AIR POLLUTION :-

* "It can be defined as the presence of one or more contaminants such as fumes, dust, gases, mist, smoke, odour, smog or vapours in the outdoor atmosphere which is harmful to human, animal or plant life or which unreasonably interferes with the comfortable enjoyment of life and property."

* The World Health Organisation (WHO) defines air pollution as "limited to situations in which the outer ambient atmosphere contains harmful materials in the higher concentrations which are "injurious to man and his environment"

→ The substances included are

Gaseous pollutants :-

* It includes oxides of sulphur (SO_2, SO_3) oxides of Nitrogen (NO, NO_2, NO_3), carbon monoxide, hydrocarbons etc.,

Particulate pollutants:-

* It Includes smoke, dust, soot, fumes, Aerosols, liquid droplets, pollen grains etc.

Radio Active pollutants:-

* It Includes Radon, Iodine, Stronium, plutonium

Classification of Emission Sources:-

* The various emission sources of air pollutants can be classified into natural and man made sources.

Natural Sources:-

* It Includes volcanoes, forest fires, Marsh gases, fungal spores, Pollen grains of flowers, Photochemical Reactions.

Man Made Sources:-

* Domestic burning of wood, Burning of fossil fuels, Air craft, Refrigiration Industries, wars, waste Treatment plants, Vehicular Emission, Thermal power plants.

→ Air pollutant levels can be expressed either as ppm or ug/m3 when subjected to temperature and pressure.

Types of Air pollutants:-

* Air pollutants are classified into three types

→ Primary Air pollutant.

→ Secondary Air pollutant.

Primary Air pollutant:-

* the Air pollutant which are directly emitted from particular sources are known as primary pollutants.

The sources include are

→ compounds of sulphur

→ Oxides of Nitrogen

→ compounds of halogen

→ Radio Active compounds.

→ Carbon Monoxide.

→ finer particles (less than 100μ in diameter)

→ coarse particles (greater than 100μ in dia)

→ Ammonia.

Secondary Air pollutant:

* Secondary Air pollutants are those which are produced in air by the interaction among two or more pollutants or by the reaction with normal atmospheric constituents, with or without photoactivation.

Examples of Secondary Air pollutants are

→ Ozone (O_3)

→ Formaldehyde (CH_2O) (or Methanol)

→ Peroxy Acetyl Nitrate (PAN)

→ Photochemical smog

→ Formation of Acid mist (H_2SO_4) due to the reaction of SO_2 & dissolved oxygen when water droplets are present in the atmosphere.

Effects of Air pollution:-

The different types (of) effects of air pollution are as follows:

→ Effect on human health

→ Effect on trees and plants.

→ Effect on animals.

→ Effect on certain materials

→ Effect on physical features of atmosphere

Effect on human health:-

* The effect of particulate pollutants are largely dependent on the particle size.

* Air borne particles i.e. dust, soot, fumes and mists are potentially dangerous for human health.

* Larger particles (greater than 1m) tend to deposit and trapped by the hairs and sticky mucus in the lining of the nose.

* Smaller particles are trapped by Tracheobronial System. However years of exposure to pollutants results in lung cancer, Asthma, Chronic bronchitis and Emphysema.

* Pollens cause Asthma.

* Hydrogen flouride causes bone fluorosis and mottling on teeth.

* Carbon monoxide (CO) may cause death to human beings.

* lead poisoning is caused by entry of lead into the lungs.

Effect on Trees and Plants:-

The air pollutants effecting trees and plants are

* Sulphur dioxide (SO_2)   * Oxides of Nitrogen (NO, N_2)

* Hydrogen fluoride (HF)   * Ammonia (NH_3)

* Chlorine (Cl)   * Hydrogen cyanide (HCN)

* Ozone (O_3)   * Peroxy Acetyl Nitrate (PAN)

* Ethylene (C₂H₄)
* Smog
* Mercury (Hg)

Effect on Animals:-

* Fluorine, Arsenic and lead may cause the contamination of vegetation and affecting the animals when they eat it.

These air pollutants can originate from
- → Industries.
- → Dusting.
- → Spraying.

Effect on certain materials:-
this can be explained in five ways:
- → Abrasion.
- → Deposition and removal
- → Direct chemical attack.
- → Indirect chemical attack.
   Corrosion.

* the various materials such as building materials, metals, textiles rubber, paints and paper.

Effect on physical features of the Atmosphere:
  Effect on visibility:- At a concentration of 0.10 ppm of SO_2 with concentration of particulate matter & relative humidity, 50% of visibility can be reduced.

* fog and Photochemical smog reduces the visibility

Effect on Atmospheric constituent:-

* CO_2 is the main factor which is responsible for rise in ambient temperature.

Effect on Urban Atmosphere & weather conditions:-

* Smoke, Dust, Fog and other aerosols are responsible for urban air pollution.

* It effects the weather conditions, due to cloudy nature, solar radiation is reduced by 30%.

Green House Effect:-

* It is caused by gases like CO_2, NO, O_3 & chemicals like chlorofloro carbons (CFC) are responsible for green House Effect.

Ozone depletion layer:-

* Ozone layer acts as a protective layer against the harmful pollutants like chlorofloocarbons and ultraviolet radiations reaching the earth. Due to these radiations, it damages immune system, entire ecosystem, ↑ skin cancers.

Acid Rain :-

* Acidity mainly ↑ with SO_2, NO_2

* $2/3$ rd of acid rain is mainly due to SO_2, which leads to H_2SO_4

* $1/3$ rd of acid rain is mainly due to NO_x, which leads to HNO_3.

* It damages forest, crops, Buildings.

Global Warming :-

* It is mainly caused due to man-made sources. This may lead due to burning of crops and cause forest fire.
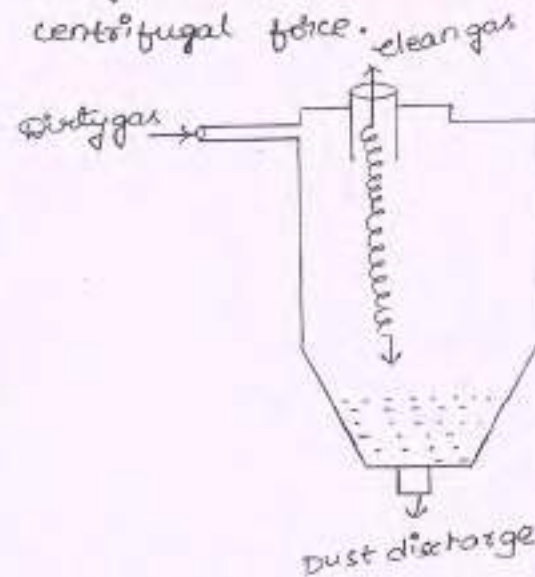
* Sealevel will be ↑ due to melting of polar ice caps.

Particulate control devices :-

* Many devices are available now-a-days choice of which depends upon the characteristics of particulate, flow rate, collection efficiency, costs etc,

Cyclonic precipitators :-

* Cyclone Seperators are also known as cyclones.

* Cyclone Seperators works on the principle of centrifugal force.
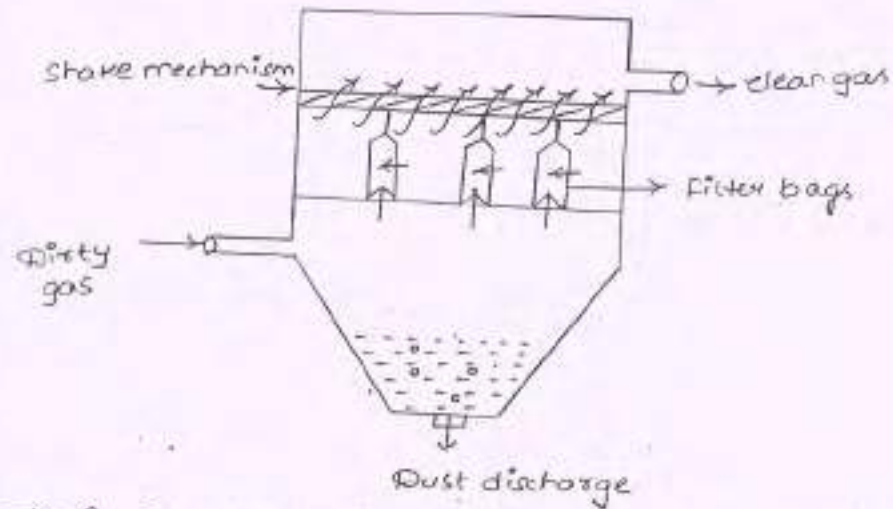

cyclone Seperator

Dust discharge

* It consists of a cylinder with an inverted cone attached at the bottom. The gas with particles in it enters tangentially at the top of the cylinder and spins forming a vortex. Due to the centrifugal force, the particles strike the wall of the cylinder.

* The particles then fall in the hopper due to gravity from where they are removed. The spinning gas forms and inner vortex leaves from the top. i.e., the clean gas leaves from the top of the chamber.

* However, cyclones are efficient in removing

the larger particles but not efficient for the smaller particles.

* For this reason, they are used with other particulate control device.

Bag house filter:-

Dust discharge

→ A Bag house filter contains a no. of filter bags made of fabric.

→ The filter bags are placed vertically with a length of 2m to 10m and a diameter of 120mm-140mm.

→ they are hanging upside in several compart-ments of bag house filter.

→ Dirty gas is passed through the filter

bags which leaves the bags through their pores.

→ The dust particles get deposited on the inner surface of the bag filters and may form a cake which can be removed by shaking.
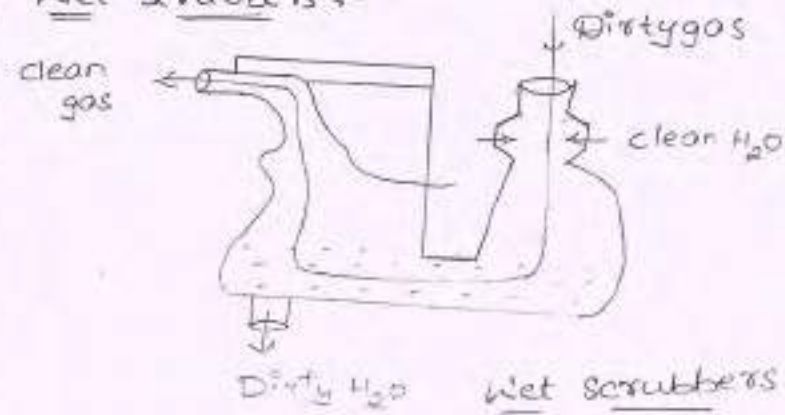
→ The clean gas will be sent out and dust particles will be deposited and discharged out.

→ This device is efficient for the removal of smaller particles and is preferred in various types of industries.

→ The bag house filters are expensive & cannot be operated for moist gases. Corrosive gases may damage the materials of the bags.
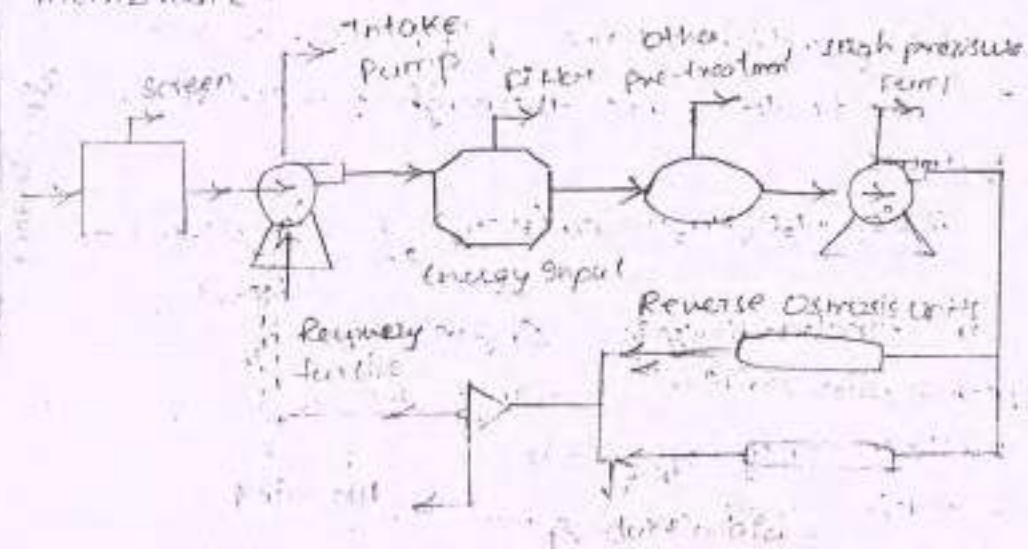
→ Various types of materials depending on the nature of the flue gases to be cleaned & used for making filter bags.

Wet scrubbers:-

Dirty H₂O   Wet scrubbers

Reverse Osmosis:-

* Reverse osmosis is commonly used for purifying the water. In this method, water is forced across a semi-permeable membrane by mechanical forces. The semi permeable membrane allows only water to pass through it but not ions like Ca^{+2}, Mg^{+2}, Na^+ & larger molecules such as glucose, urea, bacteria & also proteins like salts, sugar having molecular wt. greater than 150-250 daltons are not allowed to pass through semipermeable membrane.

Reverse Osmosis Unit

* In this initially, brackish water is treated with help of screens & filters.

* After treating brackish water, then pre-treatment is carried.

* At high pressure of 10000 KN/m² fresh water is forced to pass through these membranes. Then this pressure is called osmotic pressure.

* Reverse osmosis chamber contains spirally wounded membrane in form of double sandwich.

* Some of water get permeated into membrane and obtained as fresh water and remaining water is passed through turbine. Turbine acts as power recovery device for the brine. (remaining water)

Distillation:-

* Distillation is expensive and energy intensive and can probably be justified only in cases where valuable product recovery is feasible.

* In this technique has only limited application in the treatment of dilute aqueous hazardous waste.

* This mean hazardous waste will be present in water, that can be purified by heating. After heating the waste will be purified.

and water will be converted into steam or gas. Again steam or gas will be sent to coolants so that it will again converted to water.

* This process is called distillation.

Various control methods of the hazardous waste

* Hazardous waste plays a vital role in environment and as will as public health issues arise in many countries all over the world. There are four control methods, generally adopted for hazardous waste. They are,

* Waste minimization
* Recycling of industrial waste
* Treatment of the waste
* Collection, transport and disposal of waste in environment.

* To control hazardous waste, the above four methods are very important.

Waste Minimization

* The first step in control of hazardous waste management is to minimize the quantity of waste. There are three major waste reduction steps. They are.

* Process modification
* waste concentration
* waste segregation

Process Modification

* In these, the industrial process can be modified in such a way that it produces less raw materials and hazardous waste is also minimum.

* For example, in zinc electroplating, chloride compounds are replaced instead of sulphate salt to reduce the cyanide problem

waste concentration

* The waste concentration can be reduced by the methods/techniques such as evaporation, precipitation or decantation techniques

* Incineration is best method to decrease the quantity of waste to be handled but in these the cost of operation exceeds the net gain values
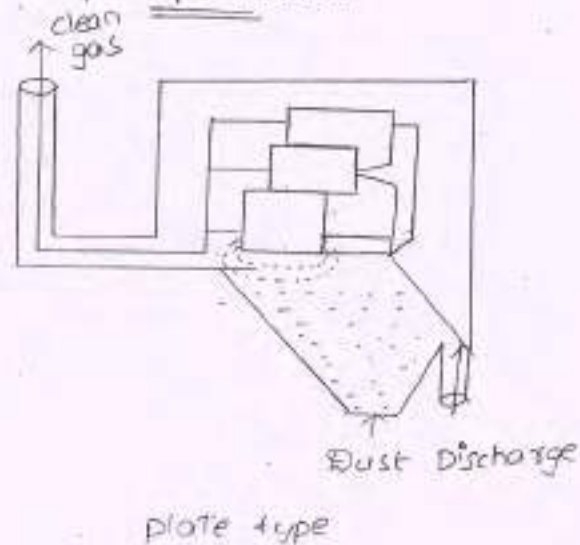
waste segregation

* In waste segregation, the separation of hazardous

→ Dirty gases are passed through water in the chamber (or) water is sprayed on the gas particles are made wet and are removed from the gas stream which leaves from the top of the scrubbers.

→ Wet scrubbers are very efficient for removing the particulates. The scrubbers are very useful for removal of toxic and acid gases also.

Electrostatic precipitators :-

Dust Discharge

plate type

* The electrostatic precipitators may be plate type (or) pipe type.

→ Vertical wires are placed between the parallel plates (or) wire is hang along the axis of the cylinder.

→ High -ve voltage is applied to the wire.

→ The dust particles while passing from the lower end get -vely charged and are collected on the +vely charged surface while the clean gas leaves from the top.

→ The deposited dust particles fall down in the dust collector (or) can be removed by scrapping.

→ Electrostatic precipitators utilise electric energy and can efficiently remove even submicroscopic particles.

Methods for controlling Gaseous Emissions :-

* The control methods for the gaseous pollutants are

→ Absorption
→ Adsorption
→ Condensation
→ Incineration

Absorption:-

→ The removal of one or more selected components from the gas mixture by Absorption is an important method to control the gaseous emission

→ Absorption is the process in which the gaseous pollutant is dissolved in the liquid.

→ As gas stream passes through the liquid, the liquid absorbs the gas, in same way as sugar absorbed in glass of water when stirred.

→ It has the removal efficiency of about 95%

→ This process involves passing of effluent gases through absorbers which contains liquid absorbent.

→ This liquid absorbent may remove one or more harmful pollutants among various gases such as SO_2, H_2S, HF, NO_x etc.,

→ Such absorbent when react with the water are known as Reactive absorbents.

The various equipments used for removing these gaseous pollutants are:-

* Packed tower
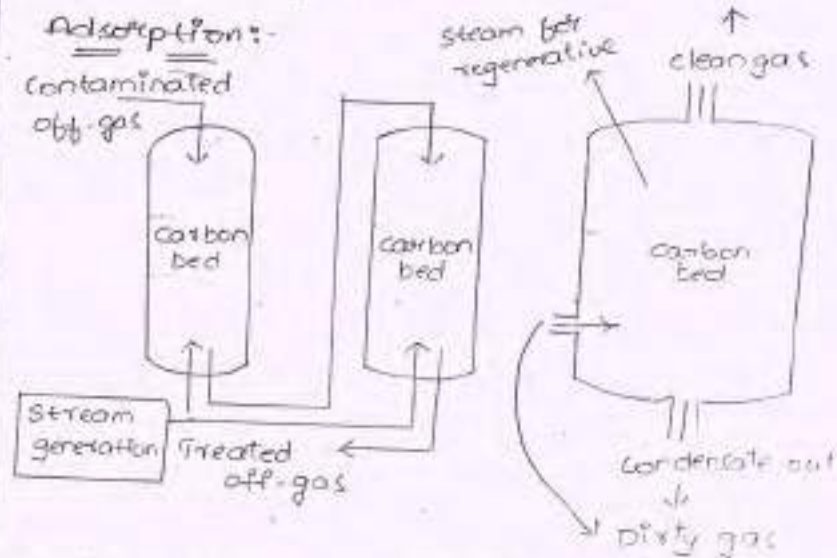* Plate tower
* Spray tower
* Bubble-cap plate tower
* Liquid jet scrubbers

The efficiency depends upon following factors

* Contact time between gas & Absorber
* Area of contact surface
* Rate of reaction

Adsorption:-

* The process of adsorption involves passing of gas through adsorbers which contains porous solid particles.

→ Here the gas will be adsorbed by the solid

particles.

→ The most commonly used adsorbers are Activated carbon, Activated Alumina, Activated bauxite, silica gel & lithium chloride.

→ This process of adsorption involves :-

* contact b/w pollutant & adsorbent.

* Seperation of adsorbed pollutant

* Final disposal of gases from adsorption chambers.

→ The efficiency depends upon the following factors :-

→ Both physical & chemical characteristics of adsorbent.

→ Nature of gas passed through adsorbent.

→ Concentration of gas to be adsorbed.

* this process is highly efficient for organic compounds.

* The Adsorber bed installation is very costly.

Condensation :-

* Condensation is the process of converting gas or vapours to liquid.

* Any gas can be reduced to liquid by lowering its temperature or increasing its pressure.

* Condensers used for pollution control are

→ Contact condensers.

→ Surface condensers.

Contact condensers :-

* In contact condensers, gas comes in contact with cold liquid.

Surface condensers :-

* In surface condensers, the gas comes in contact with cooled surface in which cooled liquid or gas is circulated.

* Removal efficiency of these condensers range from 50% to more than 95%

Incineration :-

Incineration also known as combustion, is used to control the emission of organic compounds from industries.

* Equipments used to control waste gases by combustion are

→ Direct combustion

→ Thermal Incineration

→ Catalytic Incineration

Direct combustion:-

* It is a device in which all the combustible waste gases react at burner.

* It is also called as flaring.

* It has removal efficiency of about 98%.

Thermal Incineration:-

* In this all the combustible waste gases passes through burner and then react with or sent into residence chamber.

* And then clean gas will be sent out.

* It has removal efficiency of about 99%

Catalytic Incineration:-

* It is similar to thermal Incinerators.

* The main difference is after passing through burner it passes through catalyst bed.

* Catalyst promotes oxidation at lower temperature, there by reduce fuel cost.

* Here, the destruction efficiency is greater than 95%

AIR quality Standard:-

→ The legal limits placed on air pollutant levels during a particular period in the ambient air is known as Air quality standards such as the allowable pollutant level is characterized or present in atmosphere and the amount of exposure allowed to the population is defined.

→ Air quality standard does not depend on air quality criteria but it depends on broad range of Social, Economic, political and Technical considerations.

→ The various of Air quality standards are Ambient air quality standard, Odour standard, Visibility standard, Soiling Index, Quasi-Emission standards etc.,

Indian Ambient Air quality standard acciding to World Health Organisation:-

* Air pollution control Board has divided the land into three catigories.

→ Sensitive areas

→ Industrial areas

→ Residential, rural and other areas.

* Sensitive areas involves the areas which shows clean environment. These are hillstations, tourist resorts, monuments, national parks etc.,

* Industrial areas involves the areas which includes residential, official, schools and other building.

* Industrial areas involves the area which covers large amount of industrial work.

Pollutant	Time weighted average	concentration in Ambient Air (mg/cum)		
		Sensitive areas	Industrial Areas	Residential, rural & other areas.
Sulphur dioxide	Annual	15	80	60
	24 hours	30	120	80
Nitrogen dioxide	Annual	15	80	60
	24 hours	30	120	80

Suspended particulate matter	Annual	70	360	140
	24 hours	100	500	200
Lead	Annual	0.50	1.0	0.75
carbon mono oxide	24 hours	0.75	1.5	1.00

Emission Standards:-

* Certain group of emitters (gaseous pollutants) are given some permitted emission levels. These permitted emission levels are known as Emission standards.

* These Emission standards are given by

→ Mobile Emitters.

→ Stationary Emitters.

Mobile Emitters:-

* The sources for mobile emitters of gaseous pollutants are motor vehicles, trains, ships and Aircraft.

Emission Source	Emission factor
Motor vehicles	
Gasoline-powered engines	1.36 Kg/m³ of gasoline burned
Diesel-Powered engines	12.5 Kg/m³ of fuel burned

Stationary Emittors:-

* the sources of stationary emittors are stationary sites, stacks, chimneys.

Emission source	Emission Factor
Natural Gas combustion Power plants	240 mg/m³ of gas burned
Industrial plants	290 mg/m³ of gas burned
Domestic and Commercial furnaces	310 mg/m³ of gas burned
Sulphuric acid manufact -uring	3 kg/ton of acid Produced.

AIR Pollution control methods:-

* Several methods are available to prevent the emission of pollutant including.

→ Selecting process inputs that do not contain the pollutant.

→ Operating the process to minimize generation of the pollutant.

→ Replacing the process with one that doesnot generate the pollutant.

→ Removing the pollutant from process effluent

1) Raw Material Substitution:-

→ Removing some pollutants involves simply substituting materials which perform equally well in the process but which discharge less harmful products to the environment.

→ This method of air pollution reduction usually produces satisfactory control at low cost.

eg:-

→ Typical examples are the substitution of high sulphur coal in power plants.

→ Changing a fuel like natural gas (or) nuclear energy can eliminate all sulfur emission as well as those of particulates and heavy metals.

→ Coal gasification reduces sulfur emission.

→ Substituting gasoline with ethanol or oxygenated fuels in internal combustion engines. This reduces O_3 pollution in urban areas.

2) Process Modification:

* chemical & petroleum industries have changed dramatically by implementing automated

operations, computerized process control and completely, enclosed system that minimize the release of materials to the outdoor environment.

3) Gas clearing cleaning:-

→ Industry controls air pollution with equipment that removes contaminants at the end of the manufacturing process. Many such devices exist.

4) By dilution of emission.

5) Minimize the activities which cause pollution like transportation & Energy production.

6) Using low sulphur coal in Industries.

7) Removing sulphur from coal by washing & with the help of bacteria.

8) Using mass transport system, bicycles etc.,

9) Planting more trees.

10) Using biological filters & bio-scrubbers.

Introduction:-

*Noise is an unwanted sound energy and is also considered as a pollutant when it exceeds certain limits.

→ In scientific terms, noise or sound is a pressure oscillation in the air or water or any medium which conducts and travels away from the source.

→ If noise can be controlled at the source, there is saving in energy.

→ Noise pollution increases with increase in population, urbanization, Industrialization.

→ Noise has a short residence and decay time and hence does not remain in the environment for long periods like air or water pollutants. /

→ Noise annoys, distracts, disturbs and with sufficient exposure causes physiological effects leading to deafness.

→ Annoyance results from interference with concentrated work, rest or sleep with

individual communication of speech.

Sources of Noise pollution:-

* Road traffic
* Air traffic
* Railways
* Industry equipments
* Construction activities.
* Sporting and crowd activities.

Effects of Noise pollution:-

* The effect of noise pollution is classified into following two types

→ Auditory effects.

→ Non-Auditory effects.

Auditory effects:-

→ The auditory effects of noise pollution includes deafness.

→ When subjected to 45 decibles of noise, the average person cannot sleep.

→ At 120 decibels the ear registers pain, but hearing damage begins at a much lower level at 85 decibels.

→ Deafness is temporary or permanent loss of hearing.

→ Temporary loss of deafness occurs in between the frequency range of 4000 to 6000 Hz after a period of time such hearing loss disappears.

→ Permanent loss of deafness occurs when noise is at a level of 100 dB.

Non-Auditory Effect:-

→ The different non-auditory effects of the noise pollution are annoyance, loss of working efficiency, psychological changes.

→ Increase in noise pollution develop poor concentration and decreases efficiency of working.

→ Apart from the hearing loss noise pollution can cause lack of sleep, irritability, Hearburn, Indigestion, ulcers, high blood pressures and possibility heart diseases.

Measurement of Noise pollution:-

characteristics of Sound:-

* Sound is a form of energy giving the sensation of hearing and is produced by vibrations as longitudinal mechanical waves in materials including solids, liquids and gases and it is transmitted by oscillation of atoms and molecules of matter.

* In physical terms, sound may be defined as fluctuations in pressure of waves in a fluid medium.

Sound power and Intensity:-

* The travelling waves of sound power transmit energy in the direction of propagation of the wave and the rate at which this work is done is defined as the sound power (w).

* Sound Intensity (I) is defined as the time-weighted (average power with passage of time) of sound power per unit area normal to the direction of the propagation of sound wave.

* Intensity and sound power are related by the equation

$$I = \frac{W}{A}$$

where A = unit area $\perp$ to direction of wave motion.

I = Intensity

W = Sound power.

*The relation between sound power related to sound pressure is given by equation

$$I = \frac{(P_{rms})^2}{P \times c}$$

P_{rms} = root mean square sound pressure

I = Intensity W/m^2

P = density of medium kg/m^3

c = speed of sound in medium m/s.

* Both density of air, speed of sound are function of temperature.

* Given the temperature and pressure, the density of air may be determined.

Noise control methods:-

* There are five general methods of controlling noise

- → Enclosing the noise source
- → Enclosing noise receiver
- → Putting a barrier between noise source and noise receiver.
- → controlling the noise generator
- → Regulating control by pressure

Enclosures:-

* To enclose a noisy machine in a seperate room or box than to quieten it by altering its design, operation or parts is one of the practical & economical options.

* The walls of enclosure should be massive and airtight to contain the sound.

* Absorbent lining on the internal surface of the enclosure will reduce the reverberant buildup of noise within it.

Screen the Receiver:-

* In most of the Industries, noise is an essential part of their machines used and If a worker is continuously exposed to sound hazards for long time, he may suffer from annoyance, loss of efficiency and damage to hearing.

* It has become necessary that employees be given ear muffs or ear plugs to protect them from such loses.

Ear protection :-

* Molded and pliable earplugs and helmets are commercially available as hearing protectors.

* Such devices may provide noise reduction ranging from 15 to 35 dB.

Control of Noise during the Transmission:

Devices can be used in transmission path to block or reduce the flow of sound energy before it reaches your ears. This can be done in several ways.

Seperation:-

* The use of absorptive capacity of the atmosphere can be made use of as well as divergence, as a simple economical method to reduce noise level.

* Air absorbs high frequency sound efficiently than low frequency sound.

* We can double distance from point source, we will succeed in lowering sound pressure level by 6dB.

Absorbing Material:-

* Noise like light will bounce from one hard surface to another. This is called reverberation.

* Sound absorbs materials are rated either by Sabin absorption coefficients of 125, 500, 1000, 2000 & 4000 Hz.

Acoustical lining:-

* Noise transmitted through ducts, pipes or electrical channels can be reduced effectively by lining inside surface with perforate metal sheets.

* Silencers if used as absorbing material it should cover with perforated metal sheet.

Barriers & Panels:-

* Placing screens, barriers in noise path can be an effective way of reducing noise transmission.

* We can provide barriers in large size depending upon whether noise is high frequency or low frequency.

Transmission Loss:-

* The ratio of sound energy incident on one surface of panel to energy radiated from opposite surface is called sound transmission loss.

Reducing noise in Residential Areas:-

→ The noise pollution in residential buildings are reduced by locating kitchen, bathrooms and halls on the noisy side of the structure.

→ The minimum sensitive rooms in the residential buildings should be placed next to the sources of noise like lifts, lift motors and pump rooms etc.

→ In the construction of older residential buildings noise pollution can reduce by planing rooms which shares a common wall.

Sources of noise from Industry & controlling measures:-

→ Basic noise levels for Industrial zone should not exceed 55dB at night and 65dB during the day time.

→ Noise contributes to development of cardiovascular problem like heart diseases and high blood pressure.

→ Workers exposed to high noise level have more circulatory problems, cardiac disturbances, nervous-sensity and motor impairment and even

more social conflicts at home and at work.

→ Noise pollution is minimized in the Industries by constructing sound proof walls.

→ Proper maintainance of noise producing machines reduces noise pollution in Industries.

→ Noise producing Industries should not be located near the residential areas.