JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

# JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTER

**Class – 3Year 5th Semester B.Tech Civil Engineering**
**Subject – Air & Noise pollution and Control**
**Ch – Air Sampling (unit 2)**
**Presented by –Narendra Sipani Assistant Professor**

# VISSION AND MISSION OF INSTITUE

## Vision-

To become a renowned centre of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities.

## Mission-

**M1**. Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.
**M2.** Identify, based on informed perception of Indian, regional and global needs, areas of focus and provide platform to gain knowledge and solutions.
**M3**. Offer opportunities for interaction between academia and industry.
**M4**. Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge in a range of professions.

# VISSION AND MISSION OF DEPARTMENT

**Vision-**

To become a role model in the field of Civil Engineering for the sustainable development of the society.

**Mission-**

**M1.**To provide outcome base education.

**M2.**To create a learning environment conducive for achieving academic excellence.

**M3.**To prepare civil engineers for the society with high ethical values

# CONTENTS (TO BE COVERED)

1. SAMPLING
2. AIR SAMPLING METHODS
3. AIR SAMPLING TECHNIQUES
4. AIR SAMPLING SYSTEMS
5. AIR SAMPLING PROCEDURE
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8. AIR POLLUTION CONTROL
9. PREVENTION BY LAWS
10. AIR POLLUTION CONTROLLING EQUIPMENTS

# SAMPLING

- **Air sampling:** Capturing the contaminant from a known volume of air, measuring the amount of contaminant captured, and expressing it as a concentration.

- **Air pollution sampling :** Related to analysis of pollutants in a given volume of air

# AIR SAMPLING METHODS

Air pollutant sampling are of two types :-

1. Air sampling based on the particulate pollutant
2. Air sampling based on the gaseous and vapor pollutant

- Air sampling techniques for particulate pollutants

1. SEDIMENTATION
2. FILTRATION
3. IMPINGEMENT
4. PRECIPITATION

• THERMAL PRECIPITAION

# 1. SEDIMENTATION OR DUSTFALL JAR

Simplest device used for sampling particles larger than 10 micrometer.

- A collector consists of a plastic jar of about 20- 35cm height and 10 15cm diameter at the base with a slight inward tapering of the walls from top to bottom.
- The sample is deposited over a period of one month and the material is dried and weighed. Usually, only water insoluble dustfall reported in mg/cm2.

# SEDIMENTATION

Dust particles larger than 10 micrometer are rarely carried for distance grater than 1km, station must be closely spaced for meaningful data.

**Advantages:**

 The method is simple and inexpensive and requires no electrical power or moving parts.

**Disadvantages:**

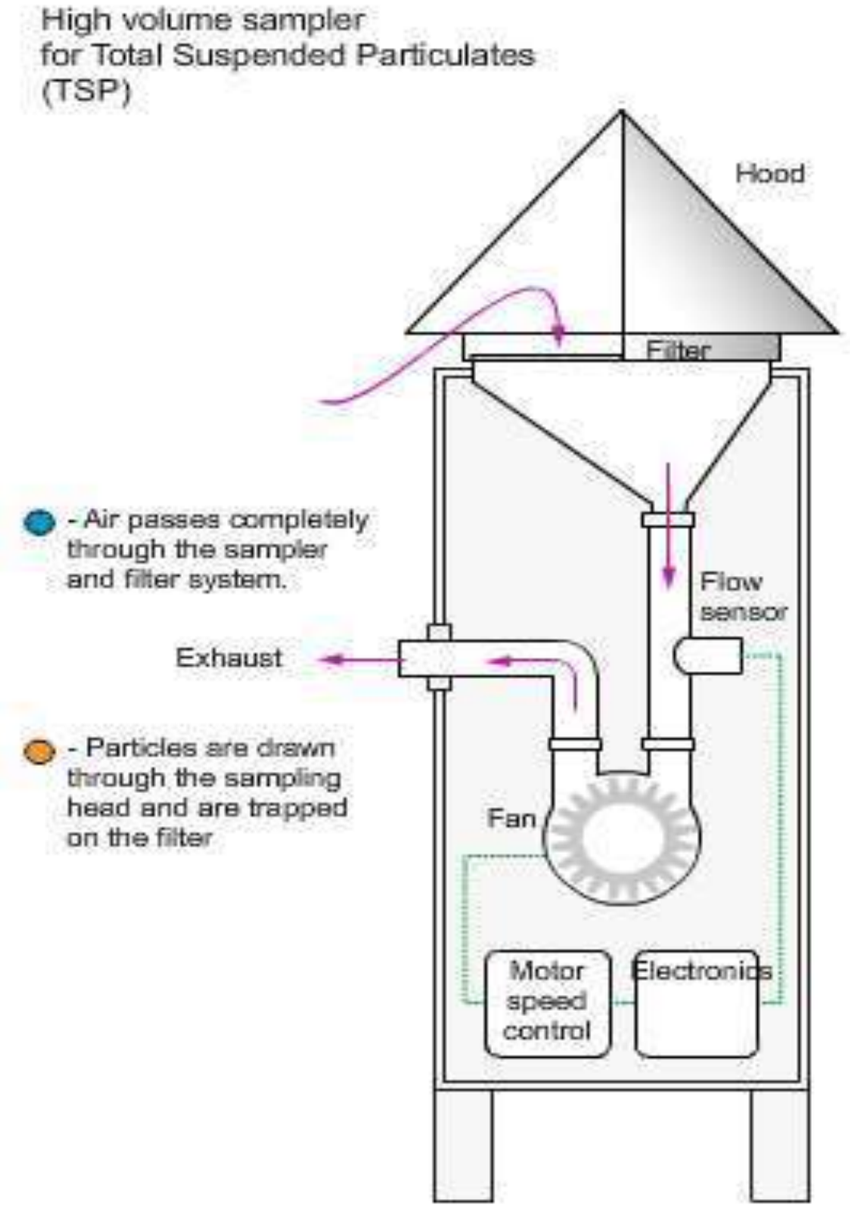
 Method lacks precision and is selective and usually nonrepeatable.

 Hence this method show pollution trend in a specific region over a period of time.

# 2. HIGH VOLUME FILTERATION

Method is popular for measurement of the mass concentration of suspended particulates smaller than 10micrometer.

 In this method, a known volume of air is sucked by a high speed blower through a fine filter and the increase in weight due to trapped particles is measured.



# HIGH VOLUME SAMPLER

- Filter is made of fibrous material, provide a dense porous medium through which an air stream must change direction in a random fashion, allowing the entrained particles to impact on the filter material
- A glass fiber filter used in air sampler has an efficiency of 99% for particles of size 0.3 micrometer and it is moderately effective for trapping particles of size as 0.05 micrometer.
- Sampling time is 24 hour and during this time over 2000 m3 of air is sucked through filter.
- The particulate level is generally expressed in terms of microgram/m3.

# 3.TAPE SAMPLER

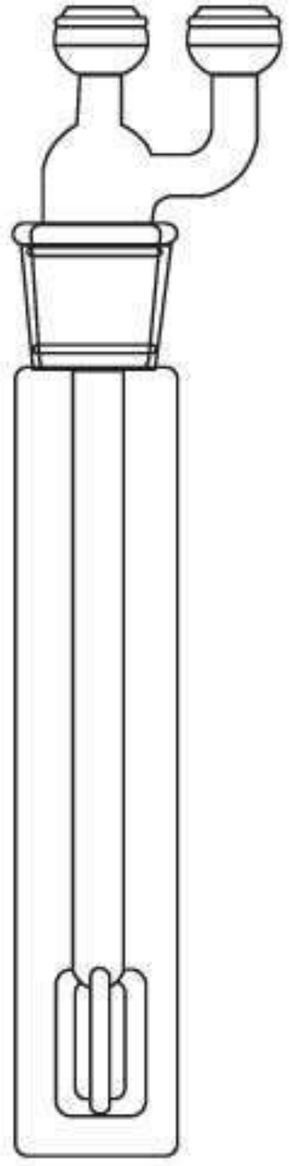
- Tape sampler is also known as ‘beta gauge’. It has appearance that looks like a reel to reel tape recorder.
- In this method known volume of air is passed through a paper tape which is advanced in discrete time intervals from a supply reel to take up reel.
- During sampling tape is held stationary. Sampling time could be from 10 min to 2 hours, depending upon the amount of particulates.
- The air is passed through the nozzle and the particulates are collected on the paper tape forming a spot.


PM10
PM2.5
E-BAM

# 4. IMPINGEMENT

In this method separation of particulates from the air stream takes place by collision against flat surface.

- Wet impingement is used for collection of particulates in liquid phase.
- As in gas sampling the air stream containing the particulate impinges at high velocity onto a flat surface immersed in a liquid. The gas breaks up into small bubbles, particles are collected by change in the direction of gas flow and promoting their contact with the liquid.

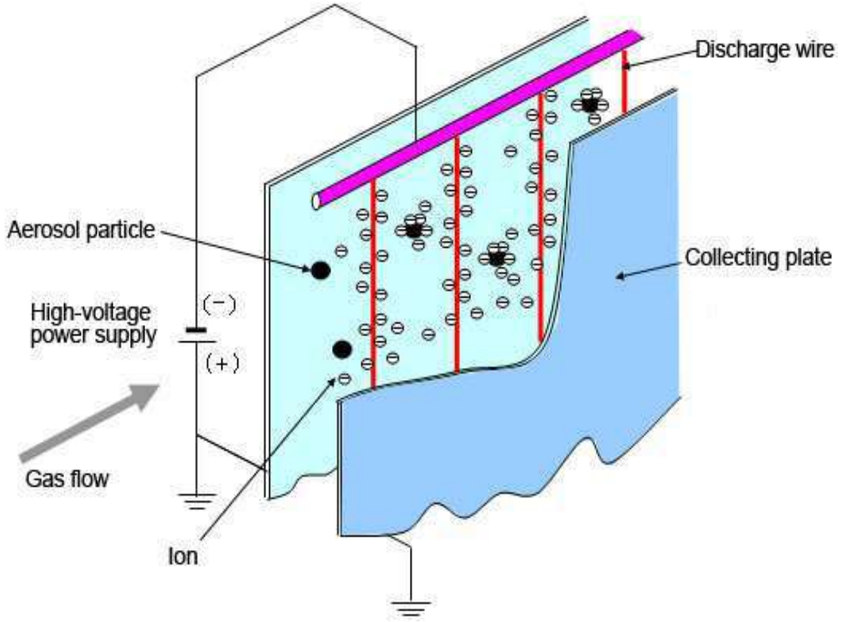


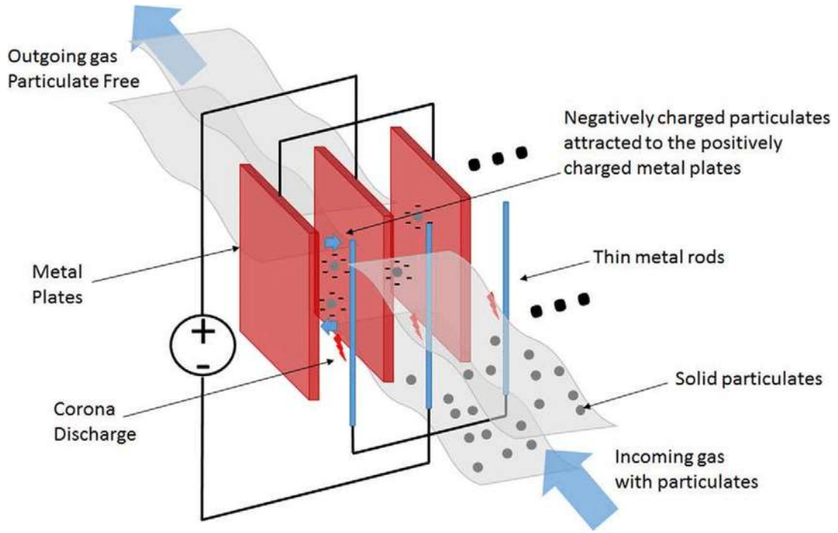
# IMPINGEMENT

- Dry impingers operate on the principle of impaction on a dry surface for particle collection. These are not as efficient as wet for collecting smaller particle <2micrometer.
- The advantage of using dry impingers is that there is no need of filtration and evaporation in liquid.
- Certain dry impingers, called cascade impactors designed for making particle size measurement.
- A typical cascade consists of 5-10 collection stages in which the sample airstream is constrained to pass through a series of jets where particle are directed against collection surfaces placed normal to the jets

# 4. ELECTROSTATIC PRECIPITATION

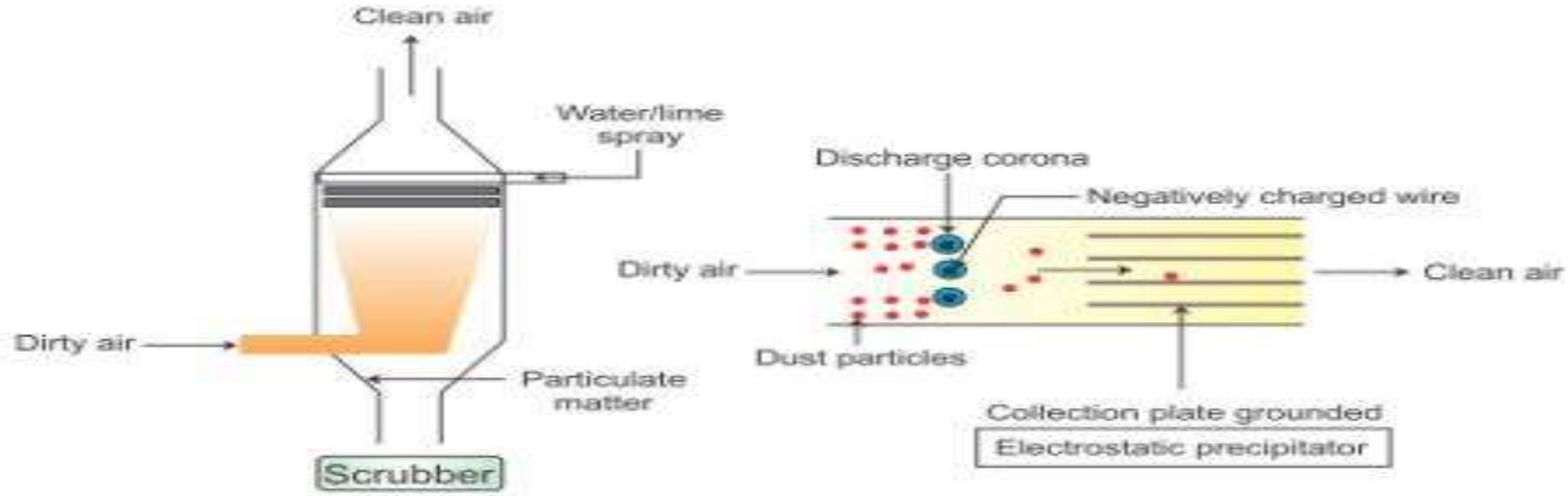
Air sampling could also be done by electrostatic precipitation.
During their operation negative charge is imparted on a wire placed axially inside a cylinder which is positively charged.
When the particle laden airstream passes through the cylinder, the particles acquire negative charge form corona discharge occurring at the central wire.
Particles or Particulates are attached with electron emitted by discharge wire.



Due to high voltage of discharge wire passing air and Particulates also get ionized

The particles migrate towards the inner surface of the cylinder which are positively charged and grounded. Particulates are removed by subsequent chemical analysis.




Electrostatic precipitator

# THERMAL PRECIPITATION

Thermal precipitator works on the principle that small particles, under the influence of a strong temperature gradient between two surface, have a tendency to move towards the lower temperature and get deposited on cooler of two surfaces.

The collection efficiency of thermal precipitators are quite high for small particle and are virtually 100% for particles in the range of 10micrometer to 0.01 micrometer. The particles are collected on a grid for further analysis.

# AIR SAMPLING TECHNIQUES

Most air pollution monitoring equipment performs the act of sampling and analysis in one action = real time measurement

older equipment = intermittent sampling (time lag between when the sample was obtained and when data was available)

Almost all gaseous pollutants are monitored by real time analysis - Particulate pollutants are still mostly monitored by intermittent sampling, even though real time methods are available

# AIR SAMPLING TECHNIQUES

When obtaining a sample for air pollution analysis

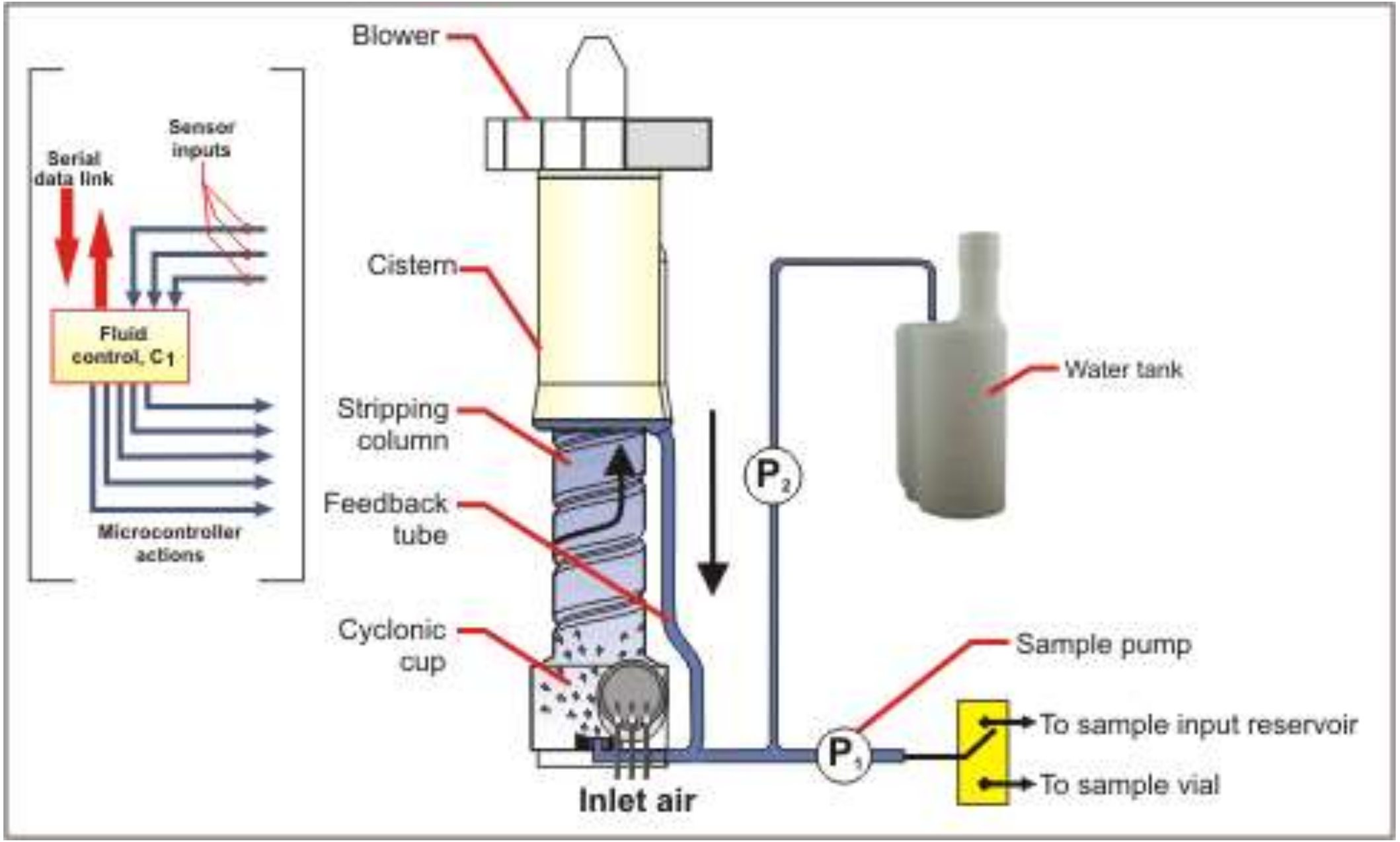
– should be sufficient sample for analysis. Most pollutants ,very low levels and require a large volume of gas for accurate measurement
– pollutants in very small quantities are easy to contaminate. Take care to purge sampling containers if grab samples are used
– Collection and analysis limitations may require collection over extended periods means data may only be a 24 hr avg.
– real time produces so much data - are often set to give hourly avg. to make data more understandable.

# AIR SAMPLING SYSTEMS

It require gases or particles to be drawn to the surface of a collecting medium or a sensor

- sampling trains, which may include a vacuum pump, vacuum trap, a flow regulator and a collecting device or sensing unit.

- Sampling trains for gases may also utilize filters to present particles from entering the collection unit


Blower
Cistern
Stripping column
Feedback tube
Cyclonic cup
Inlet air
Water tank
$P_2$
$P_1$
Sample pump
To sample input reservoir
To sample vial
Serial data link
Sensor inputs
Fluid control, $C_1$
Microcontroller actions

# AIR SAMPLING PROCEDURES

It is conducted by static, grab, intermittent or continuous procedures

- first air monitoring used static sampling – simple and cheap – requires days for data e.g. deposit Gauge.

- Grab sampling not commonly used to monitor ambient air quality – uses bladders of syringes

# SITE SELECTION

**General Requirements for Site Selection**

– purpose of monitoring
– number and type of instruments required
– duration of measurements
– best available general guide comes from AS2922
– should be easily accessible

# METEOROLOGICAL MONITORING

Changing weather conditions can produce dramatic changes in air quality and ambient pollution levels

- Factors such as:
  – wind dispersion rates (velocity and direction)
  – temperature inversions
  – photochemical reactions, and
  – rain

# CHOICE OF MONITORING EQUIPMENT

• For almost every type of air pollutant there are several different acceptable methods of analysis

• The type of equipment and methodology used for analysis may be determined by many factors such as

– cost

– the number of data points required

– the purpose for which the data are being used

– the time interval required between data points

– the devices power requirements

– the type of air pollutant, and

– the environment in which the monitoring equipment is being placed

# SOURCE SAMPLING

- Some sources are monitored continually with automated instruments (real time analyzers).
- Manual sampling techniques and testing are often required e.g. Pitot Probe.
- Introduce a probe into a waste gas stream flowing in smokestack – probe withdraws sample of waste gas, which is analyzed in laboratory.
- Gaseous pollutants collected by absorption in impingers, adsorption on charcoal or other media, or condensation in collecting traps.
- Particulate matter be collected by a variety of techniques including wet scrubbing, filtration, impaction, and electrostatic precipitation.

# STACK SAMPLING

- Emissions associated with combustion, velocity and temperature may be much higher than ambient conditions - measure to correct to standard conditions.
- Velocity data determined from pressure measurements utilizing a pitot-tube are necessary to calculate mass loading to the atmosphere, i.e., plant emission rates
- Requires airflow through the sampling probe to be at the same rate as that flowing in the waste gas stream isokinetic.

# Significance of the locations and sampling

When carrying out air quality measurements it is important to define the problem precisely (measuring plan) and to choose accordingly the site locations, measuring stations and methods. Applying the most expensive measuring instrument is of no use if, e.g., the pollutant to be investigated is influenced during its sampling to such a degree that it either cannot reach the measuring instrument at all or not in its original state. When measuring pollutant gases in the air a difference between mobile measurements and stationary measurements stations is necessary. Mobile stations (laboratories) are measuring at random and changing locations, according to a plan, to determine the spatial distribution of the air pollutants, whereas stationary measurements continuously record the temporal distribution in few fixed points of a certain area.

# AMBIENT AIR QUALITY

Ambient air quality refers to the condition or quality of air surrounding us in the outdoors.
National Ambient Air Quality Standards are the standards for ambient air quality set by the Central Pollution Control Board (CPCB) that is applicable nationwide.
The CPCB has been conferred this power by the Air (Prevention and Control of Pollution) Act, 1981
AQI index also provided by CPCB for quality of ambient air.

# AMBIENT AIR QUALITY STANDARDS IN INDIA

- The Air (Prevention and Control of Pollution) Act 1981 was enacted by the Central Government with the objective of arresting the deterioration of air quality. The Air (Prevention and Control of Pollution) Act 1981 describes the main functions of the Central Pollution Control Board (CPCB) as follows:
- To advise the Central Government on any matter concerning the improvement of the quality the air and the prevention, control and abatement of air pollution.
- To plan and cause to be executed a nation-wide programme for the prevention, control and abatement of air pollution.
- To provide technical assistance and guidance to the State Pollution Control Board.
- To carry out and sponsor investigations and research related to prevention, control and abatement of air pollution.
- To collect, compile and publish technical and statistical data related to air pollution; and To lay down and annul standards for the quality of air

# AIR QUALITY INDEX

The Air Quality Index (AQI) is a table that has been developed by the Environmental Protection Agency (EPA) to provide the regular citizen with accurate, up-to-date, and easily understandable information about daily levels of air pollution.

- The AQI takes into consideration four major pollutants: Sulfur Dioxide (SO2), Carbon Monoxide (CO), Nitrogen Dioxide (NO2) and Ozone.
- By recollecting data of the daily pollutant levels, the EPA can assign a number regarding its AQI Range.
- The AQI is divided in 6 categories: 0 – 50 (Good), 51 – 100 (Moderate), 101 -150 (Unhealthy for sensitive groups),
151 – 200 (Unhealthy),
201 – 250 (Very Unhealthy)
251 – 300 (Hazardous).

# Air Quality Index

| Air Quality Index Levels of Health Concern | Numerical Value | Meaning |
|---|---|---|
| Good | 0-50 | Air quality is considered satisfactory, and air pollution poses little or no risk. |
| Moderate | 51-100 | Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution. |
| Unhealthy for Sensitive Groups | 101-150 | Members of sensitive groups may experience health effects. The general public is not likely to be affected. |
| Unhealthy | 151-200 | Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects. |
| Very Unhealthy | 201-300 | Health alert: everyone may experience more serious health effects. |
| Hazardous | > 300 | Health warnings of emergency conditions. The entire population is more likely to be affected. |

# AIR POLLUTION CONTROL

- Cannot be fully prevented but can be controlled.

1. Preventative measures
2. Control measures using equipments.

**Preventative measures** (source control)

- Selection of suitable fuel. (Low sulphur coal in power plant, using of CNG)
- Modification in industrial process.
- Selection of suitable site and zoning for industrial unit.

# CONTROL MEASURES

- When source control not possible some measures taken to prevent pollution.
- Collecting pollutants by using equipments.
- Destroying the pollutants by thermal or catalytic combustion.
- Changing the pollutants to less toxic form.
- By releasing the pollutants through tall chimneys for greater dispersion.

# PREVENTATION BY LAWS

- Various laws has been established for the menace of air pollution.
- Air (Prevention & control of pollution ) Act,1981.
- Air (Prevention & control of pollution ) Amendment Act,1987.
- Motor vehicle Act, 1988.
- Air (Prevention & control of pollution) Union Territories Rules, 1983.
- Environment Protection Act, 1986.

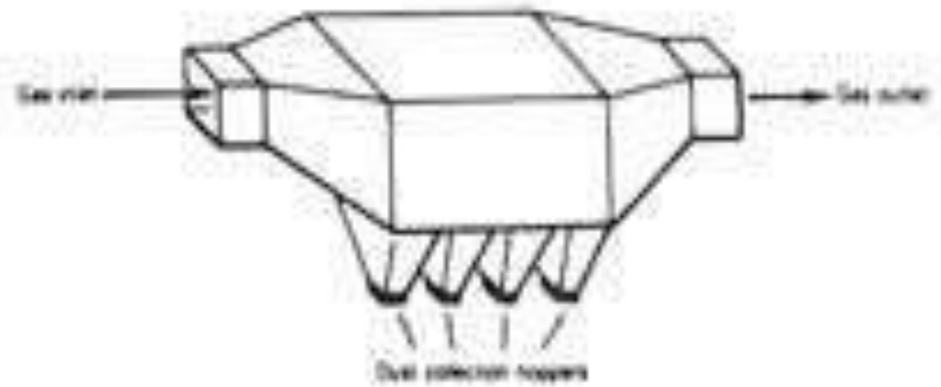
The government is trying to

- Remove the use of leaded petrol, a major cause of air pollution.
- The industrial acts are implemented to control the harmful emission of gases.
- The natural management team work to minimize the effect of various natural disaster like forest fire, volcanic eruption that are causes of air pollution.

# AIR POLLUTION CONTROLLING EQUIPMENTS

## GRAVITATIONAL SETTLING CHAMBER

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



Settling Chamber

**Advantages**

- Low initial cost.
- Easy to design.
- Low pressure drop.
- Low maintenance cost.
- Dry and continuous disposal of solid particulates.

**Disadvantages**

- Require large space.
- Less collection efficiency.
- Only larger size particles can be collected.

# CYCLONE SEPARATOR

- Centrifugal force is utilized to separate the particulate matter.
- It can remove 10 to 50 μm particle size.
- Used mostly in industries.

**Advantages**

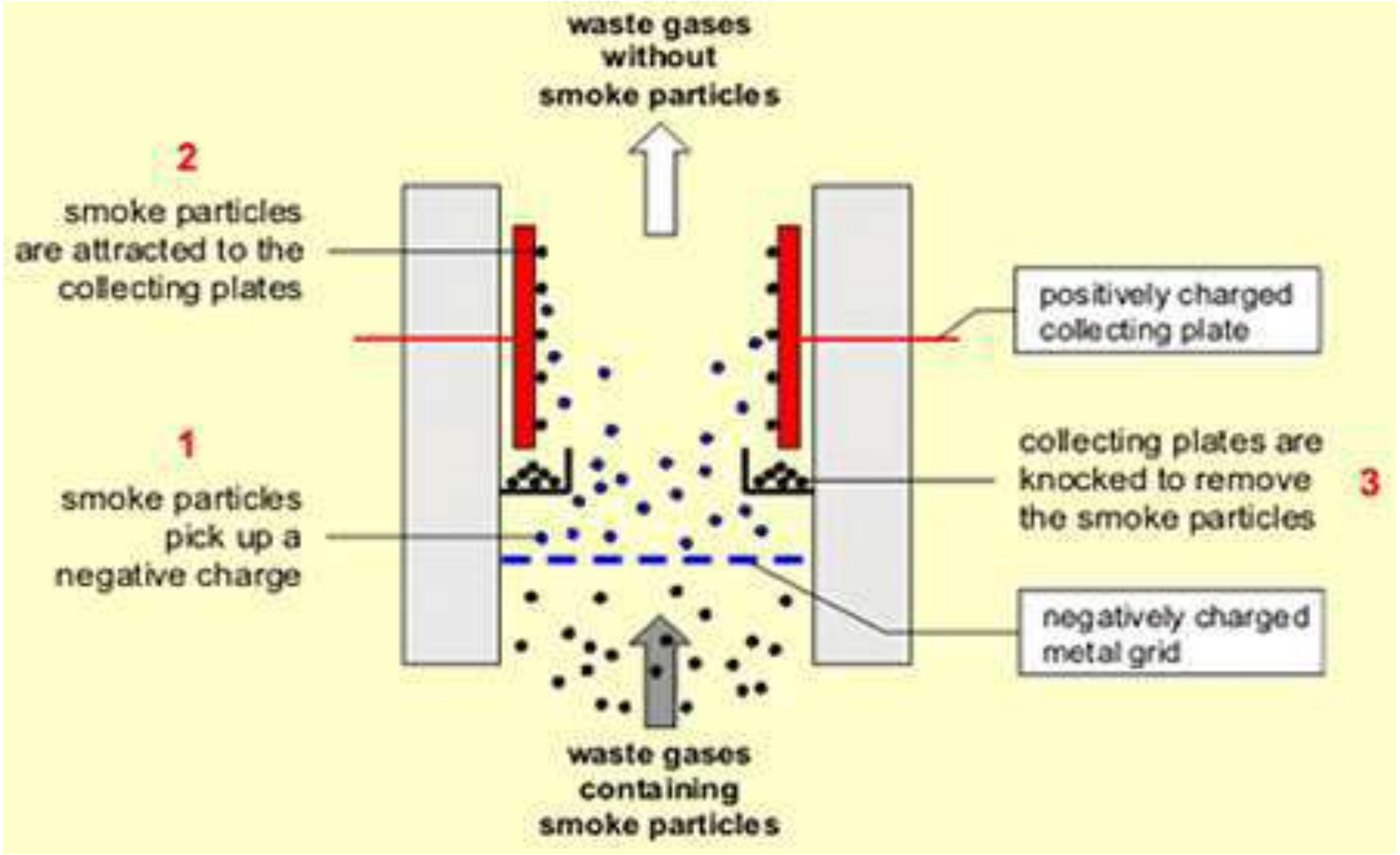
- Low initial cost.
- Require less floor area.
- Simple construction and maintenance.
- Can handle large volume of gas at high temp.

**Disadvantages.**

- Requires large head room.
- Less efficiency for smaller particles (<10μm).
- Sensitive to variable dust load and flow rate.

# 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.


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

**Advantages**

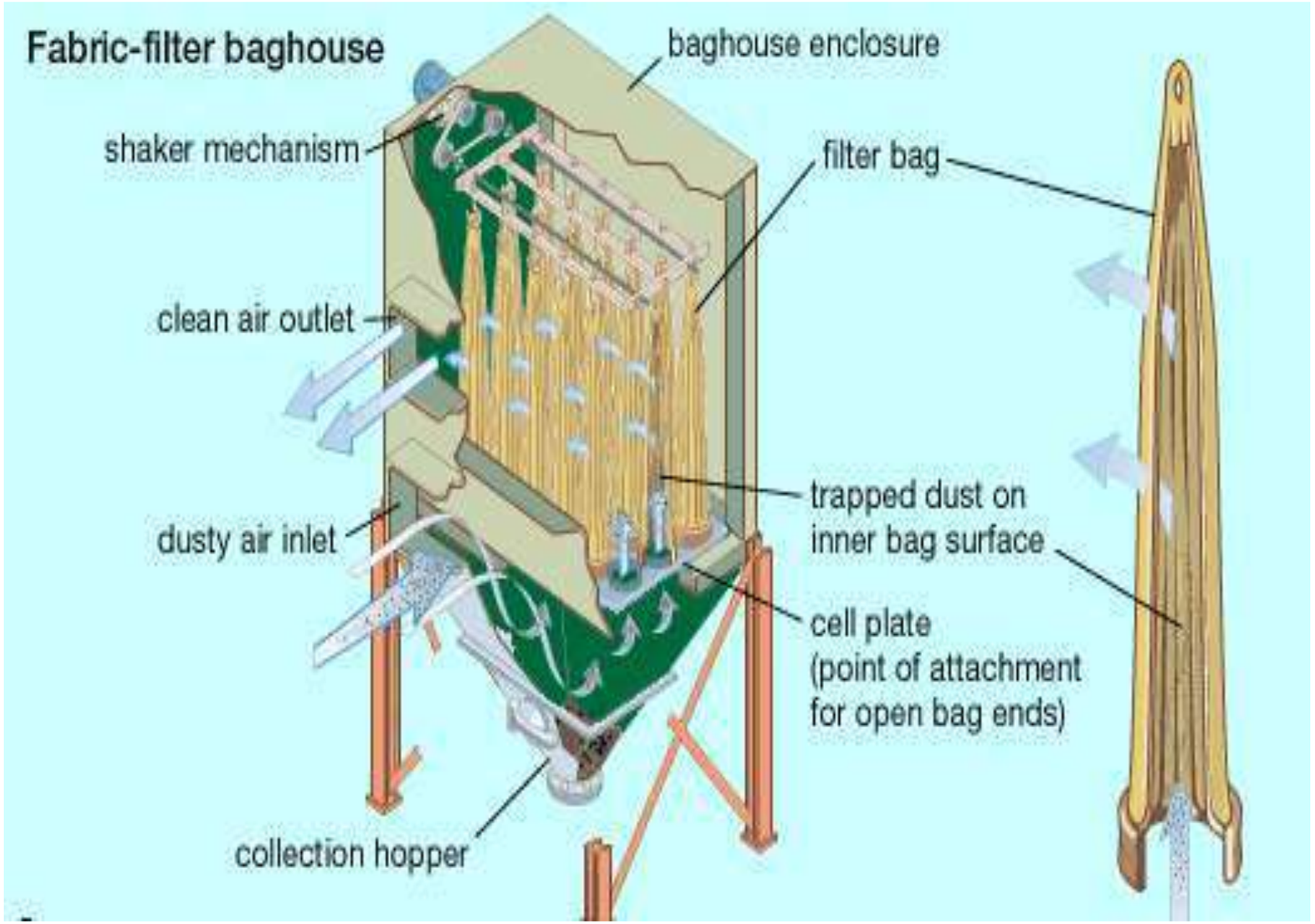
- ❑High collection efficiency.
- ❑Particles may be collected dry or wet.
- ❑Can be operated at high temp. (300-450˚c).
- ❑Maintenance is normal.
- ❑Few moving parts.

**Disadvantages**

- ❑High initial cost.
- ❑Require high voltage.
- ❑Collection efficiency reduce with time.
- ❑Space requirement is more.
- ❑Possible of explosion during collection of combustible gases or particulates.

# FABRIC FILTERS

- Flue gas is allowed to pass through a woven Fabric, which filters out Particulate matter.
- Small particles are retained on the fabric.
- Remove particles up to 1 μm.
- Its efficiency up to 99%.



**Advantages**

- ❑Higher collection efficiency for smaller than 10 μm particle size.
- ❑Performance decrease becomes visible, giving prewarning.
- ❑Normal power consumption.

**Disadvantages**

- ❑High temp. gases need to be cooled.
- ❑High maintenance and fabric replacement cost.
- ❑Large size equipment.
- ❑Fabric is liable to chemical attack.

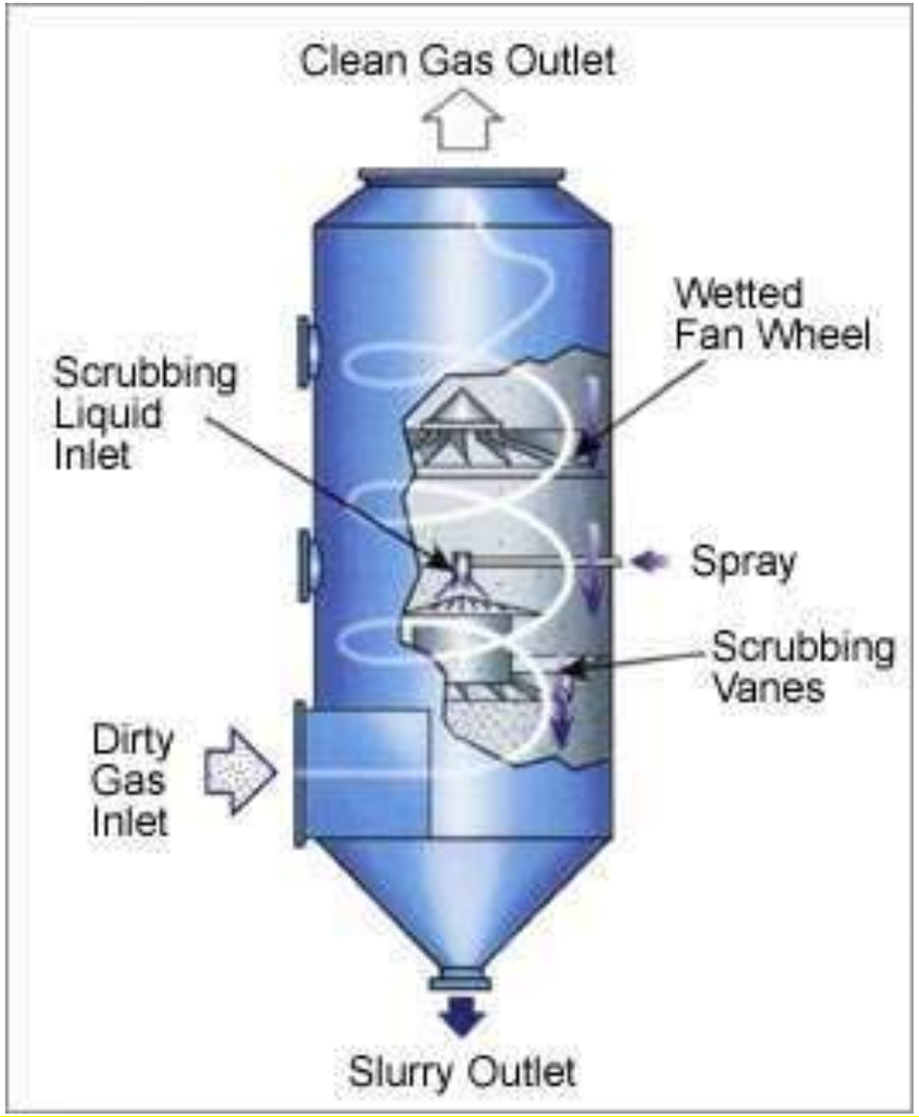
# SCRUBBERS

- Particulate matters are incorporated into liquid droplets and removed from the gas stream.
- Different types of scrubbers are-

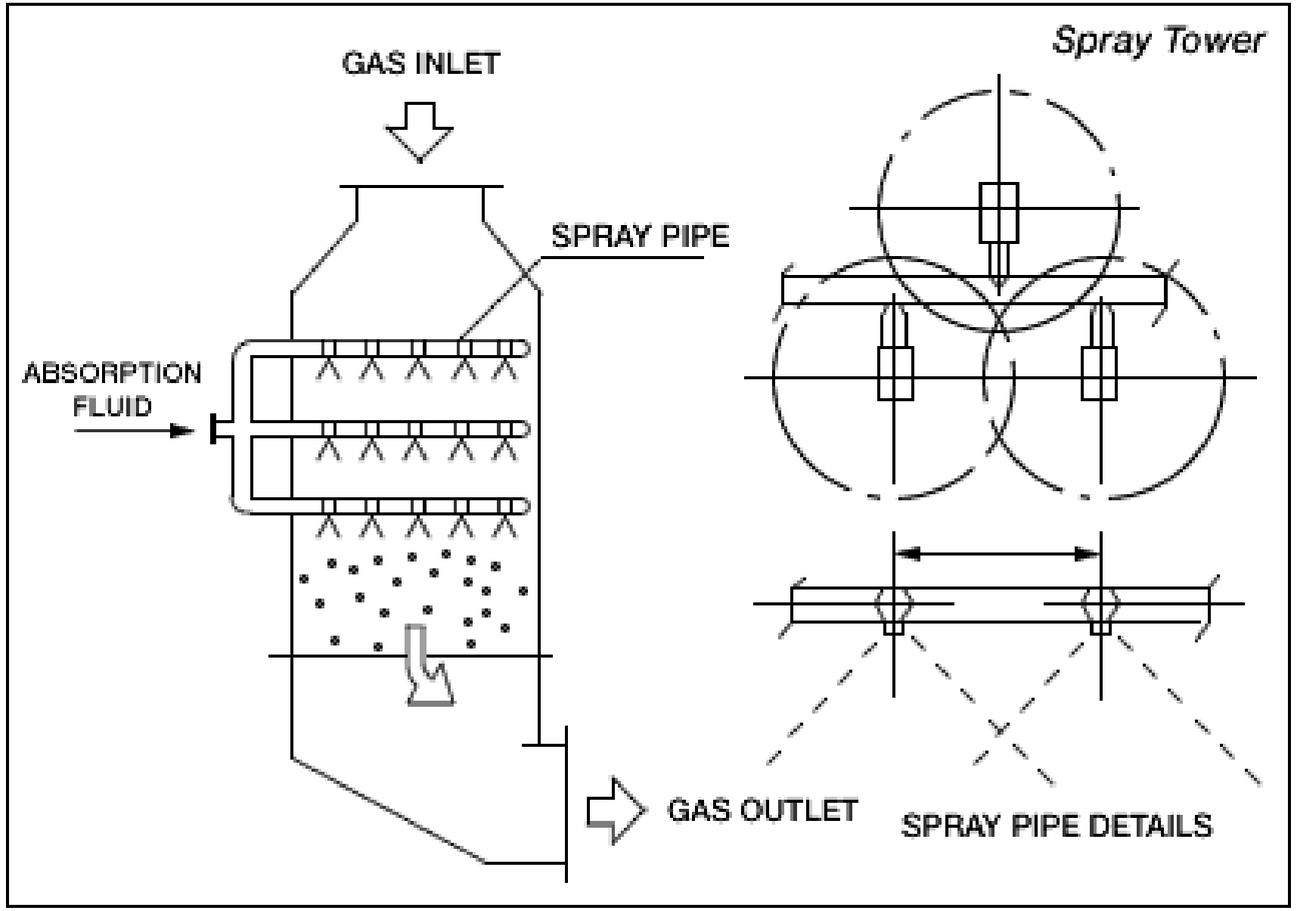
- Spray tower
- Venturi scrubber
- Cyclone scrubber

- Flue gas made to push up against a down falling water current.
- Particulate matter mix up with water thus falls down and gets removed.

# CYCLONE SCRUBBER




# SPRAY TOWER



**Advantages**

- Simultaneously remove particulates and gaseous pollutants.
- Hot gases can be cooled down.
- Corrosive gases can be recovered and neutralize.

**Disadvantages**

- Lot of waste waters produced.
- Poses freezing problem in cold countries.
- Maintenance cost is high when corrosive materials are collected.

# REFERENCES/BIBLOGRAPHY

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*Thank you!*

STAY HOME, STAY SAFE