ENVIRONMENTAL SCIENCE AND ENGINEERING (BCE101)

Requirment of Human Being :-

- Energy
- Water Quantitative & Qualitative
- Food

Environment Engineer's Work –

→ To provide good quality of water

(Water treatment plant)

→ Waste water treatment

→ Control on Air Pollution to Maintain the Air Quality

(Temperature, Pressure, Wind, Moisture)

→ Control on Water Pollution

→ Solid Waste Management

(Storage, Separation & Transportation)

1-Book Environment Engineering By Gerard Kiely
2-H.S. Peavy
D.R. Rowe
G. Technobanog Lous
3- Water Supply Engineering by S.K. Garg

1.1 Ecological Perspective:-

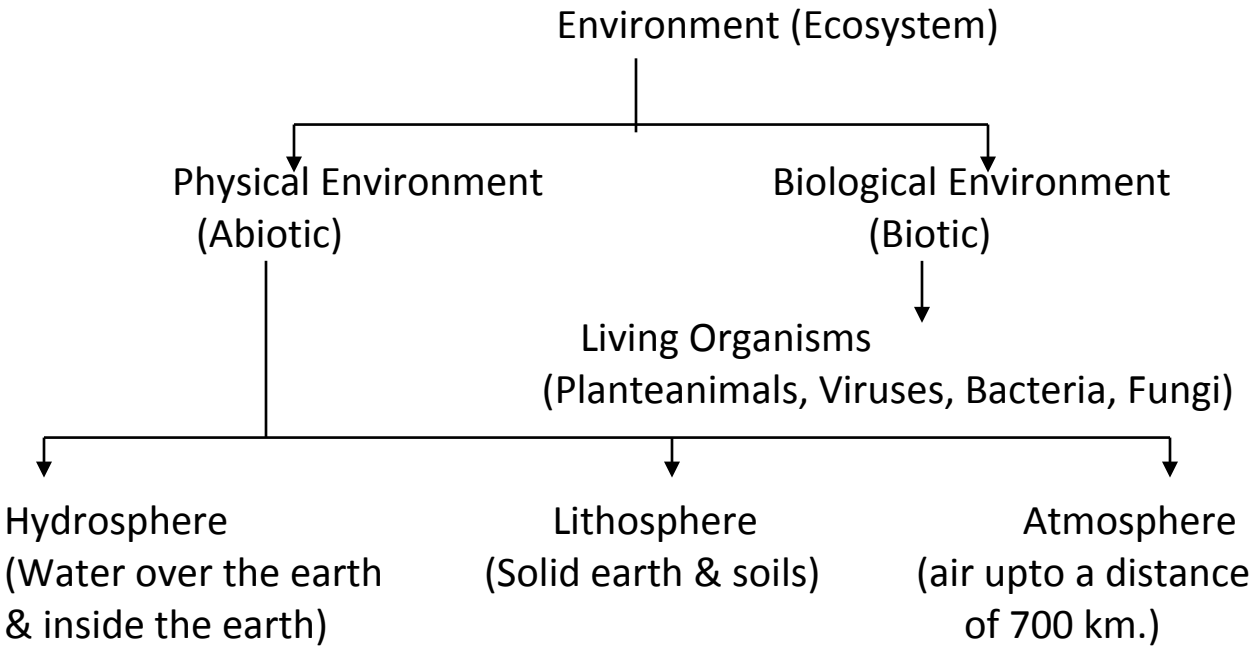
→ The environmental engineer is interested to use the varies physical resources such as natural energy (waves, wind, minerals, hydroelectric) and water for domestic & living purpose.

→ Therefore, It has to understand the functioning with the living system and its interaction with the environment.

→ Environment – (or Ecosystem)

It consists of four major element such as

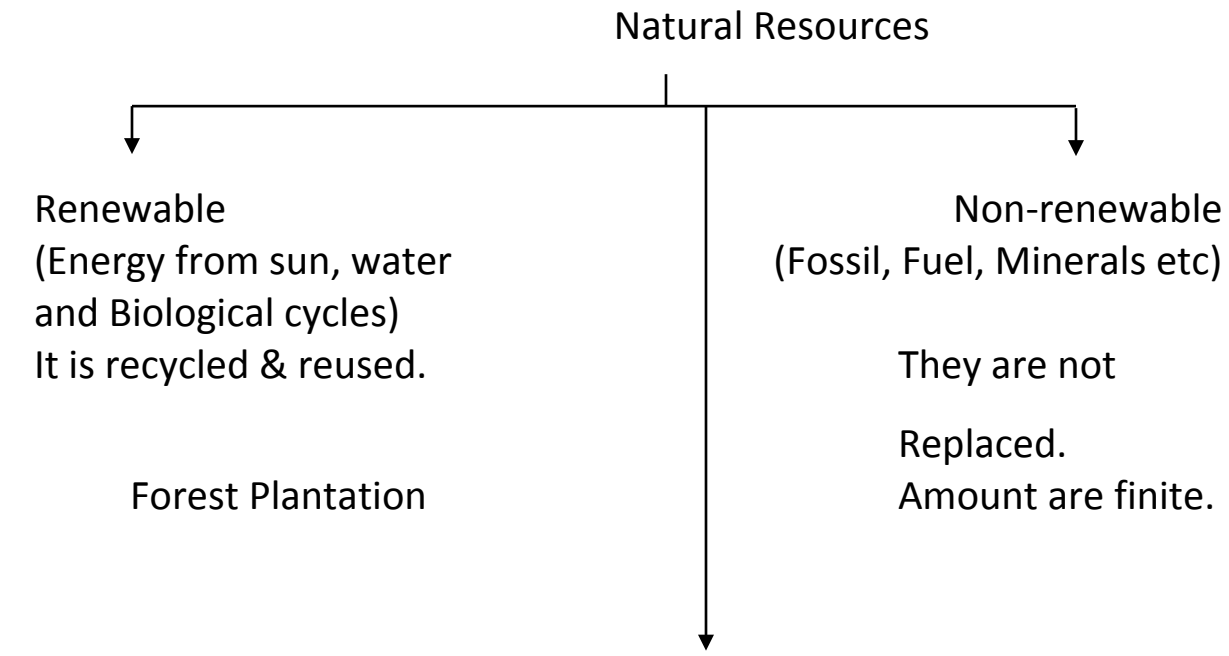
(i) Land
(ii) Water
(iii) Air and
(iv) Living Organism (Plant & Animals)



→ Living organisms are dependent on each other & depends on the physical environment.

Ex.
- Plans grow on land & in water.
- Herbivorous animals use the plant as food.
- Carnivorous animals eat herbivorous animals.

1.2 Value of Environment :- or Resources



1.3 Environment Auditing:- Listing of all the resources of an area

Different types of developmental work go ahead in an area depends on the economical consideration.

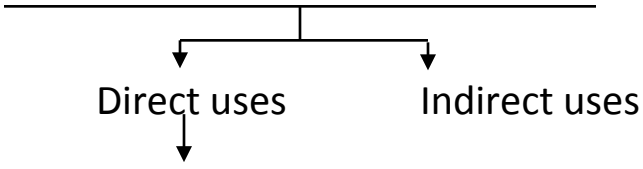
It has to restrict the economy (money) cased.

Therefore, We have to audit or make a list of all the resources of the area. (Environmental auditing)

Auditing

No's of species (Living organisms) exist

Uses of the living environment.



Food, Industrial &
Commercial products,
tourism, medicines etc.

1.3.1 Direct use

Food – Plants or domesticated animal products

Industrial & commercial products: - Mineral, fossil, fuel, wools, cotton, jute, rubber etc.

Medicines-

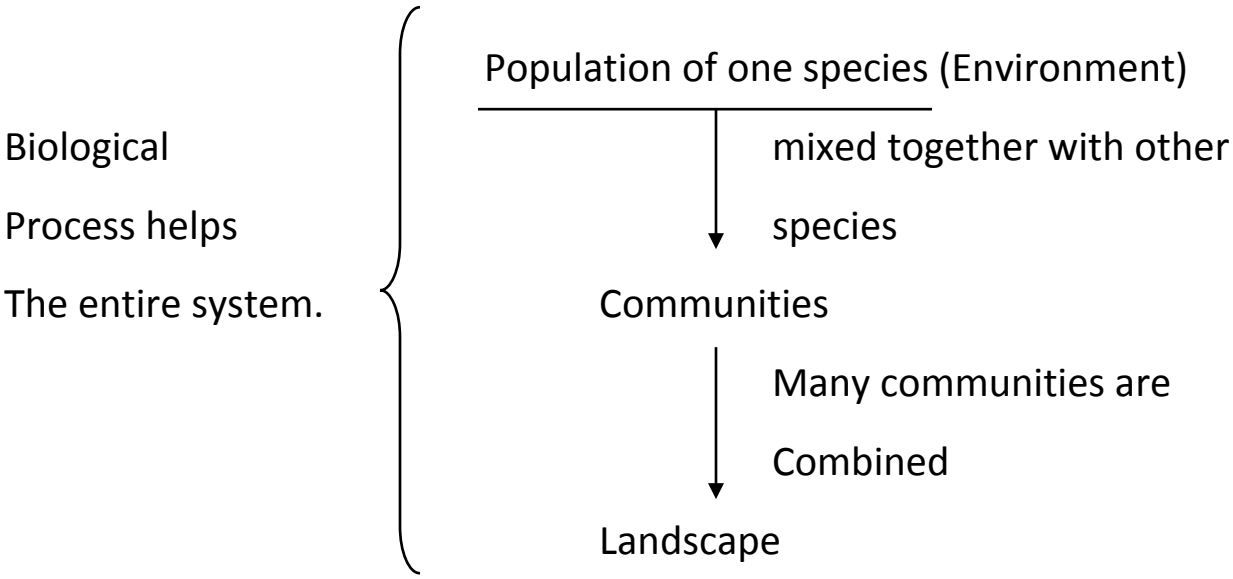
1.3.2

Indirect Uses

- ✓ Biodiversity is the biological processes themselves that provide the value.

  It is regarding about indirect uses of environments.

- ✓ Environment consists of populations of species-with air, water, land.



- ✓ Therefore, biodiversity is a basic resource which acts as a human – life support system.
- ✓

Biodiversity

Sail formation, waste degradation, air & water purification, solar energy absorption, and maintenance of hydrological cycles etc.

Loss of Biological resources

Reduction of one common species.

1- Depletion of a once – common species
2-Local or global species extinction
3- Ecosystem disruption

Environment may be changed due to habitat destruction extinction means the potential of the particular species to be appeared in future.

1.4.0 Cost-Benefit Analysis:-

→ After environmental auditing, we have to calculate the cost for the developmental work.

→ Some of the environmental process or services are excluded from the calculation such as:

- ✓ Pollution absorption by biotic system
- ✓ Ecosystem stability
- ✓ Recreational value

✓ Historic importance.

→ Environmental parameters to be incorporated is based on World Conservation Strategy (IUCN, 1980).

1.5 Biotic Component:-

→ Everything in the global environment is in one component can affect many others over space & time.

→ Six major levels of ecological organization are recognized

✓ Individual (Physiological functions)

Single species

✓ Population (Birth, death, population growth rate)
✓ Community (Interaction between different species)

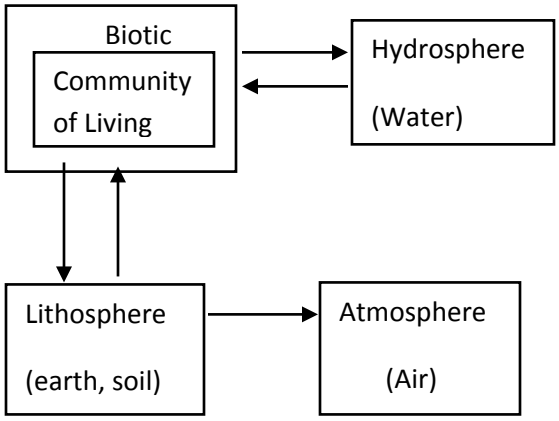
↓

Both plants & animals

✓ Ecosystem (Interaction between living & (biotic)

Non-living component.)

A biotic



A Biotic

Fig-1 Interactions between various component

→ Energy flow occurs at the level of Ecosystem

- ✓ Biomes:- Environmental conditions are similar in different parts of country.
  Ex climate.
  Vegetation type.
- ✓ Biosphere:- Part of earth & atmosphere in which life exists.
  (Lithosphere, Atmosphere & Hydrosphere comes into contact in Biosphere)

1.6 Ecosystem Process:-

→ Ecosystem is the interaction between biotic & a biotic components (Fig-1).

→ Process occurred at ecological level are

- ✓ Energy flow
- ✓ Nutrient cycling

1.6.1 Energy Flow

→ Interactions between living organism & environment is because of requirement of food which supply energy to survive

→ It also helps to construct body tissues & games for reproduction of species. (child/next generation)

Energy sources –

converted

→1- Light energy ⟶ chemical energy
(stored in living organism)

↓

Solar energy

Sun (ultimate sources of energy)

→2- Energy in Environment

Autotrophic — Heterotrophic (Energy originated From primary production in other ecosystem.)

two – ways:

1- Production of energy by green plants in presence of light through the process of photosynthesis.

2- By sulphur – oxidizing bacteria in deep sea ecosystems.

Photosynthesis

→ Gran plants create their own food through a series of chemical reactions.

$12H_2O + 6CO_2 + \text{Light} \xrightarrow{\text{Chlorophyll+enzymes}}$

Water 709 kcal

$C_6H_{12}O6 + 6O_2 + 6H_2O$

Carbohydrate (to air)
(Glucose)
+ Sugar molecules.

→ Photosynthesis is carried out in day light in leaves & in stems of some green plants.

→ Plant require inorganic substance like

- ✓ Nitrogen
- ✓ Phosphorus
- ✓ Magnesium
- ✓ Iron

} obtained from soils.

→ Glucose + chemical reaction Fat, Proteins & Nucleic acid
(used to form body tissues)

Primary production – Production of organic matter by plants.

→ When any organism requires energy, the reverse reaction to photosynthesis occurs, celled respiration.

$C_6H_{12}O_6 + 6O_2$ metabolic enzymes →

CO_2+H_2O+Energy for work

Primary Production

→The production of organic matter by plants is called primary production.

→The rate of photosynthesis & primary production plays a vital role in the ecosystem. Therefore, It has to consider the amount of primary production in different ecosystem.

Net primary production = Gross Primary production – respiration

→Gross primary production is the total amount of chemical energy stored by plants per unit area per unit time.

→The primary production is affected by the environmental factors,

- ✓ Water
- ✓ Light
- ✓ Soil nutrients
- ✓ Temperature.

Food chain

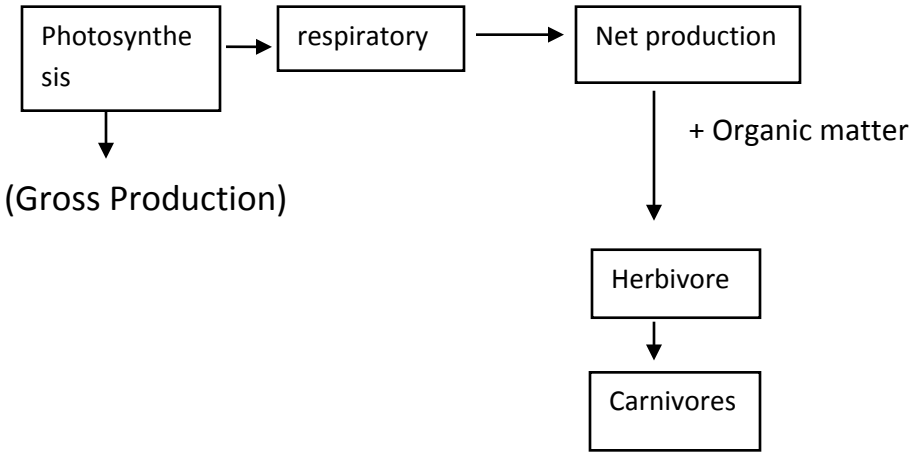
→ Autotrophs (plants) can create their own food, but heterotrophs cannot.

(animals)

→Heterotroph directly or indirectly depends on primary source of food.

Primary production ⟶ plant

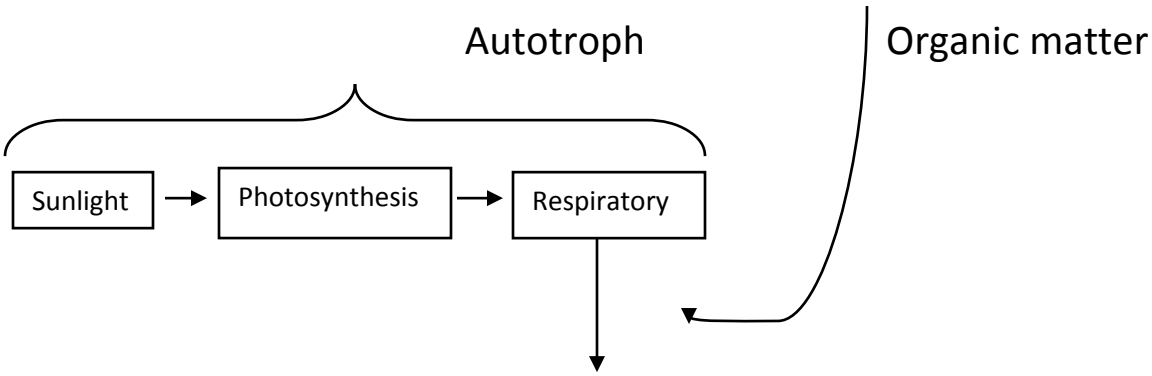
(chemical energy)



1.6.2 Decomposition & Nutrient Recycling

→ Nutrient :- amino acids, minerals, sugar, salts & vitamins.

→ With flow of energy through food chain, nutrients are passed from one – organism to another during feeding.



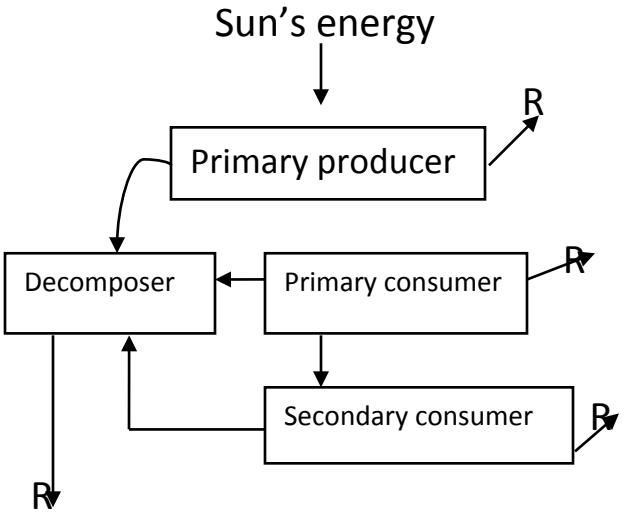
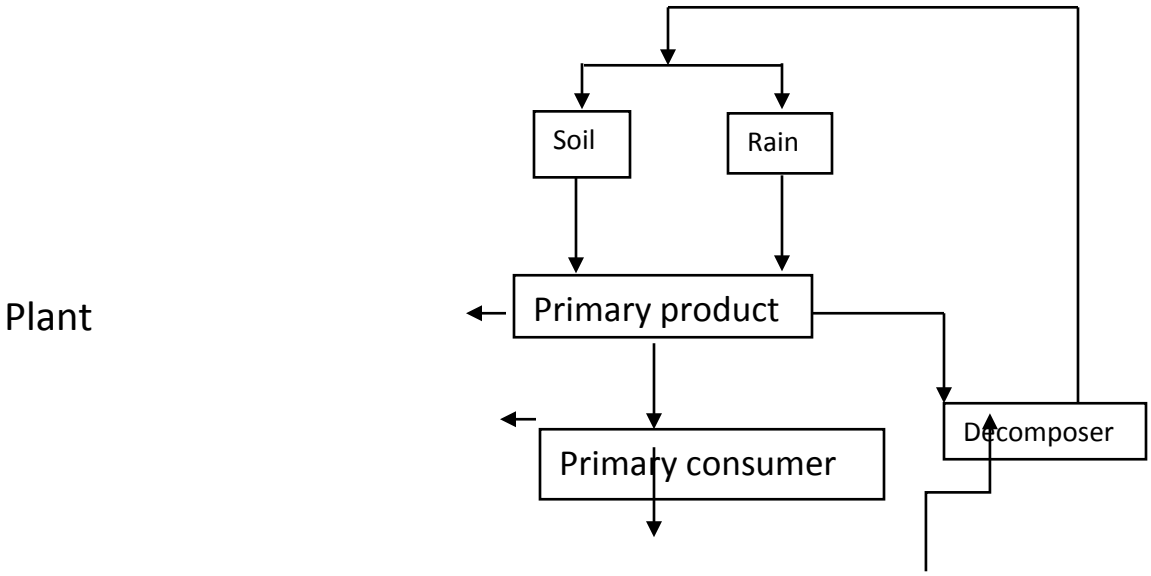


Fig-4 Energy flow



Herbivores

Carnivores ← Secondary consumer

Fig 5 Nutrient cycle

1.7 Environmental Gradients & Tolerance :-

→ Each species is not found in every type of habitat (area) → Uneven distribution of organism

→ This is because of several factors

- ✓ Light
- ✓ Temperature
- ✓ PH
- ✓ Food
- ✓ Water
- ✓ Shelter
- ✓ Predictor & competitor's interaction.

→The above environmental factors varies from the equator towards north or south; is called environmental gradient.

→The plot between environmental & population size is called tolerance carve.

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A = Species absent

B = Low population

Range of optimum:- Area of greatest numbers.

Concept of Hydrology

2.1 **Hydrological cycle:-**

Water evaporates from oceans & other water bodies, and from land surfaces. The evaporated water rises into the atmosphere until the water vapour condness. Then the condensed water vapour condenses. Then the condensed water vapour in the form of rain & sometimes as snow.

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Fig – 2.1 Hydrological cycle.

2.2 Water balance:-

→The accounting of water for a particular catchment, region or earth is called water balance.

→Therefore, water balance is the account of hydrological cycle. Moreover, the input to the hydrological cycle is due to precipitation.

→the equa for water balance is

$$P = R + E \quad \triangle S \quad \triangle G$$

P = Precipitation, mm/day

R = Stream runoff

E = Evaporation

$\triangle S$ = Change in soil moisture status

$\triangle G$ = Change in ground water status

2.3 Energy budget/balance:-

The source of energy is solar radiation. Earth surface absorbs solar radiation.

The energy absorbed by earth surface is reflected back to the atmosphere & some enters into the earth. Furthermore, the earth also re-radiates some solar-energy.

→The energy balance is the accounting of distribution of the solar radiation through atmosphere and onto the earth's surface of land and ocean. Moreover, It accounts for the outgoing terrestrial radiation from the earth's surface.

→It includes evaporation flux, sensible heat flux & net radiant emission by surface.

→Our interest is find the net-incoming radiation at the earth's surface.

Quantity of radiant energy remaining at the earth's surface.

$$R_n = LE + H + G + PS + M$$

Where R_n = Specific flux of net incoming radiation, W/m^2

L = Latent heat of vaporization (Doesn't increase the temperature)

E = specific flux energy of sensible heat into the atmosphere ($watt/m^2$)

G = Specific flux of heat into or out of the soil

PS = Photosynthetic energy fixed by plants

M = Energy for respiration & heat storage in a crop canopy.

→ Neglecting PS & M, we have

$$R_n = LE + H + G$$

2.4 Precipitation:-

→ Preciption is in the form of rain, hail or snow. We are interested to determine the amount, rate & duration of precipitation.

→ The magnitude of rainfall is determined by three ways such as:

- ✓ Precipitation gauges
- ✓ Rader
- ✓ Satellite remote sensing

} Instruments

→ Precipitation can be calculated from different method analysis results i.e.

- ✓ Area precipitation
- ✓ Dept – area – duration analysis
- ✓ Precipitation – duration – frequency analysis.
- ✓ Intensity – duration – frequency analysis.
- ✓ Extreme values of precipitation.

Area precipitation

→ $P_1 = \ .dx$

Mean area Precipitation

Total accumulation of precipitation at all point 'x_1' in the catchment

→ Time averaged main area precipitation

$$P_2 = \frac{}{M}$$

$I = 1_A A$

Total precipitation at ‘x’ & time ‘ti’.

Where

A = Catchment area

T = Total storm period.

Depth – area – duration analysis.

→ Generally, as the area of a catchment increases, the depth of precipitation decreases. Therefore, an area reduction factor (ARF) Is used for precipitation in this analysis.

Precipitation frequency

→ Rainfall record over a period of time with a specific magnitude. (No. of times)

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Fig 2.3 Depth – area – duration curve

Intensity – duration – frequency analysis (IDF)

→ From IDF curves, as rainfall intensity increases, its duration decreases i.e.

Runoff (Q) = CIA

- C → Catchment area (km^2)
- I → Locality constants.

2.5 Infiltration:-

→It is the movement of water from soil surface into the soil. About 76% of precipitation infiltrate into the soil.

1- The properties of soil which responsible for infiltration are

- ✓ Bulk density
- ✓ Particle density
- ✓ Porosity
- ✓ Volumetric water content
- ✓ Degree of Saturation.

Bulk density of a soil is:

(b)

$\int b = (\ )$

M_d = Dry mass of a soil volume

V_t = total volume (Undried cond^n)

Particle density ($\int_m$) =

V_d = dry volume

Typical value for most sails is 2.65 kg/m

Porosity (Ø) = = 1 -

V_a = volume of air

V_a = volume of water

V_s= volume of solids

Volumetric Water content (θ) = =

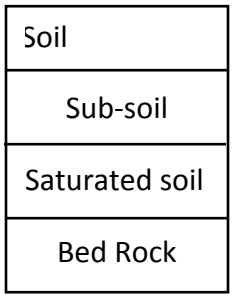
Degree of saturation (S) is the proportion of water containing pores. of the measure of wetness.

S = =

→ Soil horizons and Hydraulic conductivity Hydraulic conductivity is the rate of movement of water into the soil.

Dead leaves →vegetation (Grass, tree)

Unsaturated zone



A - Horizon

B - Horizon

C – Horizon

3-Soil – moisture content or soil – water content

→Each soil has a maximum moisture magnitude/capacity, when it is saturated.

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Aeration zone: - is the upper zone where the pores are occupied by air.

Capacity zone: - is the zone through which water will rise through the soil pores by capillary action.

Ground water zone :- exists below the water table.

2.6 Evaporation & Evapotranspiration:-

→Evaporation is the process by which water is returned to the atmosphere, from liquid & soild into the vapour state.

→Evaporation into the atmosphere occurs through the transpiration of leaf parts of plants. The process is termed as evapotranspiration.

→30% of rainfall flows in the form of runoff. Therefore, on the ocean surface of earth there is more evaporation than precipitation.

→The type of evaporation/evaporatranspiration are:

- ✓Evaporation from lake surface (E_o)
- ✓Actual evapotranspiation, (ET)
- ✓Potential evapotranspiration (PE)

Evaporation from lake or open water body surface.

It includes the evaporation & transpiration from a land surface, & vegetated. It will vary depending on the present soil – moisture status.

→Potential evapotranspioration is determined for catchment research projects, when radiation & heat balance are considered.

→Factors causing evaporation from any surface are: 1- Latent heat of vapourization & (2) wind

2.7 Ground water:-

→Ground water is defined as the water below the water table.

The level of soil below which the pore space is 100% occupied by water.

2.7.1 Aquifers

Water table

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→An aquifier is a water – bearing rock formation that contains sufficient amounts of water to be exploited & brought to the surface by wells.

→Aquifers are two types in nature:

- ✓ Contined
- ✓ Uncontined

→Upper aquifer is unconfined & it has a natural water-table-line.

Free to move up & down

→The impermeable strata between unconfined aquifer & confined aquifer is called aquaclude.

→When wells are drilled into confined aquifer water will rise & attain its own 'water table line'.

2.8 Ground water chemistry:-

(quality/properties)

→The quality of ground water depends on the subsoil & rocks that it passes through.

Ex:- hardness, iron, manganese

1- Hardness

When Ground water pass through the limestone, it dissolves/mixed with calcium & magnesium compounds; which cause hardness. (200 to 400 mg/litr)

2- Iron & Manganese

→Excess amount of irons don't cause health problem (Taste problems)

→It will give a metabolic taste to water.

→Manganese cause a black discoloration of water.

→Iron & manganese are good indicator of water pollution.

3- Hydrogen sulphide (gas)

→H_2S is present in water from rocks like limestones or shales.

→It create the same problem as in the case of Iron.

4- Sulphate (800 mg/lit)

5- Sodium Chloride (Nacl)

→This problem occurs in areas where rocks are highly permeable.

2.9 Ground water contamination:- internet Make impure which will become harmful

→The indicators of the source of contamination are E.coli, nitrate, ammonia, potassium, chloride, iron, manganese etc.

1- Bacteria & Viruses.

→ E. coli is the parameter which indicates the presence of bacteria & viruses.

→Presence of bacteria in ground water causes typhoid fever, diarrhea, gastrointestinal infection etc.

→E coli Bacteria – From septic tank effluent, landfill sites & birds etc.

2- Nitrate

→Nitrate rich water cause mathaemoglobinaemia (blue baby syndrome) to young children.

3- Ammonia

→It has a low mobility in soil & sub soil.

4- Potassium (K)

→It is immobile in soil.

5- Chloride (Cl)

6- Iron & Manganese

2.10 Ground water pollution control/prevention:-

Water Quality Requirement :-

3.1 In – Stream Standards:-

→ Water quality requirements & water quality standard.

→ Many factors affect stream-

Quality ex:-Waste water discharge & human activities

3.2 Portable – water standard:-

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3.3 Waste-water effluent standards:-

Decomposition: - The process of decay caused by bacteria & fungi

-:Water Quality in Rivers :-

4.1 Organic content parameter DO & BOD in streams

→DO – Dissolved oxygen.

→Water bodies support a variety of fish and animals. They require oxygen & a stream/river must have a minimum dissolved oxygen about 2mg/litr.

→ When an organic waste is discharged to a stream, the organic content undergoes biochemical reaction. This reaction a consumes oxygen from water bodies.

Organic content + O2 micro-organism

New+Co_2+H_2O+stable products

Biomass

→ The amount of dissolved oxygen used up from water sample by micro-organism for the bio-chemical reaction is termed as BOD.

→ The relation between DO & BOD is developed by Stricter & Phelps model.

Follow / other book

$= K_1 L_t - K_2 DO$

$= \boxed{K_1 L0\ e^{-K_1 t} - K_2 DO}$

Lo = Oxygen demand at t= to

Lt = C BOD (mg/Litr)

= Carbonaceous bio-chemical oxygen demand

amount of oxygen Remaining at time 't'

Constants
- K1 – dexygenation rate ($1/_{day}$)
- K2 – reaction rate (day^{-1})

(L_o-L_t) – Oxygen consumed.

The dissolved oxygen (Do) decreases in a river/stream by degradation of BOD. The variation of DO in the stream/river w.r.t BOD was derived by Streeter & helps model.

Seeded water –

Deoxygenation –

Chemical Oxygen Demand (COD) :- A quick chemical test to measure the oxygen equivalent of the organic matter content of waste water that is susceptible to oxidation by a strong chemical. (organic & inorganic) (both)

Or COD is a measure of the total organic carbon with the exception of certain aromatic such as benzene which are not completely oxidized in the reaction.

Organic materials such as cellulose, phenols etc. resist biodegration along with pesticides & these materials are oxidized in the COD test.

* The organic content of a waste water stream is determined by following tests.

BOD5 :- conc. Of 'Do' at day '5' –

COD

TOC:- Total organic carbon,

at day – 'O' at day – '5'

$BOD5 = P(DO_i - Dos)$

Dilation factor.

4.2 Transformation process in water bodies:-

The constituents in water – bodies are DO, BOD, temperature, salinity, nitrogen (as organic, ammonia & nitrate etc), phosphurs etc, (considering water quality).

→ The transformation process in water bodies are:

1- Influent 'clean' flows
2- Influent 'waste' flows
3- Biological oxidation of carbonaceous & nitrogenous organic matter.
4- Reparation of surface layer
5- Reduction of BOD (sedimentation)
6- Photosynthesis
7- Respiration
8- Oxygen diffusion
9- COD (Chemical oxygen demand)

4**.3 Transport process in waterbodies:-**

→ Transport processes are

1- Advection (heat, humidity & solidity in ocean)

2-Difusion :- the process by which models intermingle as a result of their

ex- two gases-mix K.E. of random motion.

See S.K. Garg & other Book For destination

with costively of the process

3-Buoyancy :- is an upward for exerted by

fluid that opposes the weigh of immersed object.

4.4 Stricter – Phelps Oxygen Sag Model :-

→ The rate of decomposition of organic matter is proportional to the amount of organic matter available ; i.e.

$$= - K_1 L_t \qquad - 1$$

L_t = BOD remaining at time 't',

K_1 = deoxygeneation rate coefficient per day

Integrate equation 1- between (L_o) to (L_t)

We have $L_t = L_o e^{-k_1 t}$ ---------- 2

Where Lo = Ultimate BOD

= (BOD at tint – "O") = initial BOD

→ 'BOD' consumed at time 't'.

$(BOD)t = L_o - L_t$

$= L_o - L_o e^{-K1t}$

$= L_o (1-e-K^{1t})$

Solve

Ex – 7.1

7.3

→ When biodegradable waste was discharged to a stream/river, It consumed oxygen.

The deticieny of dissolves oxygen is maintained through reaertion from atmosphere.

Hence, eqa 1- can be written as

$= K_1 L_t – K_2(DO)$

$= \underbrace{K_1 L_o e^{-k_1 t} – K_2(DO)}$

---------- 3

Where DO = DO deficit (oxygen deficit).

= maintain DO – actual DO

L_t – Oxygen remaining at time 't'

K_1 – deoxygenation rate per day

K_2 = reparation rate per day

→ Integrating eq, we have

$DO(t) = \underbrace{(e^{-k1t}-e^{-k2t}) + DO\ e^{-k2t}}$

---------- 4

Where L_o= Oxygen demand at t = to

Do_o = dissolved oxygen deficit at t = to

Dissolved oxygen saturation deficit at any time't'.

→ Equ 4 is the streeter – Phelps oxygen sag formula.

→ Solve ex 7.5

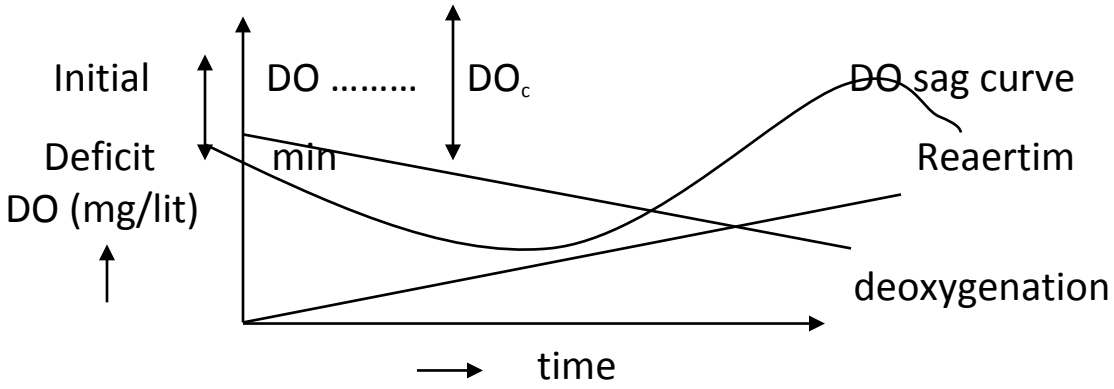


Fig Dissolved oxygen sag curve

Do$_c$ → Minimum or maximum dissolved oxygen deficit

→ differentiate equ 4 w.r.t to 't' & set it equal to zero. We have

$$- \quad t_c = \ . L_n \qquad 1- \left\{ \quad \left[\qquad \right] \right\}$$

time of occurrence of minimum DO or maximum dissolved oxygen deficit DO$_c$

$$= \quad DO(t) - \left[DO_o \qquad \right]$$

Dissolved oxygen saturation deficit at time.

Chemical Pretreatment: - to remove undesirable properties of water (excess colour of algae) Photosynthetic alghe. (doubt)

Unit (NTU:- Nephelonetric turbidity unit)

Prechorinctin for (Low turbidity water)

Activaled carbon

(Turbidity: Should be <0.3 NTU) suspended and muddy particles.

(It is invisible to naked eye)

Prechorination:-

1- Low turbiding purpose
2- Pathogenic will & reduced colour

(Bacterial using disease)

Chlorine is injected into water for a period in the setting tank. (5mg/Line →Dose)

3- It is used to reduce ammonia in water supply

Activated carbon is used for

- ✓ Removal of photosynthetic algae
- ✓ Improvement of colour & odour.
- ✓ Removal of selective organic compound.

→ Activated carbon used as powdered activated carbon (PAC)

→ PAC is deposited in sand filters & water causing the undesirable taste & odower are disposited to PAC during infiltration. Adsorbed gas/molecnle gatherdeposit-on a surface.

Aeration:-

→ Iron & manganese causes metabolic taste to water

→ Oxygen O2 content is increased to reches the bad taste (metabolic taste).

→ Addition of oxygen helps to separate the substance (Iron & manganses) in a solid form.

Adsorption :- the accumulation of gas, liquid or solutes on the surface a solid/media.

Sedimentation tank (setting tank) :- (I) dissolve participle

=

Flow velocity in horizontal degree.

V_s= setting velocity

⇒ V = () x Vs

→ There are three zones in the tank.

1- Inlet zone
2- Outlet zone
3- Sludge zone

Sedimentation of flocculent particles :- (II)

→ Setting of flocculent particles.

→ Coagulation is the first process of adding the coagulant which changes the particles electric charges & then helps to aggregate in mass.

→ Flocculation is the second process of getting the 'coagulated mix' to form larger flocs.

→ Before flocculation colloidal particles are suspended in a liquid & not dissolved in the solution.

→ In coagulation process coagulants with opposite charge to the suspended solid are welded to neutralize the ve charges on dispersed non-settable solids.

Ex 7.1 A sample of waste water is diluted with a seeded water & is placed in an airtight bottle. Measure the concentration of DO at ignition day.

1- Pretratment Process:-

- ✓ Screening :- Coarse serreemy (25_{mm}-100_{mm} size)
- ✓ Storage
- ✓ Aeration (To release excess H_2S, CO_2, O_2)
- ✓ Chemical pretreatment. (Pre-chlorination & Activated carbon)

Screeny-

→ Coarse sereeny (25mm dia bar & 100mm spelling is used to prevent large floating material)

→ Fix Sereen (6mm dia opening)
→ Micro screen (20-40 Nm opening)

} A obstruction is made with woven steel Wire net.

Storage tank – are used for settlement of suspended particles

(initial setting tank)

✓ This may be useful to reelnce pathogens by exposure to daylight.
✓ Time of storage is about 12hr.

Aration :- is supply of oxygen from atmosphere to water to change quality of water.

(PH, hardness, manganese, H_2S etc in a specified anomy)

→ Aeration is used to release (H_2S), which

→ release CO_2, which is corrosive in nature.

-:Water Treatment:-

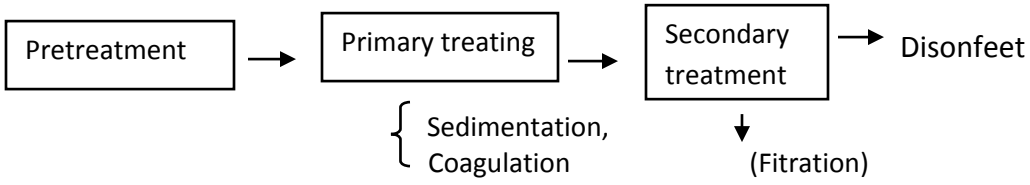
5.1 Water sources & their quality:-

→ Different water sources are

- ✓ River's
- ✓ Lake & reservoir
- ✓ Ground water

→ Quality of water are:

PH, Acidity, Alkalinity, Colour, Turbidity, DO, etc.



5.2 Water Treatment Operation:-

5.2.1 Sedimentation –

→ The separation of suspended solids from the liquid by gravity setting process is referred as sedimentation.

→ Sedimentation of discrete particles (I)

Separate part

- ✓ Setting tanks are circular/rectangular. Particles settle out individuality. The design of such tanks are based on setting velocity. A particle will accelerate vertically downwards until the drag force (F_D) equals to impelling force (F_1). Then particle will settle at a constant velocity.

Stokes velocity (V_2)

$F1 = (\gamma_s - \gamma_w) V$

γ_s = density of solid particles ($P_s g$)

γ_w = density of solid water ($P_w g$)

V = Volume of particles

$FD = C_D A_s P_w$

CD = Drag colficient

= 0.4 for spheres.

As = sphere section area.

Vs = stoke's velocity

V = kinematic viscosity =

→ Sedimentation of flocculent particles (I)

Flocculent :- cloudlike aggregations.

Flocculent particles are those particles that are chemically (Add the chemical) assisted to come together & produce large particle & settle.

5.2.2 (Coagulation :-

→ If the particle size range is better 10-7 to 10-1 mm, then because of small size, the suspended matter has negligible velocity. To settle these particles, we use chemical coagulant to collect the particles in mass.

Coagulant :- Aluminum sulphate, ferrous, sulphete & ferric chloride.

→ When alum is added to raw water, the reaction is:

$\underbrace{Al_2(SO_4)_3.\ 14H_2O}$ + $3C_a(HCO_3)_2$

Alum calcium- bicarbonate

PH = Potential of Hydrogen (Varies from 'O' to '14')

= It is the logarithm of the reciprocal of hydrogen – ion concentration in gram atoms per litre.

= < 7 (acidity)

>7 (Basic/alkalining)

Floc → Gelatinous particle (A small jelly aggregate mass formed.)

→ It there is insufficient alkalinity in water, lime is added to water. The reaction is:

$Al2\ (SO_4).14H_2O + 3Ca(OH)_2 \longrightarrow$

Calcium
Hydroxide

→ Then, the small particles attached with the flock-mass & produce a larger – mass & it settles down.

→ Solve.

Ex. 11.3, 11.4

5.2.3 Filtration is the process of passing water through a porous medium., (ex- sand layer).

→ Usually sand filtration has been used for the porous medium.

→ Classification of titration system are

- ✓ Gravity or pressure
- ✓ Rapid/slow filtration
- ✓ Depth/cake filtration

→ Gravity filtration is the process where water goes through filter only by gravity force.

→ Pressure filters – Water is forced through the filter media under pressure.

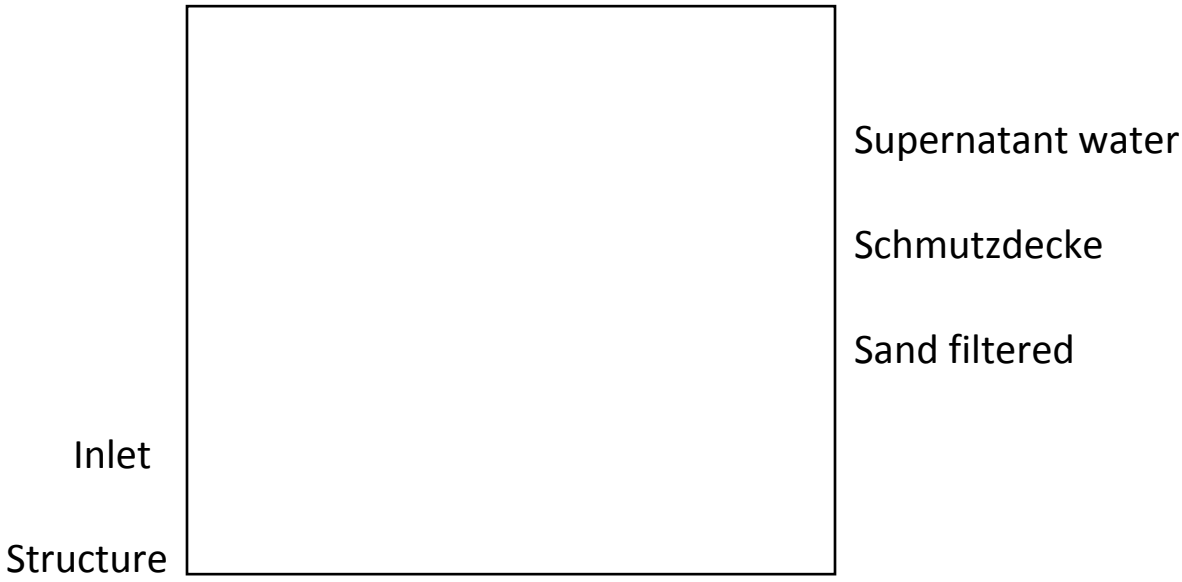
→ Slow/rapid filtration

Slow:- filtration rate (0.1 to 0.2 m/h meter)

Rapid:- filtration rate (5 to 20 m/h)

→ Depth filtration is where most of the depth of the filter medium is active in the filtration process.

Slow Sand Filteration



System of under drain.

→ Water enter through inlet and flower on the schmutzdecke layer.

↓

This layer is composed of living & dead micro-organisms.

→ The Supernatant water provides sufficient water to drive through the sand filter.

→ The filter bd is of fine sand (0.15 to 0.3mm)

In show sand filtration –

→ Total coliform bacteria removal (99.4%)

→ Removal of particle with sizes 1 to 60 r & m

→ Colour removal is not significant.

→ Turbiding (water with fine clay/mueldy particles) removal is 25%

→ Slow sand filtration filters about 2-6 month.

Rapid Gravity Filters

Influent Water head coarse material Fine sand

++++++++++++++++++++++++++++++++

→ Rapid gravity filters are used to filter chemically coagulated water & produce high quality drinking water.

→ Biological activity occur in the breakdown of ammonia to nitrate as in nitrification:

$NH4 + 2O2 \longrightarrow NO_3^- +$

Ammonia Bacteria Nitrate

$$2H^{+} + H_2O$$

→ Filtration operates with a head of about 1m of water.

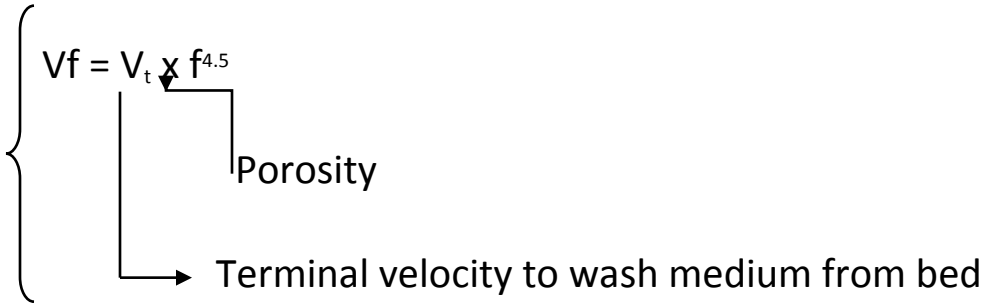
→ Maintain same filtration rate

→ Water or compressed air from bottom is sent up through backwash.

(Backwash Velocity > 0.3 melm/min)

→ Water is recycled through the plant.

→ Filtration operated on hydraulic principle.



5.2.4 Disinfection –

→ It refers to operations used to kill pathogenic microorganisms.

→ Sterilization is the process for the complete destruction of all living matter.

→ Disinfection doesn't indicate to sterilization process.

→ 90% of bacteria & viruses are removed by coagulation & filtration process.

→ The rate of destruction of micro organism is alchemical reaction (chick's law)

$= -kN_t$

solu^n ⇒ $N_t = N_o\ ^{e-kt}$

N_t = N_o of organisms at time 't'

N_o =

K = rate constant of the type of disinfectant, micro-organism

→ The common used disinfectants are

- ✓ Chlorine dioxide.
- ✓ Chloramines
- ✓ Ozone
- ✓ Ultra-videt radiaction
- ✓ Chlorination.

1→ Make a short note on the use & effect of different disinfectants.

2→ Draw the layout of the water-treatment plant.

* Brak-point Chlorination :- Due to the reactivity of chlorine, it reacts with a multitude of inorganic & organic materials present in water. In some cases, it is used as an oxidizing agent first to break down these materials. This type of chlorination is called ‘breakpoint’ chlorination. Due to high dosages of chlorine normally employed, this procedure is no longer performed in Germany, but still widely used in US & other countries.

-: Waste-Water Treatment:-

6.1 Waste water characteristics:-

→ Waste – waters are either from the sourc of industrial waste-water or from municipal waste water.

→ Components of waste water are suspended solids, biodegradable organics, and pathogens.

→ Suspended solids are organic in nature. Ex Body waste, food waste, paper & biological cells.

→ Soluble organics in wastewater are of proteins, carbohydrates and lipids.

→ Water-borne pathogens may be found in domestic wastewater.

6.2 waste water treatment processes:-

→ Domestic & industrial waste-water contain mainly organic waste.

→ So, the main treatment processes are used towards organic removal.

→ Process are:

- ✓ Pretreatment
- ✓ Primary treatment
- ✓ Secondary treatment
- ✓ Advanced treatment

6.3 Pretreatment:-

→ The floating debris destination product of building debris & grit, & oily dictionary scums are removed from waste-

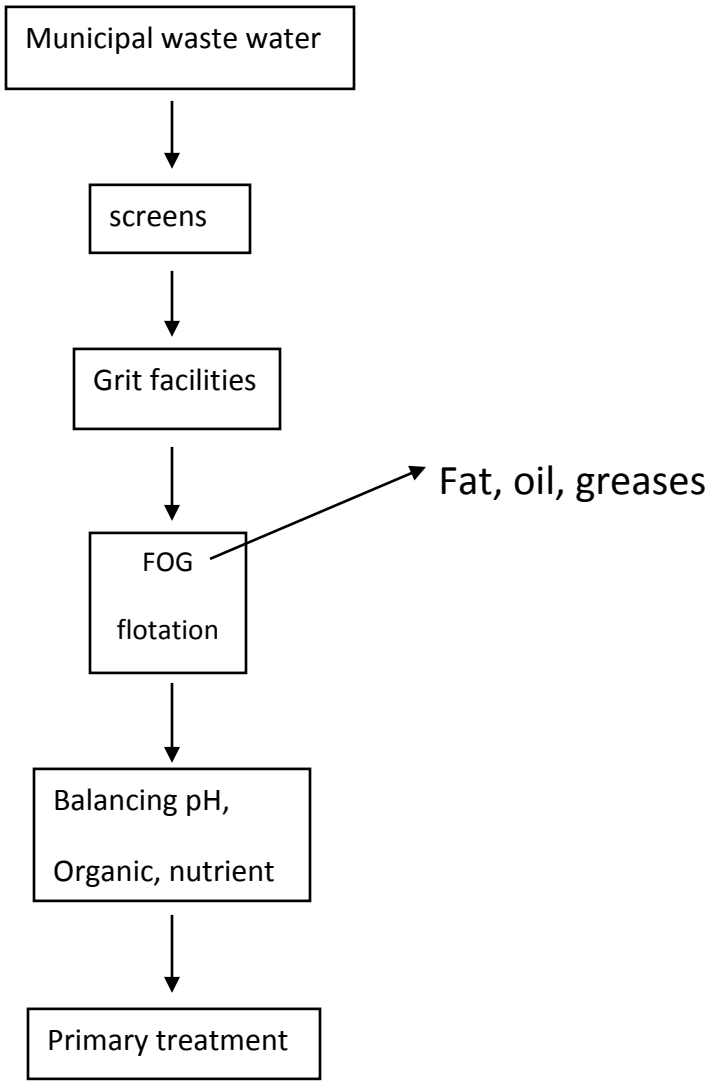
Vegetation prolent water, in the pretreatment process-

→ Sometimes, the pH of waste-water is in such a range that water is either too acidic or too alkaline for optimum biological degradation. It need pH correction. The PH correction is achieved by the addition of sulphuric acid (H_2SO_4) or lime.

6.3.1 Screening

→ The objective of screening is to remove large floating material & so protect down stream mechanical equipments.

- ✓ Corase screen with opening
  (remove large material > 6mm)
- ✓ Fine screens with opening (1.6mm to 6mm material)
  (For activated sludge)
- ✓ Very fine screen opening (0.2 to 1.5mm)
- ✓ Micro screen with opening (0.001 to 0.3mm)



6.3.2 Grit channels –

→ Grit is inorganic sand or gravel particlesd of size about 1mm.

They are washed into sewer collection-systems from road & pavement.

→ Grit does'nt exist in industrial process of waste-water.

→ Grit can abrade mechanical equipments.

→ Grit collection devices are:

- ✓ Helical flow aerated grit chamber
- ✓ Horizontal flow grit channel.

Air enters one side of channel near the bottom & this cause a spiral motion I^{ar} to the main flow direction.

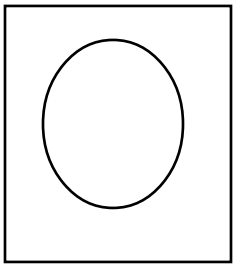


Fig Helical flow aerated grit channel

→ Heavier grit particles settle while the lighter organic matter remain in suspension.

→ Aerated grit chambers are more efficient than horizontal flow type.

→ The design of grit channel is based on setting of particle

F1 = FD

$\Rightarrow (\gamma_s - \gamma_w)\, V = C_D\, A_s\, f_w$

$\Rightarrow$ $V_s = (S_p\text{-}1)d^2$

Sp = Specific gravity of participles

CD = drag coefficient

=

V = Kinematic viscosity

=

Ex 12.4 Design a horizontal flow grit chamber to remove grit of size greater than 0.2 mm if the through flow is 10,000 M^3/d. the specific gravity of the particles is 1.9.

Solution

Setting velocity (V_s) = . ($_p$ - $_w$)d^2

= x (1.9-1) x $(0.2)^2$

= 19.6 mm/see

= 0.02 m/see

Assume Depth (D) = 1.5xwidth (w)

C/s area = A = WxD

$= 1.5w^2$

A = = $= 0.39m^2$

6.3.3 Flotation :- Flotation is used when suspended particles have low setting velocity that they are not settleable in sedimentation tank.

→ Sedimentation, in water-treatment chapter, is the gravity unit process of separating solids from liquids.

→ Flotation is the buoyancy unit process of separating 'solid' particles from a liquid phase.

→ In municipal work, solids are fats, oils & grases (FOG).

→ The process of separation involves introducing air bubbles at the bottom of a flotation tank.

++++++++++++++++++++++++++++++++++++

Fig: Dissolved Air Flotation

→ Air bubble attaches with particulate (composed of dist unit particles) dictionary) matter & the combined buoyancy helps the particle to rise to the surface. Then, it is removed by skimming. Dictionary.

- ✓ Gravity flotation
- ✓ Vacuum
- ✓ Electro flotation
- ✓ Dissolved air flotation (DAF)
- ✓ Air flotation

Make a short note

6.3.4 Equalization :- Uniformity/balancing

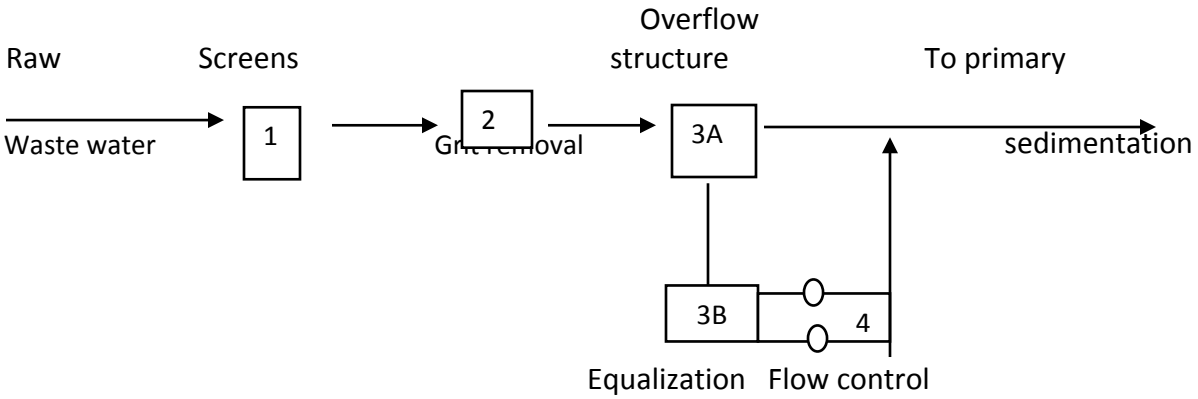
→ Waste-water treatment plant receives the waste matter (effluent), uniformity/balancing is required for that.

→ This includes

- ✓ Flow equalization
- ✓ Organic equalization
- ✓ Nutrient balancing
- ✓ PH balancing (PH correction)

(6.5 to 8.5)

→ Flow equalization/balancing operates & balanced 7 days.



6.4 Primary Treatment :-

→ Primary treatment is often called clarification, sedimentation or setting.

→ The waste water is allowed to settle for a period (about 2hr) in a setting tank and produce clarified liquid effluent in one stream.

→ Therefore, the objective is to produce a suitable for the secondary biological treatment & achieve a solid separation.

→ Hence, the primary treatment include

- ✓ Reduction in suspended solids
- ✓ Reduction in BOD
- ✓ Reduction in the amount of waste-activated-sludge (WAS)
- ✓ Removal of floating material.
- ✓ Partial equalization of flow rates & organic load.

++++++++++++++++

Fig C/s of a typical circular primary clarification tank.

- ✓ Waste-water enters through the diffusion-box. The tank is sized so, that the retention time is about 2hr. in this period, the suspended particles settle down as sludge & lift upwards through a central hopper.

6.4.1 Chemically enhanced primary sedimentation

→ The addition of coagulant chemicals

(iron, salts, lime, alum)

Before sedimentation makes the suspended fine particles into settleable flocs.

→ This process increases. The efficiency of suspended solid & BOD removal rates.

++

Surface overflow rate $m^3/d/m_2$) →

→ As the surface overflow rate increases, the removal efficiency decreases.

→ The mechanism of chemically enhanced primary sedimentation is to use an aeration tank & add coagulants.

6.4.2 Sludge quantities from primary setting:-

→ The amount of sludge produced during primary setting will depend on the total suspended solids & the efficiency of solid – removal.

6.5 Secondary treatment :-

→ In primary setting process. About 60% of suspended solids & 30% of BOD removed from west-water.

→ The purpose of secondary treatment is to reduce the BOD which does not benefit as much as suspended solids from primary setting.

→ Secondary treatment process produces non-polluting and products from the

(H_2O, CO_2, Sludge)

Biodegradable organic matter:-

→ The <u>end product</u> shouldn't provide a food source for aerobic bacteria.

(Liquid efficient)

→ The removal of organic matter includes the processes:

- ✓ Bio-degradation
- ✓ Air-stripping :-removal of covering
- ✓ <u>Adsorption</u>

(accumulation of molecules particles to form a thin film on surface of water)

- ✓ Activated sludge system
- ✓ Attached growth system

6.5.1 Activated sludge system

→ The common activated sludge systems are

- ✓ Complete mix reactors.
- ✓ Plug flow reactors.
- ✓ Oxidation ditch
- ✓ Contact stabilization
- ✓ Sequencing batch reactors

<u>Complete Mix Reactors</u> -

→ It has uniform characteristics throughout the entire reactor.

→ Aeration is provided by surface aerators.

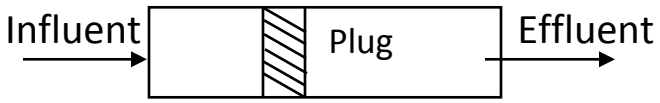
→ Dissolved oxygen (DO) levels are maintained throughout the process (2mg/L).

→ The returned activated sludge (RAS) from the clarifier is fed directly to the aeration basin

$$\text{Organic} + O_2 \xrightarrow{\text{bacteria}} CO_2 + NH_3 + \text{new biomass Olio d Process}$$

<u>Plug Flow Reactors</u> -

→ Plug flow means a 'plug' of substrate influent to an aeration basin is moved forward, without too much interaction with plug. This means satisfacting mixing occurs in the lateral direction, but none in longitudinal direction.



→ There is a high organic loading at the influent end of the basin.

→ There is an excess of food substrate at the influent end shortage of food substrate at the downstream end.

→ Through the aeration basin the food substrate. Decreases while micro-organism concentration increases.

Oxidation Ditch –

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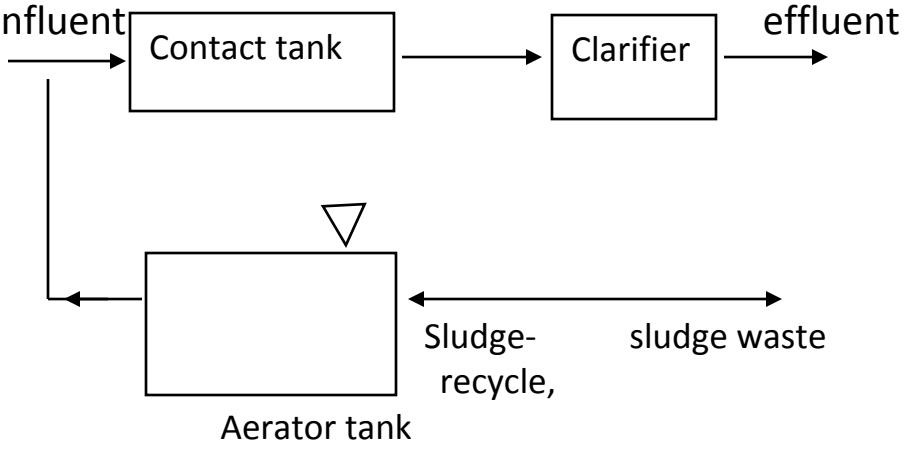
Fig Layout of an oxidation ditch system.

Contact Stabilization –

→ Aeration is carried out in two phases in two different tanks.



→ In contact tank the suspended organic matter is adsorbed by the microbial mass and the dissolved organic matter is absorbed by the biomass.

Sequencing batch reactors-

→ It is a complex mix activated sludge system without a secondary clarifier.

→ Five different sequences are followed within the single aeration basin.

→ Aeration & clarification are carried out in one tank.

++++++++++++++++++++

6.5.2 Attached growth systems (Write a short note)

→ It allow a microbial layer to grow on the surface of the media (stone, plastic)

→ It exposed to the atmosphere from where it draws its oxygen.

→ The microbial layer is sprayed with the waste-water.

→ In this process, the microbial layer convents the biodegradeable organic waste-water to biomass & by – products.

Microbial :- involving/caused by microbas

→ The microbial layer helps to reduce the BOD of effluents.

Percolating Filters – (Tricking Filters)

→ These are generally cylindrical or rectangular boxes of concrete or steel, containing stone media.

→ The media is angular rather than rounded (ex limestone is a better choice).

→ The floor of the tank has an underdrain system for collecting the underdrain system for collecting the treated waste water.

Q.1- Operation of tricking filter with diagram.

Factors affecting the efficiency of a tricking filter.

Granular media filtration:-

→ The media may natural/synthetic media & filter type is either of pressure or granting.

Adsorption :- (Activated carbon adsorption)

→ Organic compound may be removed by PAC or granulated activated urban (GAC).
Powered.

Chemical treatment :- In this process, the PH of effluent rises to 10.8 – 11.5, so that ammonia (waste water)

Nitrogen converted to ammonia gas & it released to atmosphere.

++++++++++++++

6.6 Secondary Clarification :-

→ The retention time in secondary clarificator is about 2 hrs same as in primary clarification. But it is provided with a deep setting tank.

(about 4.5m)

→ The aim is that no solids should 'escape' in the clarified effluent.

→ The solids are biological in nature.

(Biodegradable organic matter)

It may require oxygen demand from water body for the decomposition.

→ The important parameter for secondary clarification is

surface overflow rate (SOR) = → discharge

Area of C/S

6.7 Advanced Treatment Process – (Filtration)

- ✓ Granular media filtration :- It composed of one type of grains (Sand/stone ek)
- ✓ Adsorption
- ✓ Chemical treatment
- ✓ Air stripping → Removal of ammonia;
- ✓ Chlorination → when ammonia levels are high in effluent (waste water)

6.8 Wastewater Disinfection –

→ The objective of disinfection is to eliminate pathogenic organisms.

→ The disinfection producer for wastewater are ?

- ✓ Chlorine
- ✓ Ozone

- ✓ Chlorine dioxide
- ✓ Ultravidet radiation.

6.9 Layout of wastewater treatment plant –

++++++++++++++++++++

Fig layout of a typical wastewater system including filtration.

-: Anaerobic digestion :-

Process of decomposing the organic matter.

7.1 Introduction :-

→ It is used for the treatment of industrial, agricultural & municipal wastewater.

→ Anaerobic digestion is the use of micro-organisms for the stabilization of organic

(in the absence of oxygen)

matters to the form of methane and other inorganic products.

Organic matter + H_2O microbial CH_4 + CO_2 +

organism

New + NH_3+H_2S+Heat
Biomass

→ It occurs in the absence of oxygen.

→ Concentrated waste-water sledges may react with waste-water & hena, can produce bad-products or gases to the environment.

Therefore, It has to make the sludges as inert prior to disposal. The common No reaction with water or other elements. → No reaction with water or other elements.

Process is biological degradation. This process convert the solids to non-cellular end products. (dictionary) Not divided into cells

The process is commonly termed as sludge digestion.

2- Sludge digestion reduces the volume of thicken sludge as well as makes the remaining solid as inert.

- Aerobic digestion
- Anaerobic digestion

Aerobes: - Micro-organisms require oxygen for their survival, are called aerobes.

Anaerobes: - Other micro-organisms can't survive in the oxygen environment, are known as anaerobes.

3- Primary sludge contains large amounts of available organics that would induce a rapid growth of biomass if treated aerobically.

(dictionary) → total mass of living matter

4- Anaerobic decomposition produces less amount of biomass compared to aerobic processes.

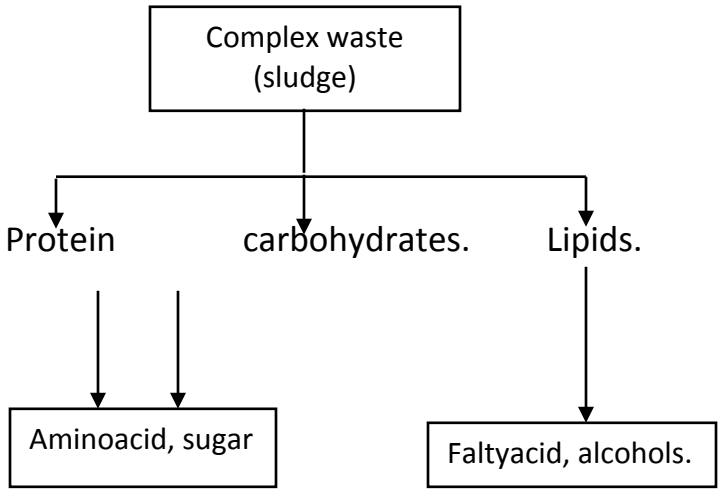
The aim of anaerobic digestion process is to convert as much as sludge to end products such as liquids & gases; while producing a little residual biomass.

7.2 Microbiology of Anaerobic digestion :-

→ Four different microbiological groups (bacteria) are recognized.

- ✓ Hydrolytic bacteria compound reacts with water & produce other compound.

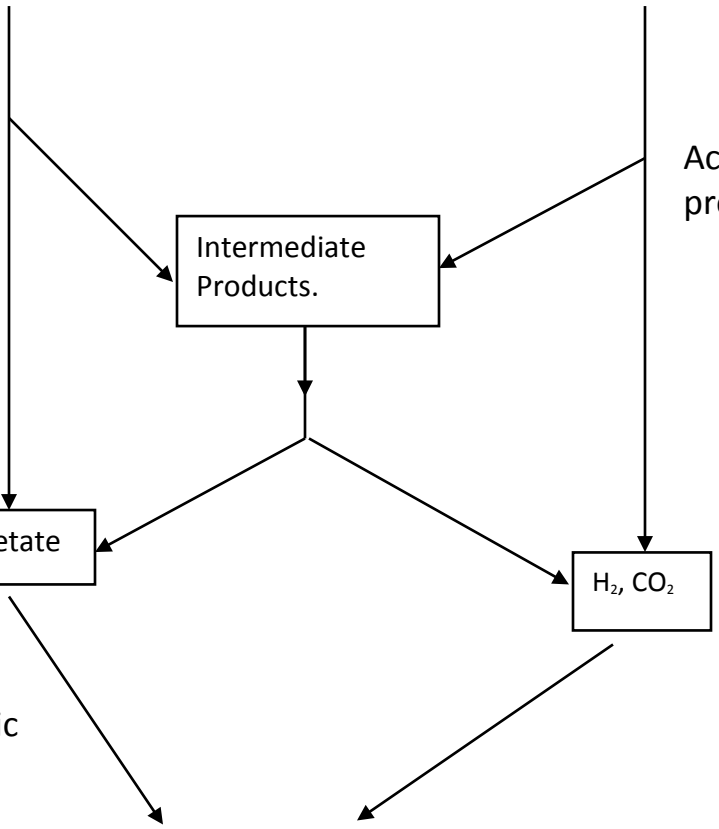
- ✓ Acidogenic bacteria formation of acid.
- ✓ Aceticlastic Methanogens.
- ✓ Hydrogenophilic Methanogens.



Hydrolysis Process

Hydrologic Bacteria.

Acidogenic bacteria



Acidogonesis process

Aceticlastic

Bacteria → Methane, CO_2 ← Hydrogenophilic Methanogens

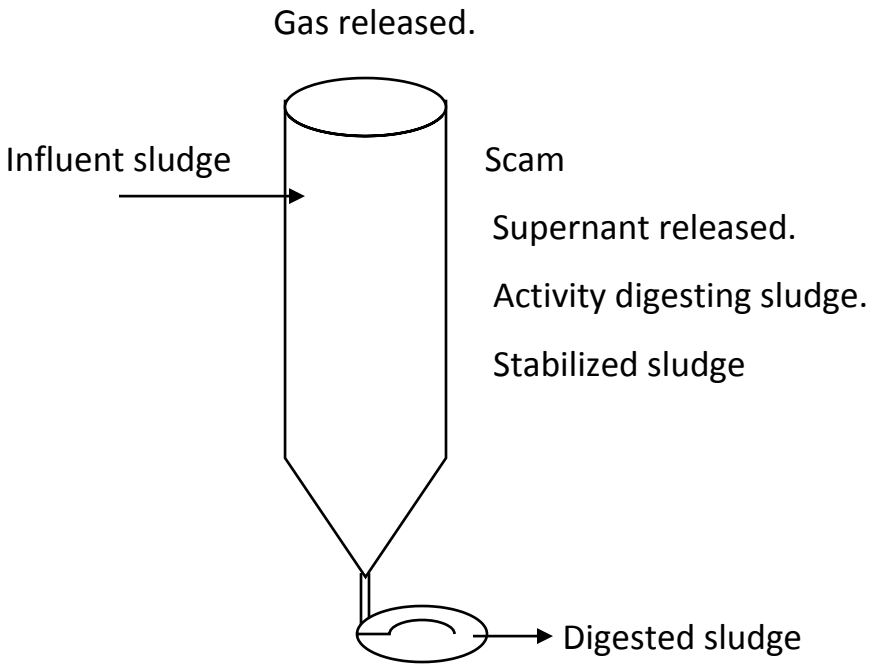
7.3 Methane Proclcetion:-

→ Anaerobic sludge digestion divides into two groups, the acid formers & methane formers.

→ The influent sludge enters the tank close to the top at the supernatant layer (purified liquid layer)

→ There is a activity digesting sludge layer below to supertent layer.

→ Finally the decomposed (digested) sludge stabilized at the bottom of tank.



Ex $C_6H_{12}O_6 \longrightarrow 3CO_2 + 3CH_4$

7.4 Application of anaerobic digestion:-

→ Agricultural wastewater treatment

Industrial

Municipal

-: Air Pollution :-

→ Man can hardly survive for 5 minutes without air.

→ However, he can survive 5 days without water & for 5 weeks without food.

→ When air gets polluted, it causes a number of diseases in human body (animals).

→ Hence, the polluted air is harmful to all types of life (plant, animals).

8.1 Air pollutants:-

→ The polluted air gets contact with the non-living materials (metal, wood, stone etc) & corrosive action of polluted air or due to the chemical attack of air pollutants.

→ Primary pollutants –

Sulphur oxides (SO_2), carbon monoxide (CO), Nitrogen oxides (NO & NO_2), Lead (Pb), hydrocarbons, allergic agents & radioactive substances, H_2S, H_2F^-, & methyl & ethyl mercaptans.

→ The primary pollutants react with each other & with water vapour & produces new pollutants, called secondary pollutants.

→ Secondary pollutants are produced from he chemical reactions due to oxidation caused by energy of sun.

→ Secondary pollutants are more harmful than the original primary pollutants.

The pollutants are:

- ✓ H_2SO_4 (Sulpharic acid)

- ✓ Ozone (O_3)
- ✓ Formaldehydes (H-CHO) or CH_2O
- ✓ Perony-acyl-nitrate (PAN) (NO_z)

1- Sulpher dioxide – (SO_2)

→ It is an irritant gas & when inhaled, it increases the breathing rate & causes oxygen deficit in the body.

ex Patients of asthma are affected by this pollutions.

→ SO_2 may oxidize to form SO_3, which when inhaled, may dissolve in body fluid to form sulphuric acid (H_2SO_4). H_2SO_4 is a very strong corrosive acid.

→ SO_3 causes severe branch spasm.
(dictionary):- difficulty in exhalation

→ SO_2 originates from refineries & chemical plants, smelting operation & burning of
(dictionary):- formation metals by heating
fulls. Thermal power plant also emits SO_2.

→ The quantity of SO_2 in air is 0.03 ppm
(Specified Air Standard)*

*Contentation of pollutant (Unit of measurement)

- ✓ Generally the concentration of pollutant can be expressed as micrograms per cubis metre ($\mu g/m^3$) at atmospheric temp & pressure.
- ✓ If the concentration is expressed in cum(m^3) per million cum of air, it is called as ppm (parts per million).
- ✓ The relation betwn ppm & $\mu g/m^3$ is:
  1 $\mu g/m^3$ =

X 10^3

→ Liter

Mol → molecule

(/mol) → Volume in Liter occupied by one molecule.

2- Carbon monoxide. (CO) –

→ CO has 200 times affinity towards blood hemoglobin (H_b) than oxygen.

→ When inhaled, CO replaces O_2 from haemoglobin & form carboxy-haemoglobin (COH_6).

It has no use in respiratory process. Hence, helf of the blood is used

→ Carbon monoxide is responsible for heart attack.

Sources → CO originates from auto mobile exhausts & incomplete combination of organic matter. (dictionary):- (Process in which substances reacts with oxygen.)

→ In cities, the concentration of CO is 54 ppm.

→ Specified standard (9 ppm).

3- Oxides of Nitrogen (NO, NO_2)-

Nitric oxide Nitrogen dioxide.

→Eye & Nasal irritations are causes by NO_2 (when concentration is 15)

→ Respiratory discomfort (concentration is 25ppm)

→ It originates from automobile exhausts:-
(dictionary)

Furnace smokes

→ Specified standard for NO_2 is 0.05ppm

4- Hydrogen Sulphide (H_2S) –

→ H_2S is a foul smelling gas with a odour of rotten egg.
(dictionary) – dirty (dictionary):-Damaged/useless

→ This gas cause headaches, sleeplessness & pain in eyes.

→ Higher concentration of H_2S may block oxygen transfer & damage to nerve tissues.

→ H_2S is rarely found in atmosphere, therefore, It is not included in the air-quality-standers. (No specified standard-concentration)

→ It is produced in industries like oil-refinibg, rubber, artificial, silk etc.

5- Methyl & Ethyle Mecaptans –

→ Ethyl mercaption :- C_2H_3SH

→ These compounds are not harmful to us.

→ They have strong odours.

6- Hydrogen Fluoride & Other Fluorides –

→ All fluoride compounds are extremely irritant gas & corrosive in nature.

→ Their smaller concentration may produces fluorosis in cattle & plants

dictionary – a pathological condition.

→ It is not harmful to human beings.

Sources → They are emitted into atmosphere from aluminum plant, steel plant, phosphate frtiliserplants etc & by burning of coal.

→ Its concentration in city air is very less (around 0.025 ppm). It is not included in air-quality-standard.

7- **Lead** (P_b) –

Sources → It is ejected into the atmosphere through exhausted of automobile.
(Gas emitted from the automobile engine)
→ It may cause irritation of mucous-mucous – membranes of nose, throat & lungs, when (a thin layer inside of nose & mouth & outside of other part of body inhaled air.

→ It may damage to Liver, kidney & gastrointestinal tracts (systems).
(dictionary)-system.
→ Specified standard for lead in air-quality-standard is 1.5 $\mu g/m^3$

8- Hydrocarbons – (Alkane, Alkene, Alkynes.)

→ Alkenes are highly reactive in atmosphere through photochemical realn.

→ It reacts with other pollutant gases & forms new pollutants.

Sources → Hydrocarbons released to the tmosphere by automobile exhausts & by smokes of incinerators & from Oil-refineries.

→ Hydrocarbons are found to cause body cancers.

→ Formal-dehyde cause irritation of eyes, skins & lungs.

→ Air-quality-standard is 160 $\mu g/m^3$ (0.24 ppm)

9- Allergic Agents –

→ Microscopic substances in air may cause allergic reactions in human bodies, called aero-allergens. (Physical matter of which thing/person consist)

→ Sneezing, asthma, skin troubles are due to allergic agents.

Sources → It Originates from plants & animals.

→ Finally powered industrial materials may cause allergic reac^{n} with sensitive persons.

→ Powered like material form seasonal plants.

10-Radioactive Isotopes – ex { Titrium (H-3)
Carbon-11, 14, 18

→ Radioactive emissions leads to anemia, cancers & shortening of life spans & genetic effects. (Its nuclic are unstable & it dispute energy by emitting radiation in the from of -,β-&γ-rays) & accidential discharges from atomic & nuclear reactors.

11-Ozone (O_3) –

→ The presence of ozone gas in air may cause irritation in the respiratory (dictionary) tract. System.

→ it may be produced by <u>photochemical</u> process

↓

Two pollutants unit together in the presence of sun-light, producing a third pollutant.

→ In day time, It is also produced by photochemical real^{n} of hydrocarbons & nitrogen oxide. (in highly motorized areas)vehicle used ← (dictionary)

→ The air standard for ozone is 0.12ppm

Environment protection agency

8.2 Criteria & Non-criteria pollutants:-

→ Criteria pollutants are:

- ✓ CO
- ✓ NO_2
- ✓ O_3
- ✓ SO_2
- ✓ Lead
- ✓ Particle matter (dia <10γm)

A small discrete mass of solid or liquid matter that distributed in gas or liquid

8.3 Influence of meteorological phenomena on pollutants:-

Meteorology :- The scientific study of earth's atmosphere & its changes.

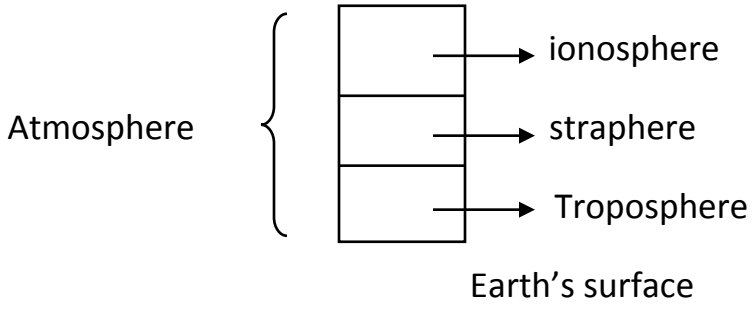
Meteorological phenomena:-1- Heat ($Temp^n$)

- ✓ Pressure
- ✓ Wind
- ✓ Moisture

→ When a pocket of gas is released into the atmosphere from a source, it gets dispersed into atmosphere into various directions depending on wind, temperature & pressure conditions of the environment.

8.3.1 Lapse rate –

→ In troposphere, temperature of surrounding air decreases with an



Increase in height. The rate of change of temperature is called Lapse rate.

→ The rate will differ from place to place & from time to time (day to day) at the same place.

→ Lapse rate at a particular place & time is determined by sending a barbon equipped with a thermometer & a self-recording mechanism.

Ambient lapse rate/Environmental lapse rate

surrounding.

→ When a parcel of air, which is hotter & lighter than the surrounding air, is released, the

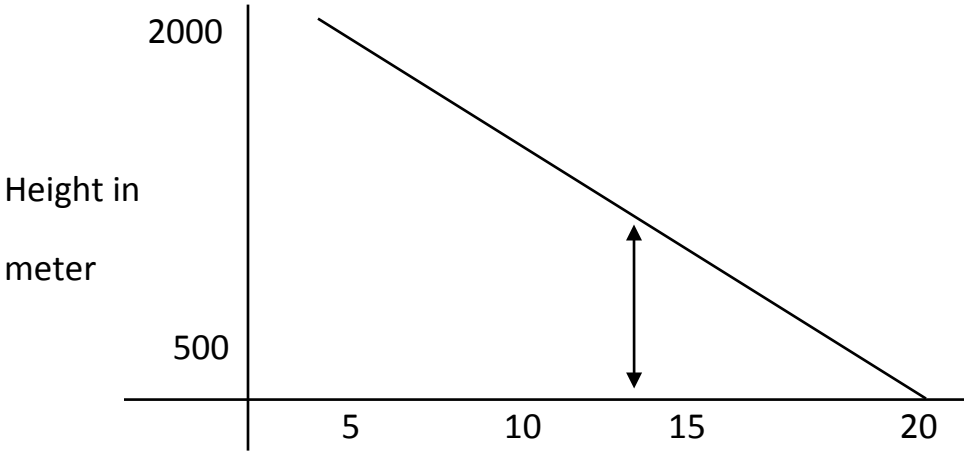
Emitted gases

it tends to rise up

Until it reaches to a level, where its own temperature & density becomes equal to that of surrounding air.

→ The rate of decrease of temperature may be different than ambient lapse rate. This is called adiabatic Lapse rate.

Without the addition of loss of heat



To

→ Environmental Lapse rate =

→ The emitted gas is called plume. (Lapse rate vs disperstmot)pollution

Emitted plume Behave in air under these conditions.	Lopping plume	Lofty plume
	Neutral plume	fumigating plume
	Coning plume	Trapping plume
	Fanning plume	

8.3.2 Impacts of winds

→ The moving air is known as wind.

→ The movement in air is due to unequal distribution of atmospheric tem^{n} & pressure over the earth's surface & also because of rotation of earth.

→ The direction of wind is from high pressure areas to low pressure area.

→ Quicker heating & cooling of earth compared to sea may cause flow of air.

- ✓ Day time (from sea to land)
- ✓ Night time (from land to sea)

This may affect to the air pollution problem wind speed is measured by anemometer.

→ The velocity of wind at any height 'z' is:

$U = Uo^{k}$

Where U_0 = wind speed at height 'Z_o'

- ✓ K = const ≈ for large lapse rate.
  = (average value)

→ The direction & speed of wind will influence the diffusion of polluted gases. & emission of particulates from factories or automobiles.

unit

8.3.3 Impact of pressure –

→ High pressure systems (clear SR/, Light ward condition) cause a bad dispersion of pollutants.

→ Low pressure systems leads to good mixing & rapid dispersion of pollutions.

8.3.4 Impact of moister-

→ The presence of moisture blocks & obstructs the solar radiation reaching to ground, which affect the air quality.

→ Humidity leads to formation of dog & increases the corrosive action of air pollutants.

→ Excessive moisture in atmosphere will lead to rain, which will be helpful in improving the quality of ambient air.

Because it wash down the pollutants to the earth.

→ Removed of atmospheric SO2 through rain cause problems due to reaction of SO2 with water, forming H_2SO_4.

-: Water treatment process:-

Ex.11.3 Determine the daily requirement of alum, Lime & polyelectrolyte to coagulate a flow of 200 L/S, if the jar test indicates that qrtimum coagulation occurs when 1 Litre of

water is dosed with 3ml of 10 g/L alum solution, 1.8 ml of 5 g/L suspension of lime & 0.2 mg/L of polyelectrolyte.

Ans → Coagulants are sometimes assisted with further chemicals, known as coagulant-aids.

Ex – 1 Polyelectrolyte.

Lime alkalinity addition

PH correction :- Lime, sulphuric, acid (H_2SO_4)

→ The amount of chemical coagulant polyelectrolyte required for particular raw water quality can be determined using laboratory Jar-test.

Electrolyte :- A solution that conduct electrolyte.

→ transmission of electricity

Polyelectrolyte :- A electrolyte of high molecular weight.

Solution → 1min → 1 hr

Daily flow rate = 200 x 60 x 60 x2 4

= 17.28×10^6L → 1 day

Alum requirement 3 mL of 10 g/L

= 30 mg/L x 17.28 x 10^6 L

= 518.4 kg/day

Line requirement 1.8 mL of 5g/L

= 9 mg/L x 17.28 x 10^6 L

= 155.5 kg/day

Polyelectrolyte = 0.2 mg/L x 17.28 x 10^6 L

= 3.46 kg/day

Ex9.2 S.K. Garg

The maximum daily demand at a water treatment/purification plant has been estimated as 12 million litres per day. Design the dimensions of a suitable sedimentation tank for the raw water supplies, assuming a detension period of 6 hrs & the velocity of flow as 20 cm/minute. (assume basin within is 10_m)

Solution

Given – Quantity of water treated in 24 hrs (daily)

$= 12 \times 10^6$ liters

Quantity of water treated during detention period

= (x6)

= 3x106 litres

= 3000 cu.m (m^3)

The capacity of tank required = 3000 m^3

Given data – (Velocity of flow to be maintained through out the tank) = 20

= (0.2)

Length of tank required = (velocity of flow) x t

(Detention time (t) =) → Length of tank

↘ Velocity of tank

= 0.2 x 6 x 60

= 72 matres

C/S area of tank =

=

= 41.7 m2

Given Basin width = 10_m

Water depth = = 4.17

= 4.2m

Ex 9.6 S.K.Garg

In a continuous flow setting tank 3m deep 60m long, what flow velocity of water would you recommend for effective removal of 0.025 mm particles at 250C. the sp. Gravity of particles is 2.65 & kinematic visocity 'v' for water may be taken as 0.01cm^2/see

Sohtim Setting velocity $V_s = (S_p-1)d^2$

dia of particles

Sp.gravity of particles

Kinematic viscoeity = v

$= (\quad_s - \quad_w)d^2$

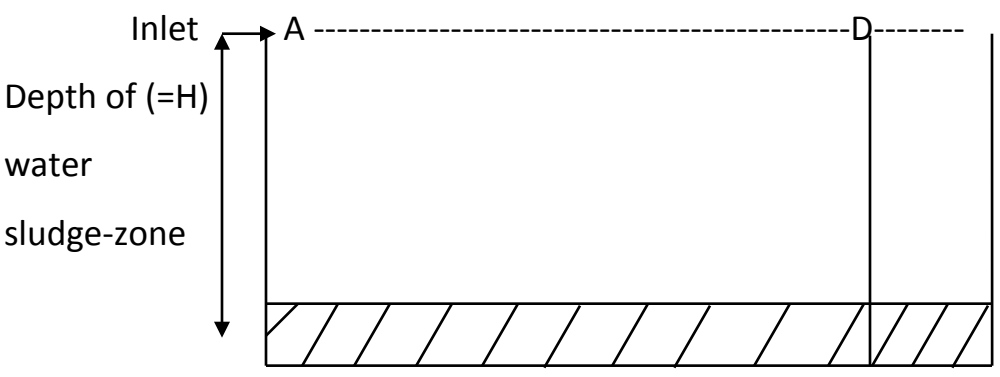
So, $V_s = (sp-1)d^2$

Kinematic viscocity

$\Rightarrow v_s = x(2.65-1)\ (0.0025)^2$

$\Rightarrow v_s = 0.0562$

Setting velocity



V = flow velocity in horizontal direct

V_s = setting velocity

→ From the vector diagram from 'A' to 'C', we can write.

Flow velocity ↙

⇒ V =) x V_s

= x 0. 0562

= 1.35 cm/see.

Derivation of stokes law:-

Vs = (S_p-1)

Kinematic visocity of water (m^2/see)

F_1 F_1=Impelling for

F_D F_D = Drag force

Sp = Sp. Growth of particle

= density of particle

density of water

→ Drag force increases with increase of velocity, till it becomes equal to effective weight of particle i.e. ($V=V_s$)

→ Effective weight of particle (F_1)

= Total weight – Buoyancy

=) y_s -) y_w

Volume Volume of sperial particle

$= \pi r^3 (V_s - V_a)$

Unit wt. of water

Unit weight of particle

= (

→ Drag force (FD)

(Area of particle) $(\pi r^2) = C_D A_s . P_w$.

CD = drag colt.

=

= 0.4 (for spherical particles)

V = dynamic visocity of water

density in kg/m3

(m^2/see)

$F_1 = F_D$

$\Rightarrow V_s =$

$\Rightarrow V_s =$ $(S_p - 1)$

Where $S_p =$

V =

*Drag force refers to forces acting opposite to the relative motion of any object moving with respect to the surrounding fluid.

-: Noise Pollution:-

9.1 Introduction :-

→ Noise is defined as an unwanted sound. The unwanted sound produces several undesirable effects on our body health, therefore, it can be called as a pollutant.

→ It interferes with one's activities like work, rest, sleep etc. & produces undesirable physiological & psychological effect's in body.

→ It is mainly in highly industrialized countries, characterized by high volume of traffic; & sporting activities & low-flying aireaft etc.

→ It reduces the 'quality of life' & causes' a significant health hazard.

Ex 1) People living adjacent to busy road tend to have higher blood pressure.

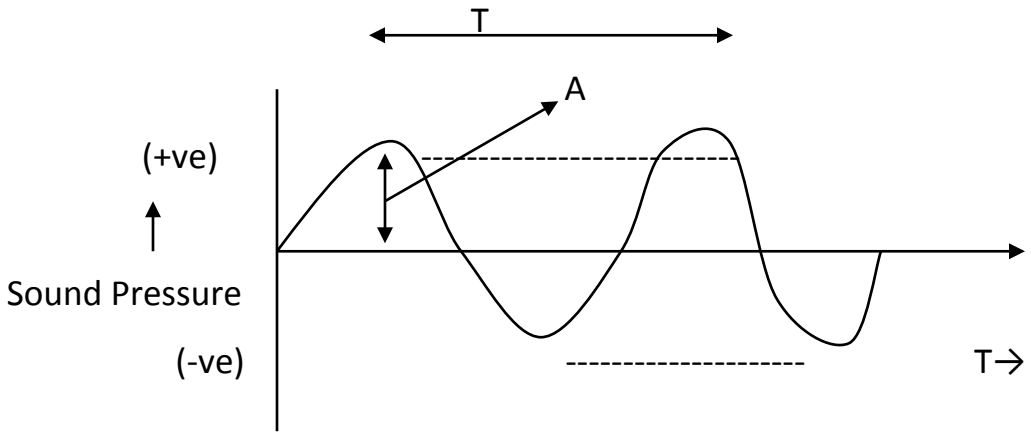
2) High noise levels of sufficient duration can result temporary/permanent hearing loss.

3) Irritation, headache etc.

9.2 Physical properties of sound:-

→ Sound is produced in the environment by alternating pressure changes in the air because of vibrations of solid objects. or separation of fluids.

→ Alternating pressure variation produces sound waves which propagate in the form of sinusoidal wave pattern/cosine wave pattern.



A = Amplitude

T = Wavelength = Distma betwⁿ two successive crests.

→ Time period :- The time required for a complete rotation oscillation

→ Frequency :- The no of completed cycles per unit time.

→ Most sounds are not purely sinusoided. They vary both in frequency & magnitude.

Sound pressure (Prms)

↳ Root mean squre.

$= (P^{-2}) = {}^{1/2}$

(P = pressure at each instant of time.)

Sound power & intensity

→ The rate at which energy is transmitted by sound waves is called the sound power (W) – measured in watt.

→ The average sound power per unit area normal to the direction of propagation of a sound wave is termed the sound intensity.

$I =$ Wetts/m^2 ——→ metre.

I = sound intensity/acoustic intensity ata distance 'r' from the sound wave.

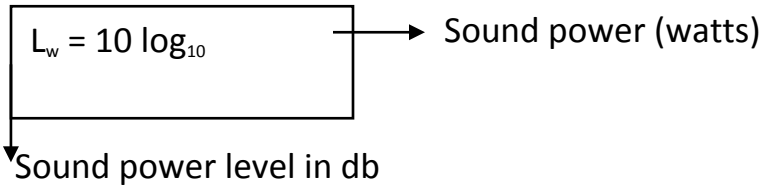
9.3 Noise criteria:-

→ Loudness of a sound is determined by its sound pressure level & frequency.

9.4 Noise standard :- (x)

→ Sound power is in different range.

Deeibel :- Sound power level is measured in decibel (db). It is the reference power level; 10^{-12} watts (db).



9.5 Noise measurement :-

→ Sound power can't be measured directly, whereas sound intensity can be measured with modern instrumentation.

- ✓ Sound level meter.

  (Read the

9.6 Noise control :-

→ When noise level is excessive, the solution involves three steps.

(a) Source – Source could be modified by the treatment to machine surfaces.

(b) Transmission path – Could be modified by containing the source (machine) inside a sound insulator and by constructing a noise barrio (absorbing material)

(c) Receiver – Protection of the receiver (ear) by providing ear protection.

Sound protection in building –

→ External sound will enter a building through the weakest transmission path.
(may be window)

→ When sound pressure wave meet a wall/building surface, the building vibrates & sound is radiated buck into space.

→ Part of sound energy is reflected, part is absorbed by surface & remainder is transmitted.

→ Vibration will be larger at the natural from of element (will/building).

→ Natural from depends on weight, surface area & rigidity of building element.

→ { Sound reduction is better for higher natural frequency

-: 10. Solid Waste Management:-

10.1 <u>Introduction</u> :-

→ Solid wastes include paper, plastics, glass, food waste, ash etc. it also include

paints, old medicines, etc. liquid wates

→ From health point of view, solid wastes are

- ✓ Human pathogens
  (ex Handkerchiefs, contaminated food & surgical dressing)
- ✓ Animal pathogens (ex Waste from pets)
- ✓ Soil pathogens (ex Garden waste)

10.2 Sources & classification

→ Solid waste/municipal solid waste is collected from domestic, commercial & industrial sources.

Source	**Types of waste**
→ Domestic (Single family house, Multi – Family house. Low, & high-rise apartments)	Food, paper, packaging, glass metal, ashes. other household waste
→ Commercial (shop, restaurants, Markets, office, Buildings, hotels & institutions)	**Types** Food, paper, Packaging, glass, metals, ashes. (same as domestic)
→ Industrial (Fabrication, Manufacturing, refineries,	**Types** Industrial, process

chemical plants, mining wastes, oil, metal, plastics etc.

→ Construction & demolition. (destruction)	Soil, concrete, timber, steel, Plastics, glass.

10.3 Composition of MSW :-

Municipal solid waste.

→ The basic idea is to identify waste as being organic or non-organic (Inorganic).

Organic :- Food, vegetables, paper,
Cardboard, plastics,
Clothing, garden waste,
Wood, bone.

Inorganic :- Metals, glass ash,
Stone, brick, etc.

→ WHO (World health organization, 1991)

Category the industrial waste into three types:

- ✓ Non-hazardous industrial waste.
- ✓ Hazardous waste.
- ✓ Hospital waste.

10.4 Properties of MSN :-

→ Waste handlers needn't to know the physical,
Chemical & biological properties of solid waste.

→ For proper waste management (disposal, transformation, reuse & recycling), we have to know the physical, chemical & biological properties of solid waste.

→ Physical properties are :

- ✓ Density & moisture content (kg/m^3)
- ✓ Particle size distribution. (mm)
- ✓ Field capacity (%)
- ✓ Hydraulic conductivity (m/day)
- ✓ Shear strength (KN/m^2)

(LxBxH)

metre

Field capacity – is the maximum percentage of volumetric soil moisture that a soil sample will hold freely against gravity.

→ Density & moisture content of MSW is about 200-40 kg/m^3 & is 1s to 40% for the compaction (density) (moisture)

Of soilds waste in landfill.

→ Hydraulic contecting is the rate of movement of water into soil. Sludge resists the movement of warter down through the solid waste.

Dense waste :- $7x10^{-6}$ m/s/Loose waste :- $15x10^{-15}$ M/S

→ Filed capacity = 0.6-0.55

W= Overburden weight of solid waste in lift.

→ Shear strength of sludge in Landfill is about zero.

Hardness :- is defined as the concentration of multivalent metallic cations In solution.

Organics :- These are carbon – compound products.

- Biodegradable organic
- Non – biodegradable organic

Biodegradable organic :- Materials can be cetilized for food by naturally occurring micro organizations. These materials consists of starches, facts, proteins, alcohols, acid etc.

Non-biodegradable Organics :- Some organic materials have the resistant to biological degradation.

Aeration :- It is a process used in preparing the potable water.

(drinking)

- ✓ It may be used to remove undesirable gases dissolved in water

Biochemical process :- These chemical reactions are not spontaneous but require external source of energy for initiation.

Turbidity :- is a measure of the extent to which Light is either absorbed or scattered by suspended material in water.

It is not a quantitative measurement of suspended material.

Sp. Gravity :- The density of a substmee/particle relative to the density of water.

Effluent :- Water mixed with waste matter

Viscocity :- Resistance of liquid to shear force in flow.

PH :- Potential of hydrogen (Logarithm of the reciprocal of hydrogen – ion concentration in gm atoms per litre).

Diffusion :- the movement of a substance from an area of high concentration of that substance to an area of lower concentration. Sludge :- the precipate produced by sewage treatment.

Sewage :- waste-matter carried away in sewers

Decant :- Cause to flow out from a container.

.4 Properties of MSW:-

→ Most of the MSW was dumped so it not necessary to find the chemical properties.
→ Since recycle, reuse & transformation technology followed, we are determining the chemical properties of MSW.
→ Chemical Properties
→ Technology/Analysis process used to find the chemical properties as:

- ✓ Proximate analysis
- ✓ Ultimate
- ✓ Energy content.

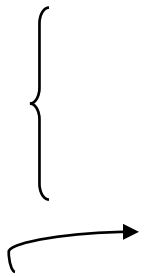
→ Proximate analysis include

(a) Moisture content by percentage weight
(b) Voletine matter
(c) Fixed carbon
(d) Non-combustible fraction (ash).

→ The energy content is based in heat value.

Heat energy produced, it the

Solid waste is burnt



→ (Joule/kg) /or $^{MI}/_{kg}$

→(H_u) = (H_{awf} x B – 2.445xw)

Easily burning

B = Flammable fraction. (%)

(Volatile matter + fixed carbon)

W = moisture content fraction by weight (%)

→ Ultimate analysis is followed to know the energy produced by combustion or biological transformation of solid waste.

1)

(Dulong equation)

Where C,

→ Ultimate analysis include the % of the above element.

2) Khan etal (1991)

E = 0.051

Energy content in
F = % of from by weight
CP = % of carboard & paper by weight.
PLR = % of plastic & rubber by weight.

→ Biological properties Due to aerobic/anerobic digestion, solid waste is transformed into energy & other end products.
→ Anerobic digestion process is responsible for the decomposition of 'food wastes' to end product methane,
→ The solid water related to biodegradation. Are Oil, fat, proteins, cellulose etc.
→ Therefore, the biodegradation of food fraction of MSW is determined by

BF = 0.83 – 0.028 LC

Lignin content- (%)
Biodegradation fraction expressed on a volatile solid basic.

LC → Lignin content (dry weight) of Volatile solid.

Lignin → A complex polymer constitute of wood

other than carbohydrate.

Volatile → Substance that changes readily from solid/liquid to

vapour at normal temperature.

Dispose :- to arrange things/or people in a particular way/position.

Disposal :- the act of getting rid of 5th.

to be free of sb/thing

that has been annoying you-

haulier :- a person/company whose business is transporting goods by roads/railways.

10.5 Separation :-

→ Separation of different fraction of waste from the total solid waste can be done at source (household/or industry) or at final destination.

→ Based on separation, the total MSW is divided into:

- ✓ Wastes that are desirably separated at source
- ✓ All other household waste.

→Wastes that are desirable separated at source-

(source separation)

- ✓ Food waste
- ✓ Paper & cardboard
- ✓ Plastic → a very thick paper
- ✓ Metals
- ✓ Glass.

→ Other household wastes are

- ✓ Bulky waste (tyres, furniture etc)
- ✓ Hazardous household waste.
- ✓ Yard waste.
  - An area outside a building (with a surrounding well)

10.6) Storage & transport of MSW :-

→ Different types & sizes of storage containers are used for MSW.

→ The range for size vary from 25L capacity to 40000 litre.

→ For apartment building, the size of container is from 600 to 1000 Litre.

→ The types of storage depend on the collection facility.

- ✓ Haulier for bulky items.
  a person/company whose business is transporting goods by road/railways.
- ✓ Doorstep collection
  (area very close to door.)
- ✓ Regular kerb collection
  (side of road)
- ✓ Vacuum truck etc.
  (empty space)

→ Types of storages are plastic bag, wheeled, bin, vaccum, truck, paper bag etc.

(a large container with a cover/aid)

10.7) MSW Management :-

→ The technologies used for treatment & disposal of MSW are :

- ✓ Waste minimization
- ✓ Reuse & recycling
- ✓ Biological treatment
- ✓ Thermal treatment (combination/incineraton)
- ✓ Landfiling

10.8) Waste minimization :-

→ It follows the reduction in amount of solid waste generated at sources.

Examples of sources are:

1- Production units for food & household products. (Industry)
2- Production units for commercial products.
3- Shopping outlets (Business place)
4- Households
5- Office, institutes & commercial properties.

10.9) Reuse & Recycling :-

→ Aluminium cans are considered for recycling purpose.

(dictionary) → container

→ Paper & cardboard are used as a recycling solid-waste material.

→ Glass was well recycled.

Ex different types of bottles.

→ Plastics aremostly non-biodegradable.

Hence, it is undesirable in land filling.

Therefore, plastics are recycled.

→ Yardwaste, organic food fraction etc.

10.10) Biological Treatment :-

- ✓ Aerobic or composting → It is an aerobic process Which decompose the organic food waste.
- ✓ Anaerobic or Biogas
- ✓ Combined anaerobivc & aerobic

1- Composting – is an aerobic process where micro-organisms decompose the organic food waste in an oxygen environment.

$$\text{Organic matter} + O_2 \xrightarrow{\text{aerobic bacteria}} \text{New cells} + CO_2 + H_2O + NH_2 + SO_4$$

→ The final product (compost) consists of minerals & complex organic material.

→ The required parameters for the composting process are:

- ✓ Temperature *
- ✓ Moisture content (%)
- ✓ Oxygen (% of oxygen)
- ✓ (range 6-8)
- ✓ Biochemical composition (It influences the process rate)

2- Anaerobic digestion – (Absence of oxygen)

$$\text{Organic matter} + H_2O \xrightarrow[\text{anaerobic bacteria}]{} \text{New cells} + CO_2 + CH_4 + NH_3 + H_2S$$

→ The beneficial end product is the CH_4 (methane).

→ This process decompose the food waste to CH_4.

3- Combined anaerobic & aerobic process-

→ Anaerobic digestion followed by in-vessel aerobic composting.

(1st process) (2nd process)

10.11) Thermal Treatment :-

→ Thermal degradation of organic material can be carried out with/without oxygen.

→ Thermal degradation with excess oxygen is called combustion.

→ When the fuel is a waste, the thermal degradation process is called incineration.

→ Incineration – Organic material is converted into heat energy, gas, slag.

10.12) Landfill :-

* A schematic (Layout) of landfill process.

-: 11- Hazardous Waste Treatment :-

11.1) Hazardous waste & its generation :-

→ Hazardous waste means

- ✓ It causes fire (Ignitable)
- ✓ It reacts with other (reactive)
- ✓ It destroy/corrode other (corrosive)
  Tissue/material
- ✓ Solid – waste is danger to health. (toxic)
  It pollute water, food & air

→ It may be medical hazardous waste.

or household hazardous waste or from industry.

→ Examples

- Copper (C_u), Zine (Z_n), Lead (P_b) &
- Mercury (H_g) etc.

- Lubricating oil, drilling oil, synthetic oil
- NO_2, Organics, hydrocarbons, etc.

Task Write examples of hazard/solid wastes from medical/household/industry.

11.2 Treatment for Hazardous Waste :-

* Incineration –

→ Hazardous waste can be managed/treated by incineration/Land filling process.

→ In the incinerator, the waste is oxidized in an oxygen-rich environment at elevated temperature.

→ The most important criteria for hazardous waste incinerators is the complete destruction of the major hazardous compounds.

→ The combustion efficiency (CE) is calculated as :

Where

→ Incineration is a controlled high-temprature oxidation of primarily organic compound to produce carbon dioxide & water.

Organic waste Incineration CO_2+H_2O+By-protein

→ The net heat value (NHV) for waste in incineration process is

$$NHV = 1.25(T-15) \times [1+0.268(NHV+EA)]$$

Where T = (the required temperature for incineration, ^oC)

= 15 +

EA = Heat capacity of excess sir of 1.25 $^{KJ}/_{Kg.}{}^oC$

→ During incineration, heat transfer occurred by conduction, convection & radiation.

(low temp^n)

at(high temp^n)

Energy spreads in the form of wave rays.

Convection :- transfer of heat through fluid (liquid & gas)

Conduction :- transmission of heat (transfer from one medium to another medium.)

Types of incinerators –

→ Incinerator type depends on age of structure & economics.

- ✓ Rotary kiln
- ✓ Liquid injection for (liquid organic waste)
- ✓ Plasma arc electrical conduction through a gas
- ✓ Wet air oxidation
- ✓ Fluidized bed.

→ The use of an electrical arc for waste treatment generally it is used within chemical & metallurgical industry as tool to provide high temperature. ($28000^{o}C$)

→ Wet oxidation is an aqueous phase oxidation where organic & inorganic materials suspended or dissolved in watee are exposed to oxygen/(gaseous source).

11.3) Handling of treatment plant residences :-

→ Residue from incinerator are :

- ✓ Slag from rotary kiln
- ✓ Dust from heat boiler
- ✓ Reaction end products

→ Residue from inorganic plant are :

- ✓ Filter cakes
- ✓ Waste water

→ The above wastes require further treatment.

*Secure landgfill
*Stabilization (solidification)

Secure Landfill –

→ Secure landfill are the disposal sites for filter cakes, slag, dust from a full-treatment facility (treatment plant).

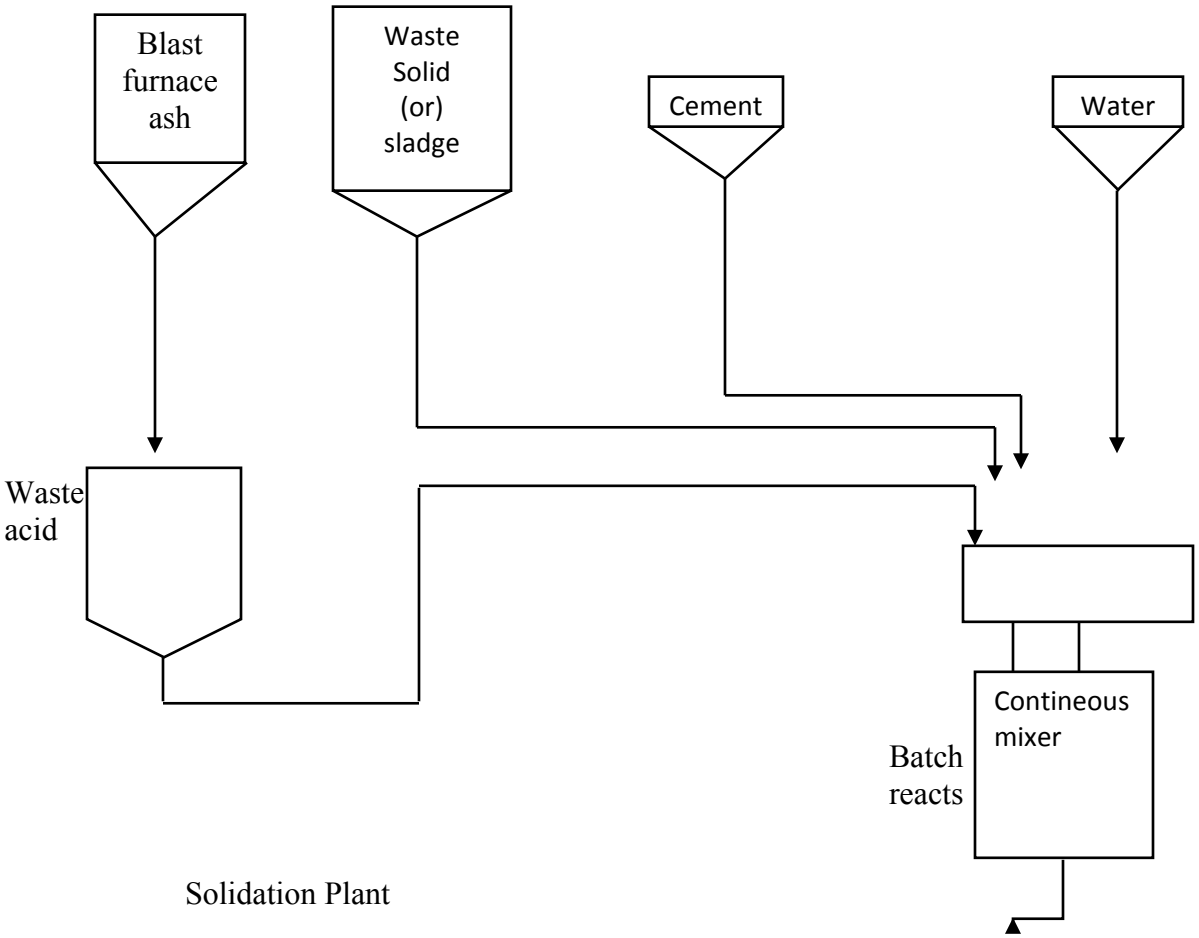
→ The design of a secure landfill is similar to that MSW landfill.

- ✓ Site Location
- ✓ Design of landfill
- ✓ Construction of landfill
- ✓ Operation

Stabilization (Solidification) –

→ When hazardous solid waste is not treated by Land filling process, stabilization is the next choice for further treatment.

→ All ingredients are mixed in a continuous mixter



Solidation Plant

11.2 Treatment for hazardous waste (Continued……)

1- Rotary Kiln –

→ Rotary kiln is used in the cement, lime, clay, iron, coal & phosphate industry.

→ Traditional cement kilns are now choosen as hazardous waste incinerators.

→ Rotary kiln provide the processes for incineration

- ✓ Mixing of solids
- ✓ Containment of heat for heat exchange.

  (can't spread)/to prevent accidental recycle

  of radioactive material.
- ✓ Chemical reaction

→ Rotary kilns are capable to treat bulk solids, sledges, liquids etc.

2- Liquid injection incineration –

→ It is usually used to ideal Liquid waste streams containing minor

concentration of organic contaminants. makes impure

(substance that contaminates)

→ In Liquid injection incinerator, the waste don't contain the necessary heat value to sustain its own combustion.

10.12 MSW Landfill :-

→ The traditional method of disposing of MSW is Landfill.

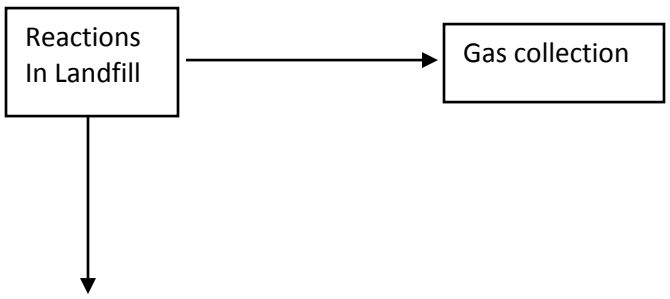
→ The design of Landfill & secure Landfills are similar in nature.

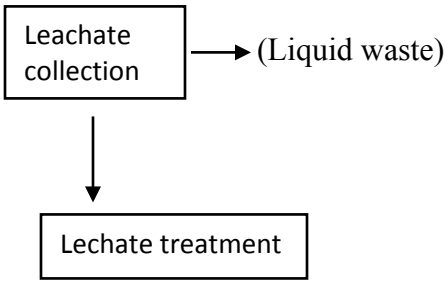
→ Parameter for design of Landfill to satisfy impermeability in material (generally concock).

& to prevent leahate (Penetration of Liquid through the material).

→ Landfill Design :-

1) Foundation design
2) Liner design (To avoid seepage of leachete.)
   A protecting cover that constructs inside of landfill to protect the surface.
3) Leachate collection & gas collection.
   (Lechate & Landfill gas is released)
4) Drainage design
5) Filling design
6) Runoff collection → surface welfer
7) Closure design





→ Leachate is the contaminated water in landfill, which products through external precipitation.

(make harmful/impure)

Landfill Operation :-

→ waste items, Loads, type etc.

(solid, liquid)

(organic/inorganic)

→ Cell/compartment for hazardous waste.

→ Cell/compartment for non-hazardous waste.

Landfill types :-

→ Landfills are two types 1) Attentuate & disperse sites.

to make 5th weaker.

2) Containment sites.

Attenuate & disperse sites –

→ Old-Type { Leachate disperses/spreads through Pores & fissures into the underlying saturated zone.

→ New landfills are containment sites. Leachate & Landfill gas are collected with special design procedure, which is isolated from the surrounding environment.

:- Environmental Impact Assessment:-

12.1 Introduction :-

→ EIA is a process that requires environmental & public participation in the decision making process of project development.

→ EIA includes the following procedures:

- ✓ Screening (To decide which project should be subject to environment assessment.)
- ✓ Scoping (Issues should be included in environmental assessment)
- ✓ EIS preparation (Scientific & objective analysis of preparation of documentation.)

Environmental Impact statement 1 Review

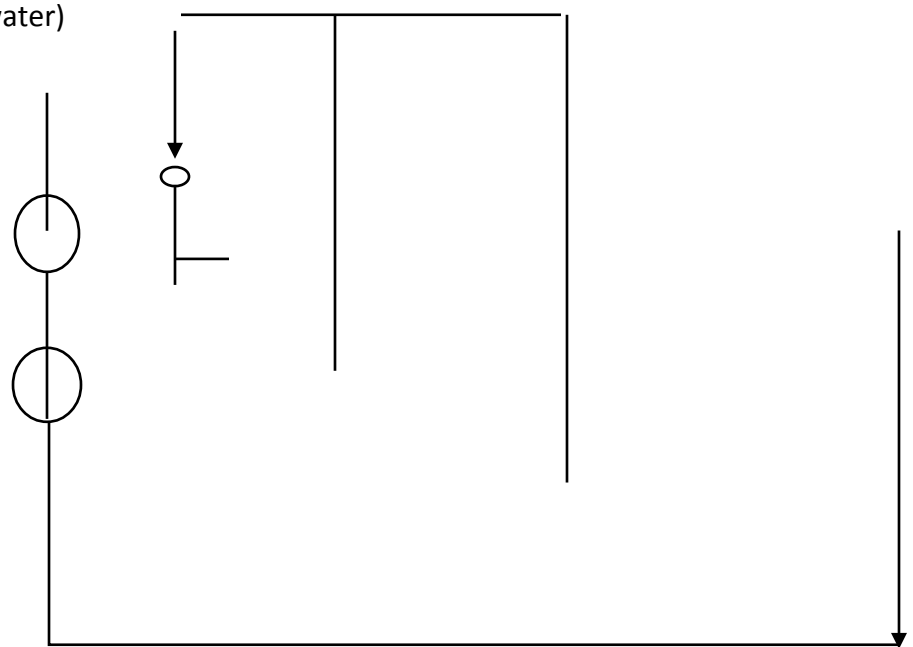
Methods developed to assists the task.

→ Defuis survey is to be taken by a government organization/agency.
The review panel guides the study & then advices the decision makers.

Wet air oxidation :- (continuing from previous pages)

Air/oxygen

(cooling water)



Heat exchanger.

→ The temperature of operation is from 150 to 325^{0} C & operational pressure is from 2000 kpa to 20,000kpa

→ The process is it carries in a batch reactor.

Batch reactor :- It consists of a tank with moving or shaking facility & auditioned heating & cooling system. A variety of operation such as mixing, dissolution. chemical reach & crystulization can be done inside the batch reactor.

→ Due to high pressure & high temperature, the construction material of reactor. Must have the resistance towards corrosive action of hazardoces waste.

→ An extent water-based cooling system is provided. If the waste is in suspension, it is directly pumped into the reactor.

→ During treatment in a horizontal reactor, oxygen/air are injected at certain position into the reactor. A continuous oxidation takes place & majority of the organic compounds are oxidized.

Fluidized Bed Combustion :- Consists of

- ✓ Air fluidization system
- ✓ Bed material
- ✓ Fluidized bed vessel
- ✓ Waste feed system
- ✓ Flue gas cleaning equipment.