectors.

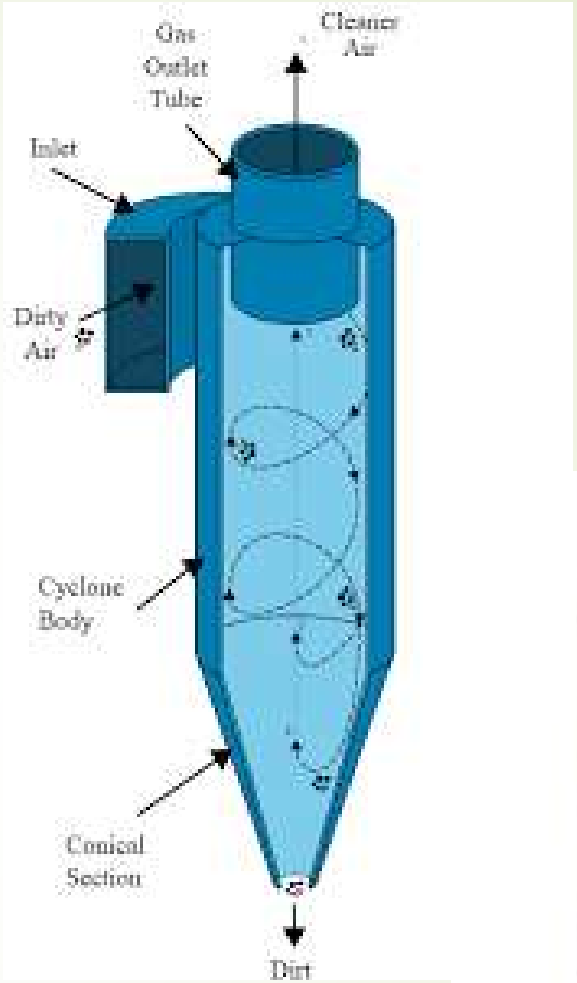
# ADVANTAGES AND DISADVANTAGES

- Initial cost simple construction.
- Low Maintenance cost.
- Low pressure drop.
- Continuous disposal of solid particulates.
- It Can be constructed out of almost any materials.
- And pressure limitations imposed only by material of construction used.

- Large Space requirement.
- Relatively Low particulate collection efficiency.
- In multiple tray settling chamber main warp during high temperature operations.

# CYCLONES

- The air stream with suspended particulate matter os whorled through the special chamber in circular motion.
- The particulate matter get collected on the wall and at the bottom of the cyclone collector.
- The wall of the cyclone is narrow towards bottom which allow particles to collect.
- The general principle of inertia of separation is followed which says particles laden gas is forced to change the direction.
- Action of the particulate depends on the generated centrifugal force which in turn depend depends on
  - **Mass of the particle**
  - **Inlet gas velocity**




# IMPORTANT ASPECTS

- It consist of RAW parallel tube about 25 cm in diameter with a common inlet chamber a common outlet plainum and a common dust collection system.
- 30 chambers must be designed for a constant pressure drop in each to avoid any channeling of the directly gas to any particle single cyclone or group of cyclones.
- Used for cement clinkers Steel mill centre and stone dust enquiry and Asphalt operations

- CYCLONE EFFICIENCIES ARE:
- For particulates with dia. of the order of 10 um, greater than 90%.
- For particles with dia. higher than 20 um, efficiency is about 95%.
- Can be operated at temp. as high as 1000°C, pressure 500 atm and can handle gas volumes ranging from about 0.85 to 700 $m^3$/min.
- ► A 15% gas leakage can bring down the efficiency to virtually zero.

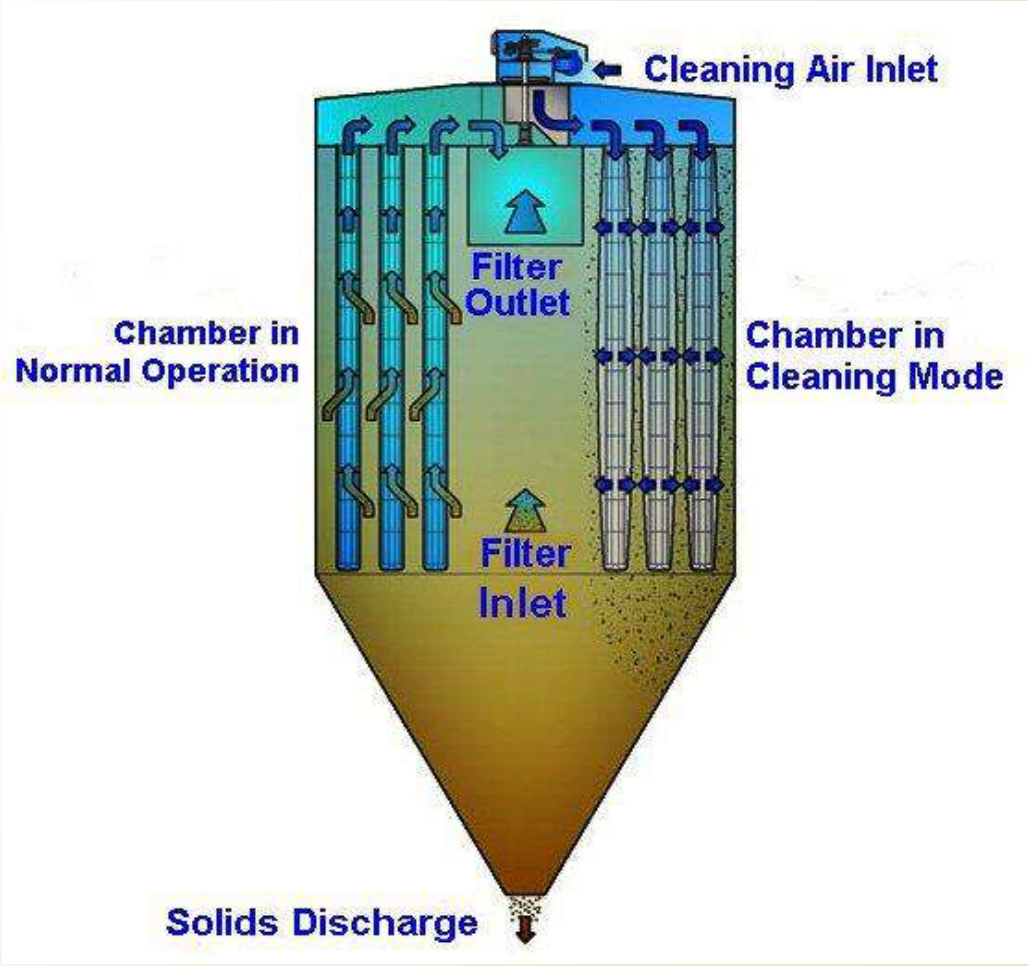
# ADVANTAGES AND DISADVANTAGES

- Low initial cost.
- Simple construction and Operation.
- Low pressure drop.
- Low Maintenance requirement.
- Dry collection and disposal.
- Pressure limitations are only dependent on the material of construction.
- Small space requirements

- Low collection efficiency of particles of size less than 5-10mm.
- Equipment is destruction to severe abrasive deterioration.
- Decreasing collection efficiency with time.

# FILTERS (BAG FILTERS)

- It consists of numerous verticles bag which is made up of polyesters or Teflon with 120 to 400mm of diameter & 2-10m of length.
- Dust, laden, air are passed through these bag filter under pressure which allow dust to stick to these bags.
- Periodically these bag are shaken out and collected in the hooper.
- Collection efficiency is close to 99%.
- Capable of efficiently collecting particles over the size range of 0.1um to 1000um.



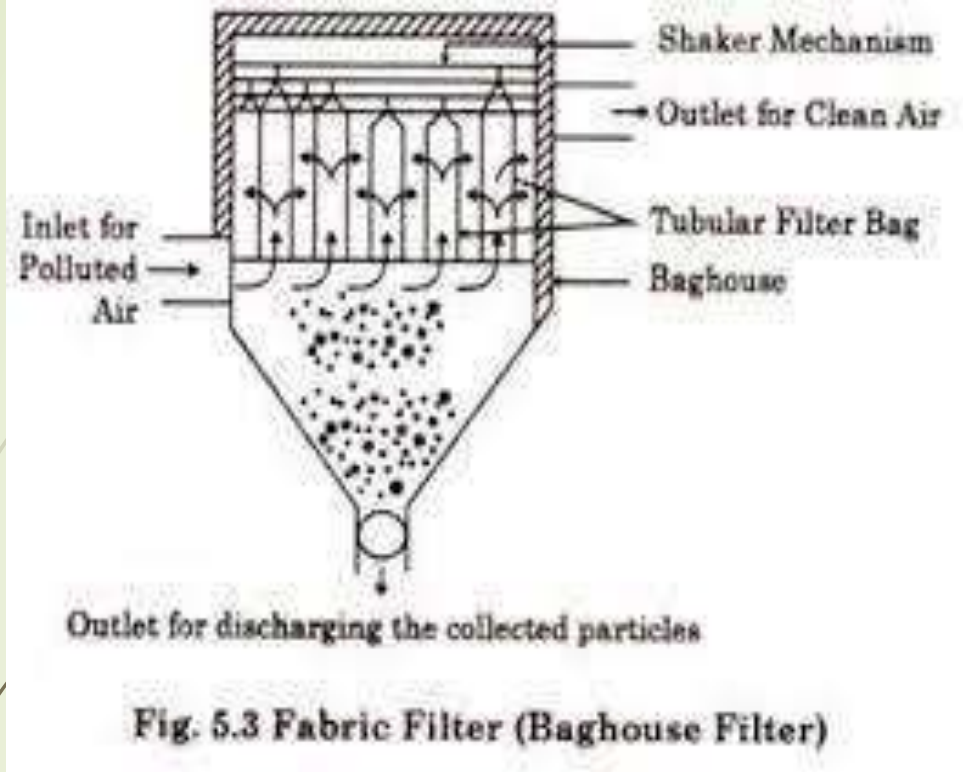
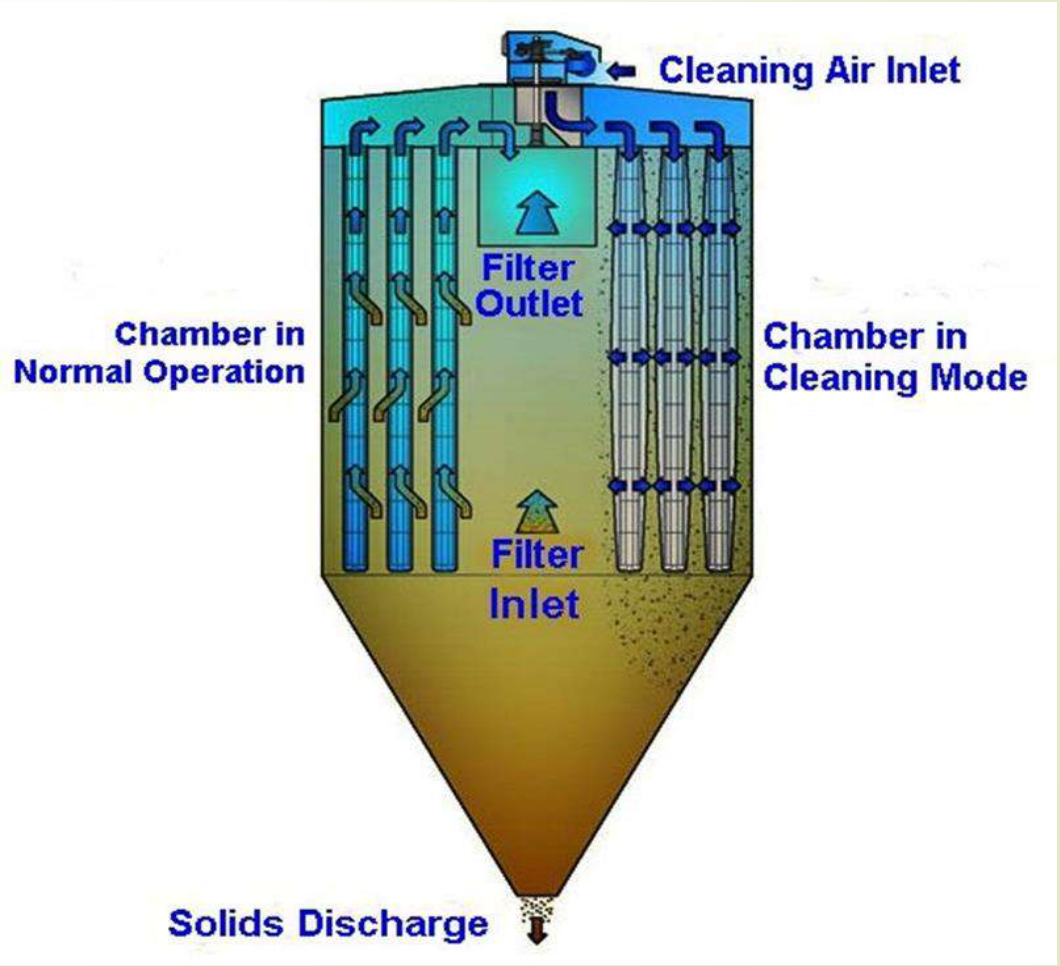



Fig. 5.3 Fabric Filter (Baghouse Filter)

# BAG HOUSE FILTERS



# IMPORTANT ASPECTS

- Particle Collection Mechanism:
- Multiple mechanism are responsible for particle capture within dust layers and fabrics.
- **Impaction:** It is an inertial mechanism that is most effective on particles larger than about 1 um.
- **Brownian Diffusion:** It is moderately effective for collecting sub-micrometer particles (0.10--1.0 um).
- **Electrostatic Attraction:** Particles can be attracted to the dust layer and fabric due to the moderate electrical charges that accumulate on the fabrics, the dust layers, and the particles.
- Efficiency during the pre-coat formation is low but increases to 99% after the pre-coat (cake) is formed because the pre-coat itself acts as the filtering medium.
- The accumulation of dust increases the air resistance of the filter and therefore filter bags must be periodically cleaned.
- They can be cleaned by rapping, shaking, or vibration, or by reverse airflow, causing the filter cake to be loosened and to fall into the hopper.
- The normal velocities of airflow through the bags is 0.4-1 m/min.

# APPLICATIONS

- Fabric filters re primarily used in
- The metallurgical industry
- Foundries
- Cement industries
- Chalk and lime plants
- Flour mills, etc.

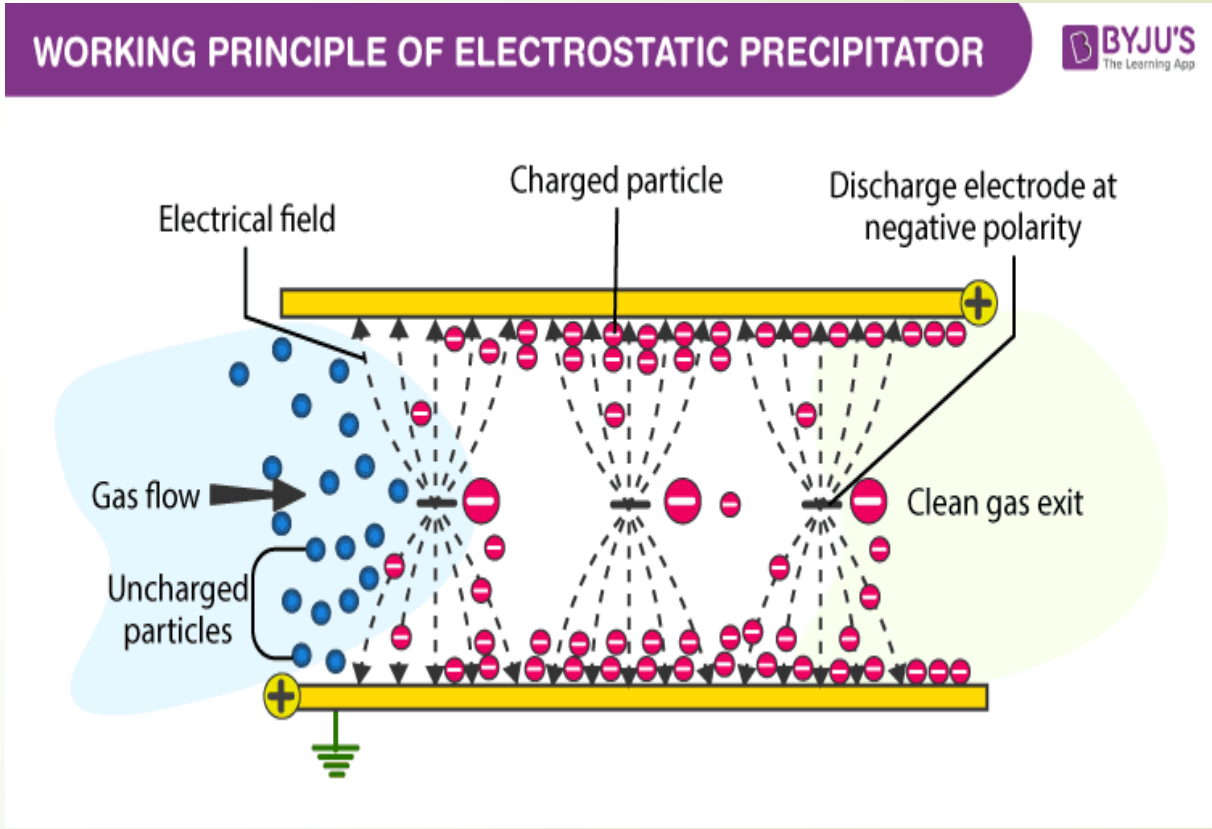
# ADVANTAGES AND DISADVANTAGES

- High collection efficiency
- Effective for a wide range of dust types
- Operates over wide range of gas flow rates.
- Good efficiency for small particles.
- Dry collection and disposal.

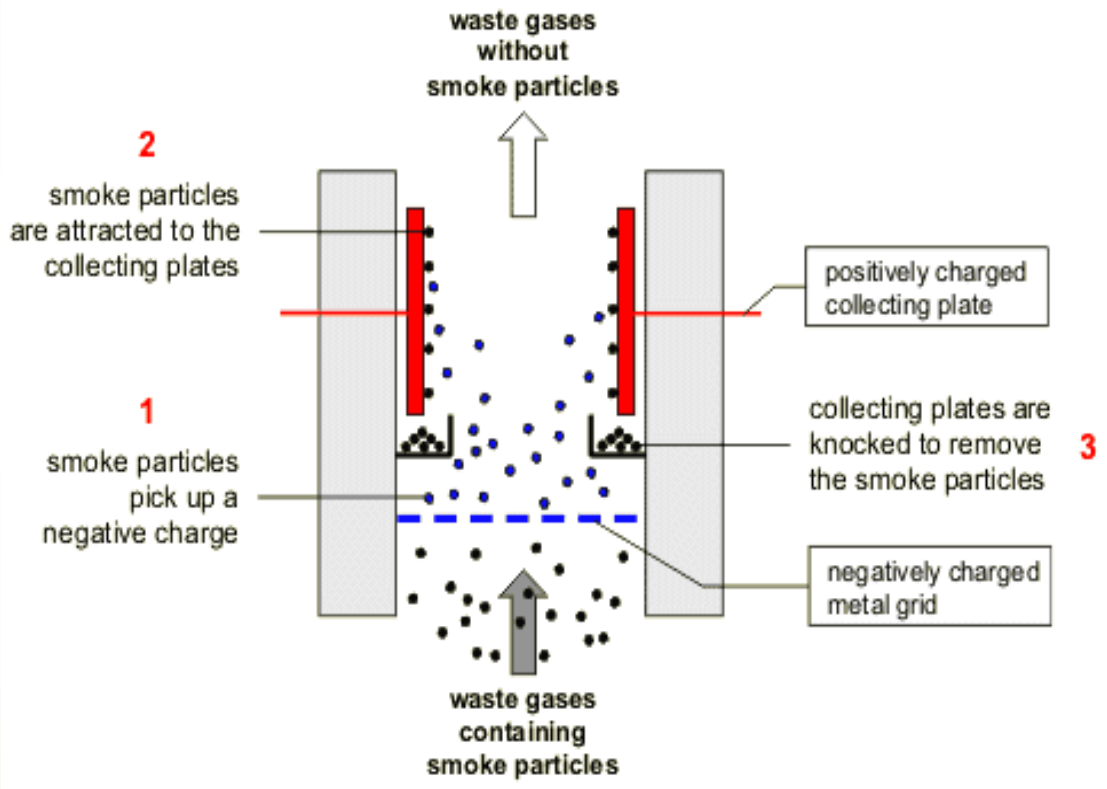
- Large size of equipment.
- Requires dry environment.
- Fire or explosion potential.
- Problems in handling dust.

# ELECTROSTATIC PRECIPITATORS

- The installation of these precipitator can reduce 99% of fly ash produced by coal burning.
- It is a device which contain & electrodes of opposite charges which are connected to high voltage cable when dust laden gas enter the precipitation.
- The large size particles settle down due to gravity while the small size particles accumulate on the opposite charged electrode where they get neutralize.
- The particles are collected and they are removed periodically.



- Electrostatic precipitators are mainly used for removing particulate pollutants from the air. It cleans the air by the following steps:
- The contaminated air is passed through high voltage negatively charged plates.
- The smoke particles picks up the negative charge.
- It is further passed through the positively charged plates.
- The positive charge attracts the negatively charged smoke particles and pass the clean air.



# ADVANTAGES AND DISADVANTAGES

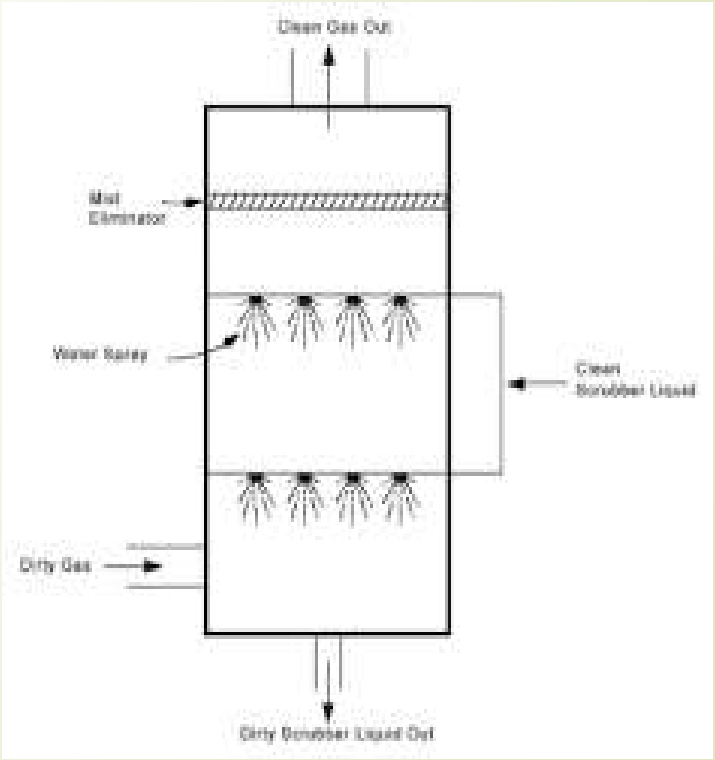
- High collection efficiency.
- Particle as small as 1mm can also be removed.
- Treatment time is negligible.
- Easy handling and cleaning.

- High installation cost.
- Need large space.
- Sometimes poisonous gas ozone can be produced.
- High maintaince cost.
- Possible explosion happen during collection of gases.

# SCRUBBERS OR WET COLLECTORS

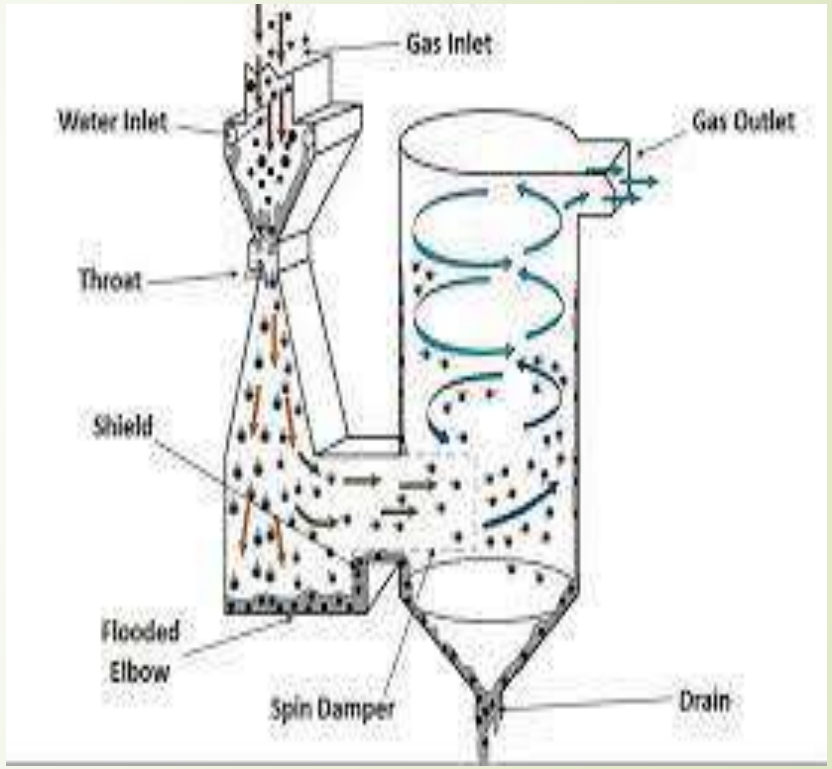
It is a device which is used for removal of particulate matter as well as other gases by absorption or adsorption.

- It is of two types:-
- **SPRAY TOWER:-**
- **VENTUARY TOWER:-**
- Spray tower:- it is the simplest scrubber in which flue gas is passed to the nozzle which is allowed to come in contact with liquid absorbent.
- The clean air is collected at the top while the particles or dust is collected at the bottom.
- It has efficiency to remove 94% of 5mm size particle 99% of 25mm size.



# VENTUARY TOWER/ SCRUBBER:-

- It has 3 section:-
- Converging → Throat → Diverging
- At inlet the area decreases which causes velocity of gas to increses liquid is induced in throat sec. and turbulently mix with high velocity gas.
- At the bottom the velocity of gas slows down where the particles get settle down at ventuary.



# ADVANTAGES AND DISADVANTAGES

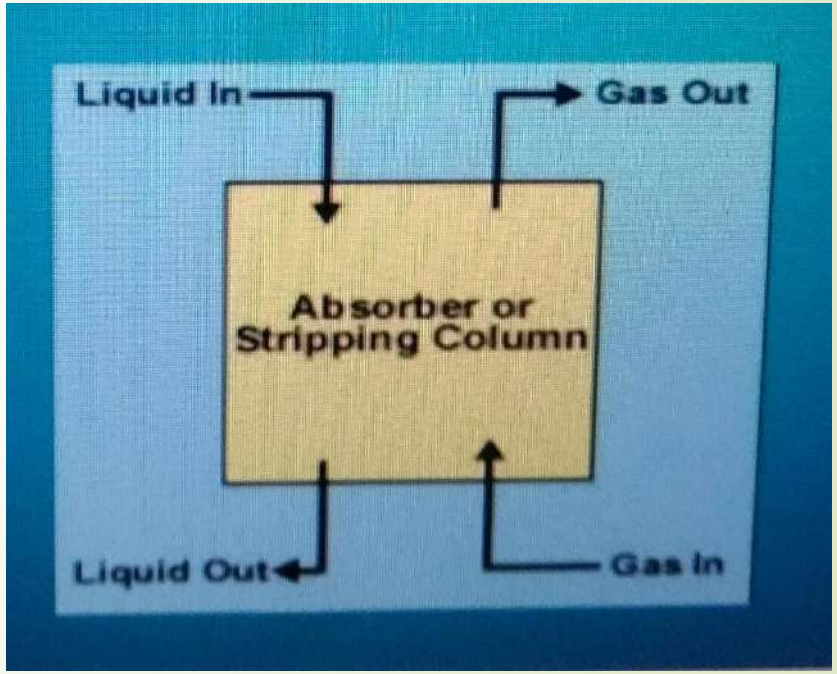
- High removal efficiency.
- Simple and compact design.
- Gases pollutants(SOX), particulate matter can be absorbed.
- Disposal of gases mix pollutant effluent.

# GASEOUS POLLUTANTS

- The removal methods for gaseous pollutants are designed to concentrate the pollutants in a liquid (absorption) or a solid (adsorption).
- Sometimes direct conversion of gaseous pollutants is possible by combustion. The central pollution (prevention and control) board, New Delhi has fixed standard for ambient air quality in India under the Air Act,1981 beyond which an ambient air can

# A) ABSORPTION

- This processes is selected to remove gaseous pollutants by dissolution into a liquid solvent such as water or in a caustic or acid solution. (most commonly water is used as an absorbent).
- As the gas stream passes through the liquid, the liquid absorbs the gas. Absorption is commonly used to recover products or to purify gas streams that have high concentrations of organic compounds.
- Among several considerations in absorption unit design, the most important is the selection of a suitable liquid solvent, determination of the limits of absorption efficiency, selection of appropriate equipment for liquid-gas contact and capital cost of the unit.



# ADSORPTION

- Adsorption is a process where gases, vapours or liquids are concentrated on a solid surface as a result of surface or chemical force (physical adsorption and chemisorptions respectively). The amount of adsorbed substances depends directly on the internal surface area of solid and the kinetics of the process.
- The most important adsorbents in industrial use to-days are Bauxite,activated carbon, activated alumina, silica gel and molecular sieves.


Thank
You