Air cleaning systems and air filters

•Human comfort is related to the control of temperature, humidity and air movement.

•Human health is related to the control of dust, pollutants and other contaminants.

•This is achieved by filtration or by dilution of air.

•Temperature most suited to majority of people are the following;

- **Summer: 20-23 ^{o}C**
- **Winter : 18-20 ^{o}C** due to body temperature
- **Office, club, lounge etc : 24.5 ^{o}C**
- **Shops, super market, cinema hall, public places: 23.5 ^{o}C**
- **Major operation theatre: 21 ^{o}C**
- **Computer room, laboratories: 22 ^{o}C**

•Humidity control: It depends on the moisture present in the air
•Dehumidification : Removal of moisture in the air
•Humidification : Addition of moisture in the air.

- **Human comfort : 55±5 %**
- **Pharmaceutical : 45±5 %**
- **Computer lab : 50±5 %**
- **Spinning and weaving : 65±5 %**
- **Low humidity :** The air has very less moisture content. The air has tendency to absorb moisture from the surrounding.
- **High humidity :** uncomfortable, reduces evaporation process through skin and in turn cooling the body. Our body maintain comfort by perspiration as in coastal weather.

Air cleaning

•The removal of impurities provides the following;

•Improves the quality of product.
•Protects the machines and the equipment from corrosion.
•Insures better health to the occupants and increases the efficiency of the industrial workers.
•Eliminates the dust nuisance.
•Reduces the required refrigeration capacity of the air conditioned space.

Dust is classified;

i. Atmospheric dust

ii. Process dust

•The impurities in air mainly divided into six;

i.Dust is small earthy particles and does not involve chemical reactions. Ex. Cement, corn, coal.

ii.Fumes are solid particles and does not involve chemical reactions such oxidation.

iii.Smoke is a term generally used to a visible aerosols. It is the effect of combustion of organic materials such as wood, coal, oil and tobacco.

iv.Fogs are the microscopic water particles resting on small solid particles already suspended in the air.

v.Pollens from trees, flowers, and vegetables are carried with the outdoor air into an air conditioning space.

vi.Bacteria are minute living organisms, some of them are harmless and some are dangerous to the human health.

•Methods of air cleaning

(i)Air filtration (ii) Air sterilization (iii) Air ionization (iv)Odor suppression

Air filtration

The selection of particular type of air filter depends on :
(i)the nature of dust and
(ii)diameter of the dust

Types of dust	*Diameter of dust in micron*	*Type of the area*	*Concentration of dust in grams per 1000 m^3*
Dusts Fumes	< 100 μ, < 1 μ,	Rural and Suburban area	0.05 to 0.1
Smokes Fog	< 1 μ, < 100 μ,	Metropolitan area	0.1 to 0.2
Bacteria Fungi Pollen	0.2 to 5 μ, 1 to 20 μ, 5 to 150	Industrial area	0.25 to 0.3

Air Sterlization

Air sterlization is used to kill bateria and germs from the air using ultraviolet lights.

Sterlizing lamps can be mounted directly in AC spaces provided they are shielded to prevent eye injury.

Many times bactreicidal mists are also used to kill bacteria.

The mists consist of tiny droplets of either propylene glycol or triethylene glycol and are dispersed in the air at a concentration of 1 grams per 50 to 200 million cubic centimeter of air.

Air sterilization is not economical if people work in germ-free offices and live in sterile homes.

They can not escape from bacteria as they move in crowded vehicles, stroes, and restaurants where the possibilities of infection are more.

Air Ionization

Effects of ions on the atmospheric air on the health of people and working efficiency has received considerable importance in last few years.

The ion content of air naturally increases with air temperature.

For ionization, machines are in use in heavy ventilating work.

Currently it is not commercially used in comfort air conditioning.

Odour Suppressions

Odor creates dullness and reduces work efficiency.

Adsobent materials are used to remove some odour bearing materials and vapours.

Activated carbon contained in perforated container is used for removing odours.

When it becomes ineffective, it can be made effective by heating it to 550 ^{o}C.

Air filters

- Dry filters
- Viscous filters
- Wet filters
- Electric filters
- Centrifugal dust collectorS

Air purification methods

- Filters classified based on type and porosity.
- Porosity is number of pores per unit area in the filter.

(i)High efficient particulate air filters (HEPA)
(ii)Ultra-low penetration air filters (ULPA)
(iii) Activated carbon filters
(iv) Plasma air purifiers

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Dry filters

- They separate dust, pollen, bacteria by using fabrics, woven cotton, wool, felt, cellulose or fibre glass

- The filter is supported in wire or angle frame located in return air path.
- Fiber glass media is less expensive and very widely used.

- They are confined to smaller size systems: 450x450, 500x500, 600x600 etc

- Air flow required is up to 5 m^3/s

- Types: Permanent, Dry replaceable type, Throwaway filter, standard filter

- **Permanent dry type:**
- Efficiency is 95%
- Fabrics processed from plastics or brush
- Serviced by washing or by compressed air cleaning or vacuum cleaning.

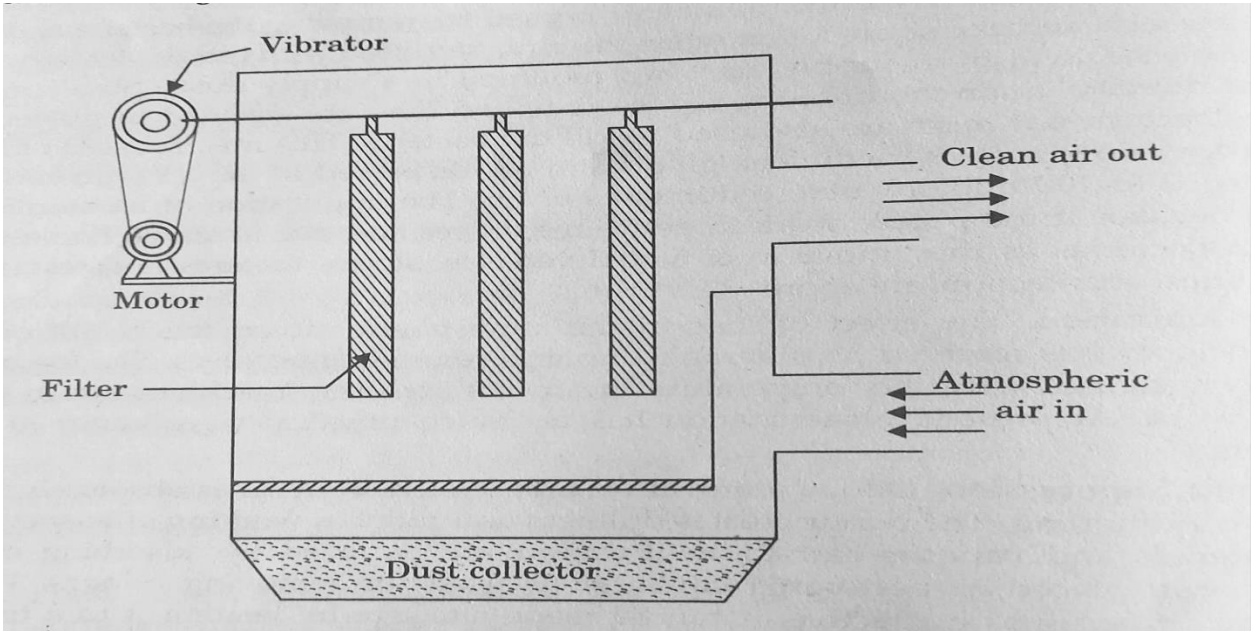
Dry replaceable type

- Efficiency : 95%
- Serviced by replacing the media
- Used as main filter or pre-filter to high efficiency filters.

- **Throwaway filter**
- Efficiency : 95%
- Used in smaller plants
- Panels with filter media of fabrics, plastics, glass or metal fibre over wood or metal frame.

- **Standard filter**
- Metallic filter ½", 1". 13/4" thick
- Polypropylene filter- ¼" thick
- Used in simple applications of comfort AC
- It can be used in central, packaged and window units
- Dust filteration is upto 25-30 microns.

- Throw away filters are made of glass wool, plastic fibers, steel wool, animal hairs or vegetable fibers.
- Dry type filters able to remove 0.3 to 10 micron diameter.
- It can not be used where the dust concentration is higher than2.5grams per 1000m^3.
- Dry filters can not remove smoke from air.



Bag filter

Viscous filters

- Better than any other type of filters.
- These filters are made in the form of pad and bats using glass wool, steel wool, plastic meshes, or copper mesh.
- Card board can be used so that the filter can be thrown away when it is full of dust.
- Some viscous filters can be washed through gasoline.

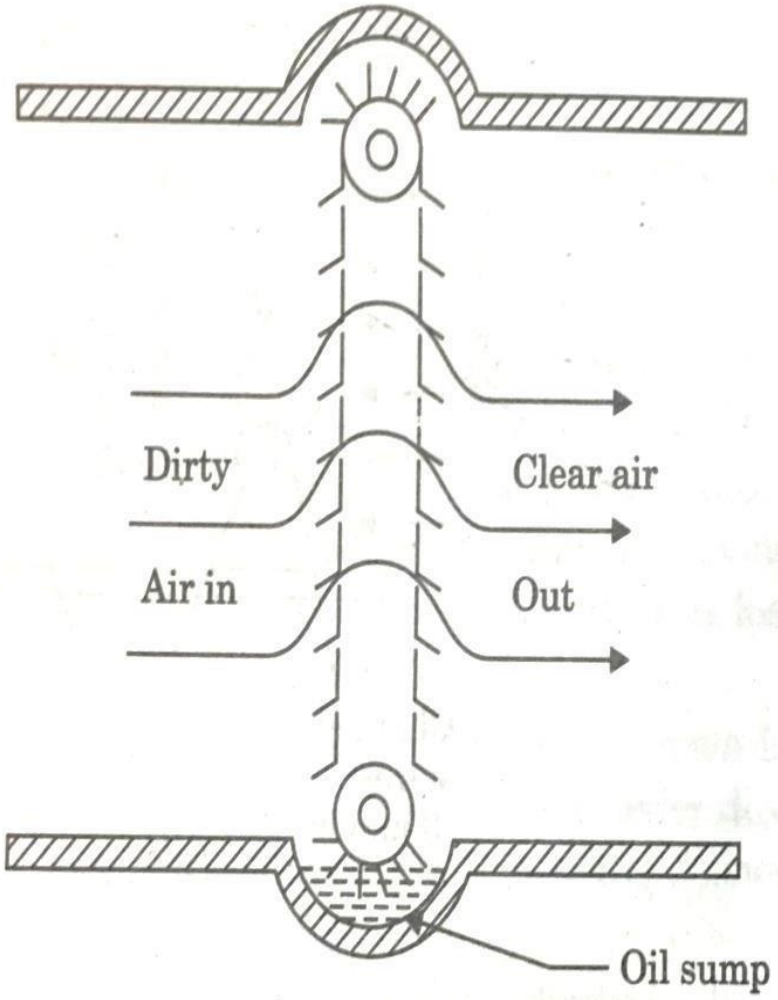
- The viscosine used must have the following;
- It must have the constant viscosity over a wide temperature range in
- order to be sticky enough when cold and it should not be when hot.

- It must contain some germicidal action to prevent the growth of bacteria.
- It should not evaporate more than 1% of its weight during the life time of the filter.

Self cleaning filters;

They are in the form material coated with the oil and is driven by motor across the air stream as shown in Fig.

The filtering screen is continuously running over rolls at the top and bottom while the bottom roll is in a sump filled with viscous liquid which acts to wash the screen and to recharge with the fresh viscous liquid.



Wet filters

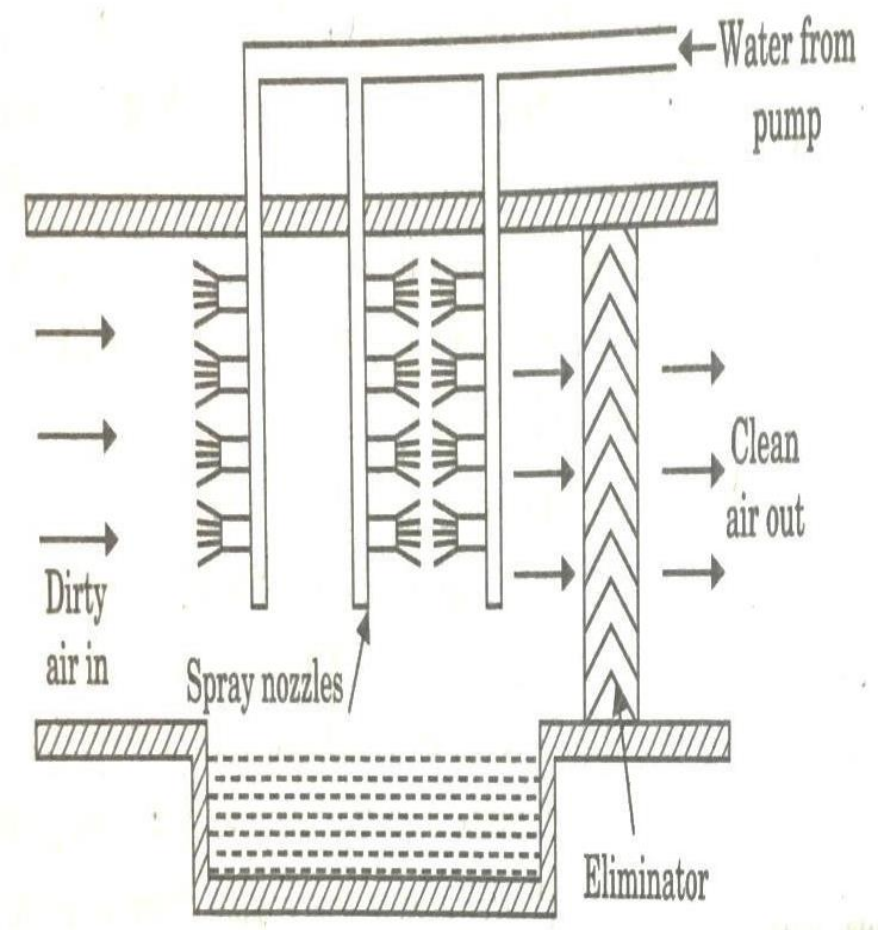
Water spray type air washer is also known as air filter.

The dust particles are wetted by water spray and then owing to the additional weight of the water, the particles fall to the bottom.

The effectiveness of washer in removing the dust depends on the wettability of the dust by water .

It is almost impossible to wet a greasy particle like pollens.

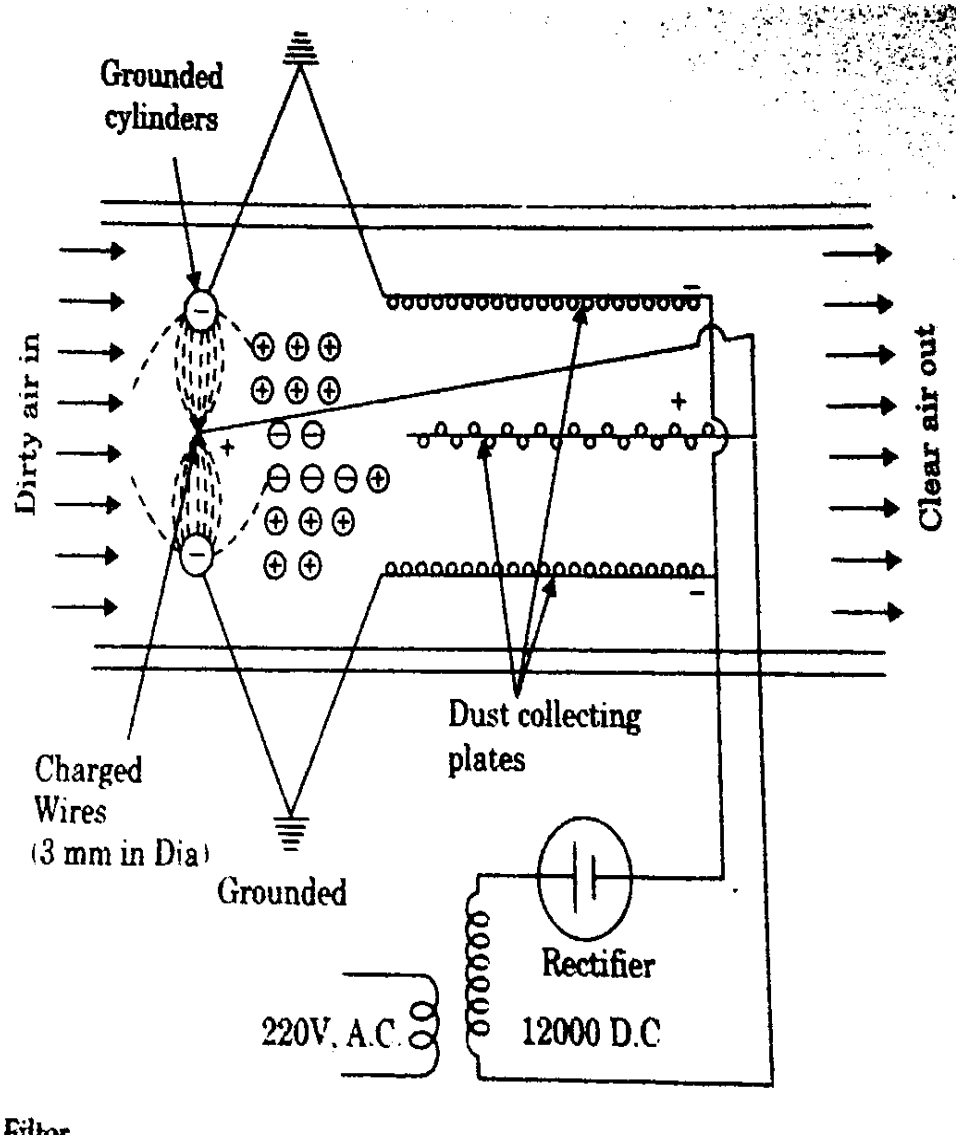
Used in industrial area for the absorption of soluable gases, which are dangerous and unhealthy for the occupants.



Electronic filters

Air is passed between a pair of oppositely charged conductors and it becomes ionised as the voltage applied between the conductors is sufficiently large(8000 to 15000V).

As the air is passed through this ionised chamber both the negative and positive ions are formed. The latter being large in quantity (20% negatively charged and 80% positively charged).



- The air carrying the ions and coming out of the ionising chamber is further passed through the collecting unit.

- This unit consists of set of vertical plates, spaced 15 to 20mm apart. Alternate plates are positively charged and earthed and attract the negatively and positively charged dust particles respectively.

- The voltage applied to the plates is approximately half of the ionizing wires. As the alternate plates are grounded high intensity electrostatic field exists between the plates.

- When the charged dust particles are passed between the plates, the electrostatic field exerts a force on charged particles and drives them towards the grounded plates.

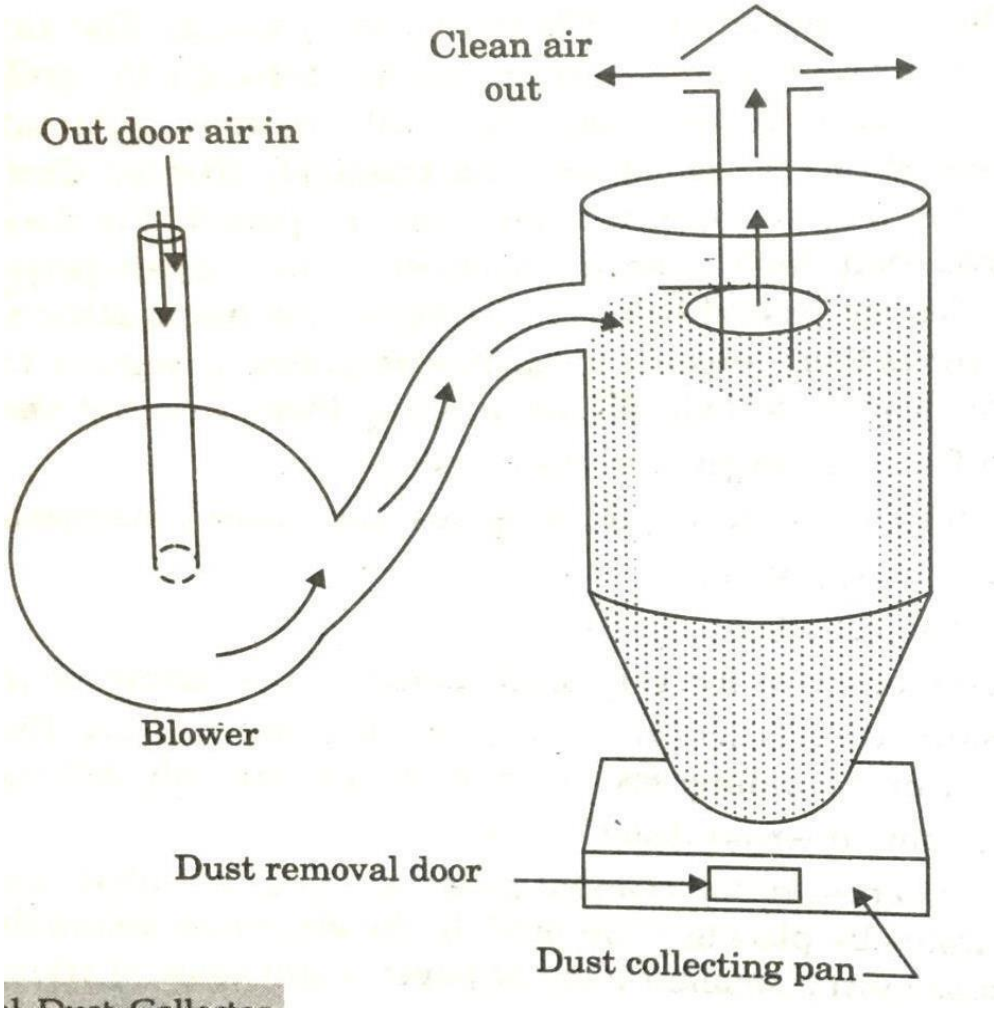
- To remove the dust accumulation, the collector plates are cleaned periodically by washing them with hot water spray.

Advantages of this air cleaner are;

- It assures low initial cost, lower working cost, lower maintenance cost.
- It provides ease of operation
- It requires smaller installation space
- It is very effective for very small particles.
- Max. pressure drop is 2.5 cm of water at 150 m/min velocity. The power requirement is considerably less as unit handling 800m3 of air requires only 200 watts.
- Drawbacks;
- It is advisable to protect the device by placing a mesh in the air stream before ionising chamber.
- A prefilter or other type is necessary before electronic filter to reduce the load.
- The efficiency of the filter decreases from 100% to 80% when the quantity of air flow increases from $1000m^3/min$ to $60x10^3$ m^3/min.

Centrifugal dust collector

- Used in industrial air conditioning systems.
- It does dual function-remove the dust and collect the dust.
- A high velocity air stream is directed into a conical chamber. This produces whirling air current within the chamber and throws the heavier dust particles which are collected at the bottom.



Advantages and disadvantages

Advantages

- Does not require high skilled service.

Disadvantages

- Effective only removing large particles.
- Large amount of power is required compared with the other filters.

Air filters used in Air conditioners

- Filters classified based on type and porosity.
- Porosity is number of pores per unit area in the filter.

High effective particulate air filters

- This are ideal for removal of particulates with high efficiency.
- The method of filtration is straight for 100 to class 100,000 for clean rooms.
- Prefilters which are used with clean rooms have the efficiency in the range of 30-95%.
- The final filters to be used should be of HEPA with min. efficiency of 99.97 to 99.99% for 0.3 micron particles. The HEPA filters are used in an inline filter housing or as a terminal distribution device.

Ultra low penetration air filters

- The ULPA filters have a minimum efficiency of 99.99% for 0.3 micron particles.

- Currently various grades are available with efficiency of 99.9999% for 0.1 micron.

- ULPA filter contains a filter media similar to HEPA. Both of its filter media and sealing are more efficient than HEPA.

- The removal of large particles in prefilter reduces dust load and increases the life of HEPA. Monitoring the pressure drop and its maintenance of periodic washable low efficiency air filters have a direct impact on filter performance.

Activated carbon filters

- These filters are widely used to elucidate objectionable odours and irritating vapours of gaseous air borne particulates typically ranging from 0.0003 to 0.0006 micrometers in size from the air stream by absorption.

- A typical carbon trays of 60x60x1.5cm weighing 5.496 kg is used. Low efficiency filters are used as prefilters for protection.

- When air flows through a typical assembly of 125 to 165m/min, the corresponding pressure drops are between 0.5 to 0.8 cm of water.

Plasma air purifier

- LG air conditioners use plasma air purifiers in split, window and package air conditioners.

- Smallest gems, bacteria, smoke, unpleasant odours, microbes and viruses are removed easily.

- With this type, it is not necessary to replace the filter for a life time.

Type of filter	Efficiency of filter
Dry fabric (Cotton-wool pads)	25-35%
Dry fabric (fine glass wool)	50-75%)
Viscous filters	5-15%
Electric filters	70-90-%
Centrifugal type	

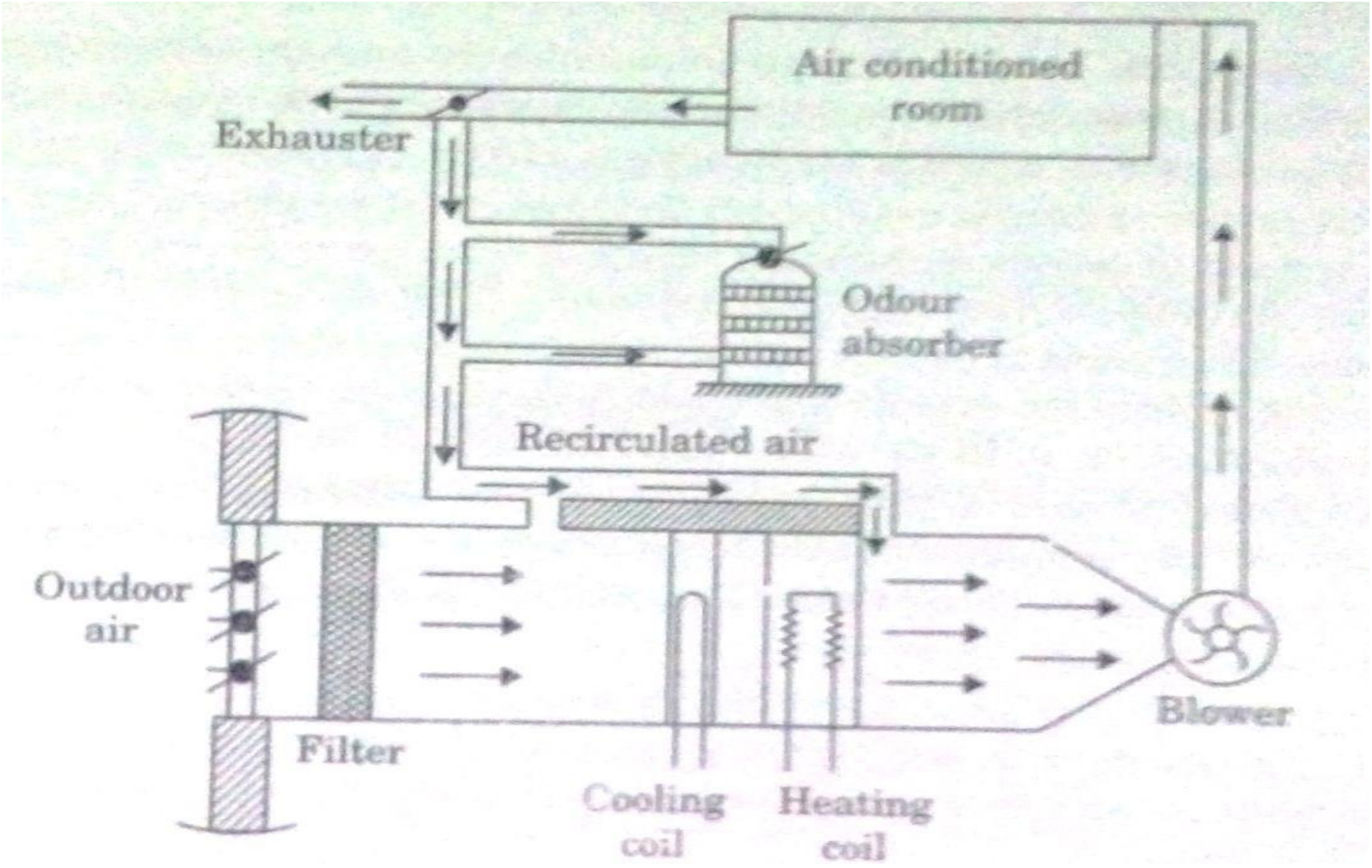
Dust types

Type of dust	Size of dust particle in microns	Concentration	Type of cleaner		
			Dry	Viscous	Electrical
Coarse dust	>5 μ	Low High	Good Fair	Good Good	Good Good
Fine dust	0.5 to 5μ	Low High	Good Fair	Poor Poor	Good Good
Smoke	<0.5μ	Low High	Good Fair	Very poor Very poor	Best BEst
Pollen	15.50	Low	Good Fair	Good	Good

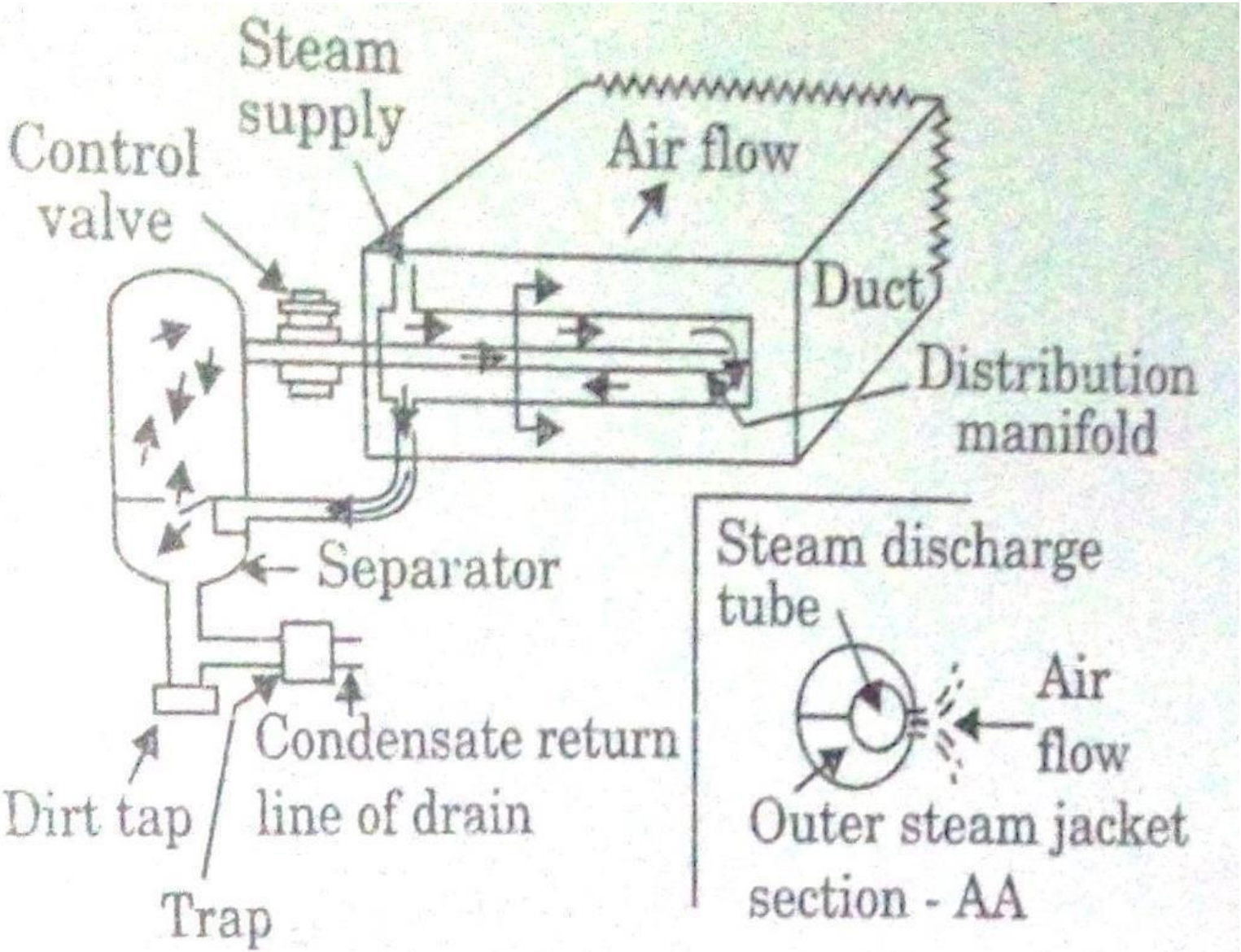
Odour elements

Odour causing element	Definition	Source	Concentration in kg per million (Cu m of air)
Butytic acid	Butyric acid is a fatty acid that's created when the good bacteria in your gut break down dietary fiber. It's also found in animal fats and vegetable oils	Body odour	1.5
Valeric acid		Body odour	0.01
Pyridine	Pyridine is a colorless liquid with a foul odor and several hazardous properties	Burning tobacco	0.035

Odour causing element	Definition	Source	Concentration in kg per million (Cu m of air)
Cresol	Cresols are a group of aromatic organic compounds.	--	0.85
Aerolin	---	Frying fat	1.0
Essential oils	----	Perfumes	1.0



Odour absorber system for inside source



Steam jet type humidifier

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