Purification of Water

Large Scale:

The purpose of purification is to provide safe and wholesome water which is i) free from impurities ii) chemical substance, iii) colour, odour, taste iv) bacteria

* It usually depends upon nature of raw water.

Eg:- Ground water - no treatment (Spring, wells)
Surface water - extensive treatment (River).

* The steps involved are.

i) Storage
ii) Filtration
iii) Disinfection.

i) Storage:

- Water is drawn from the source and stored.
- Further pollution of water is excluded.

Three aspect of purification

a) Physical → By mere storage. impurities settles down 90% and water becomes clearer.

b) Chemical → Aerobic bacteria breaks down the organic matter. Ammonia is converted to nitrate.

c) Biological → Drop in the bacterial count takes place by 90%. If the water is stored for longer period of time then algae and bad smell may occur.

ii) Filtration:

- In this purification 98-99% of bacteria and other impurities removed.

Two types of filters.

i) Biological or Slow Sand filter
ii) Mechanical or Rapid Sand filter

1) Slow Sand Filters or Biological filters

- It is the standard method of water purification.

Elements of slow sand filters:

a) Supernatant water
b) a Bed of graded sand
c) An Under-drainage system
d) A System of filter control valves

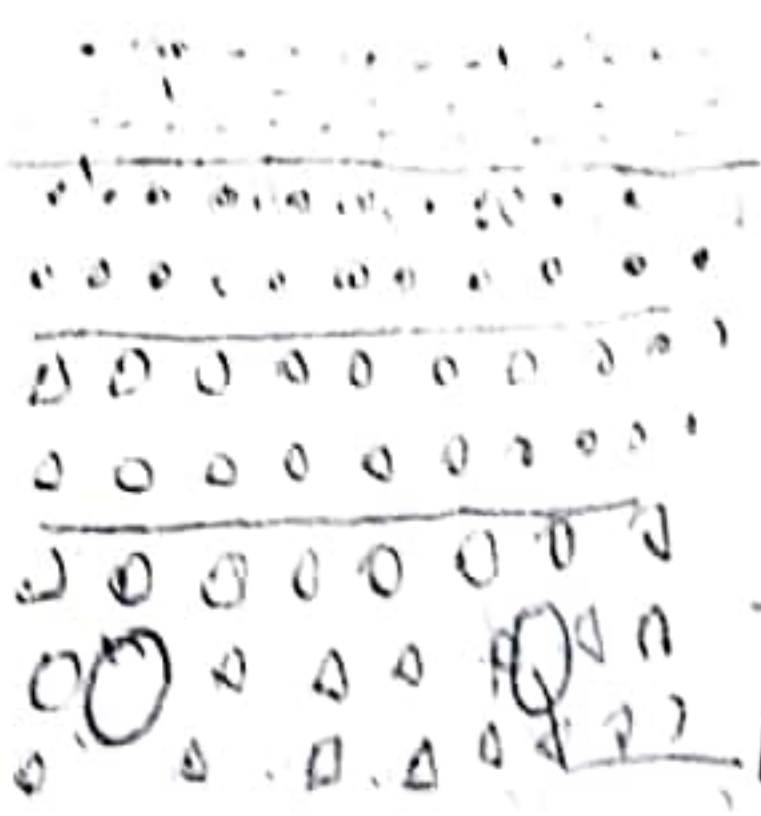
a) Supernatant water:

- Depth from 1 to 1.5 meters
- Two important purposes
  i) Constant head of water and confines overcomes the resistance offered by the sand and promotes downward flow of water.
  ii) Waiting period of 8-12 hrs which allows the sedimentation to settle down.

b) Sand bed:

- Important part of the filter
- Depth of 1 meter.
- The sand grains are carefully choosen with rounded shape and free from clay.
- The sand bed is supported by layers of graded gravel which prevents the fine sand from being washed through pipes.

- Sand bed helps in providing vast area, water flows slowly, during this mechanical straining, sedimentation, oxidation and bacterial action all take place.



Vital layer of Slow Sand filter:

- When the filter is laid it is called as mere mechanical strainer, it is not biological, but soon, a slimy growth known as "Schmutzdecke" forms. It is called Biological or zoological layer
- It is a slimy and gelatinous layer which consists of algae, diatoms, bacteria. It is called "Ripening" of the filter. It is the heart of the filter.
- It removes organic matter, Bacteria free water, Ammonical nitrogen to nitrate.
- Until the Vital layer is formed it is run to waste

ii) Under-drainage system:

- At the bottom of the filter bed it contains the perforated and porous pipes.
- Used for outlet of the filtered water and to support the filter above.
- Filter box contain the first 3 elements of the filter bed: Made of stone, brick or cement

iv) Filter control:

- Certain valves in the outlet pipe system which helps in constant rate of filtration.
- Venturi Meter.
- Filter can be left without cleaning for weeks

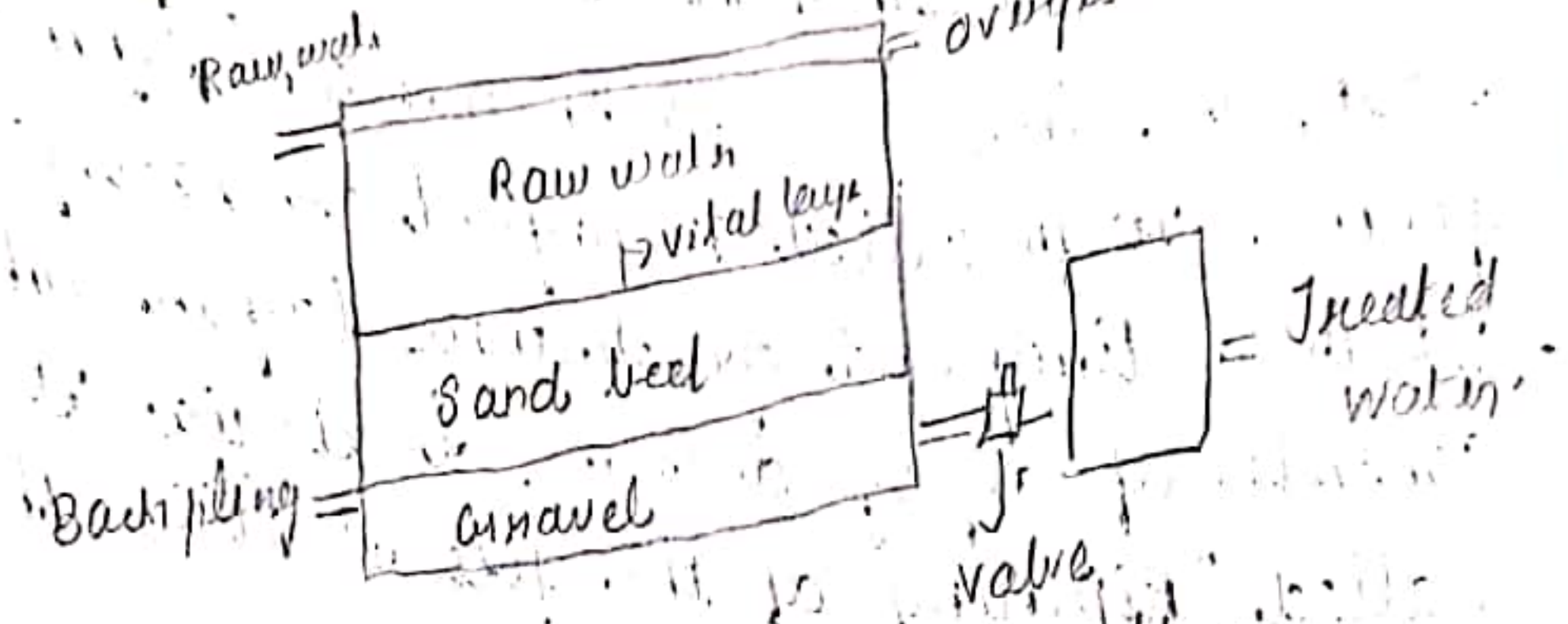
and the sand bed is cleared by scraping. It can be done by unskilled labours using hand tools.

Advantages:-

i) Simple to construct ii) cheap cost iii) No high skill is needs. iv) Reduce bacteria by 99-90%.

Disadvantage:

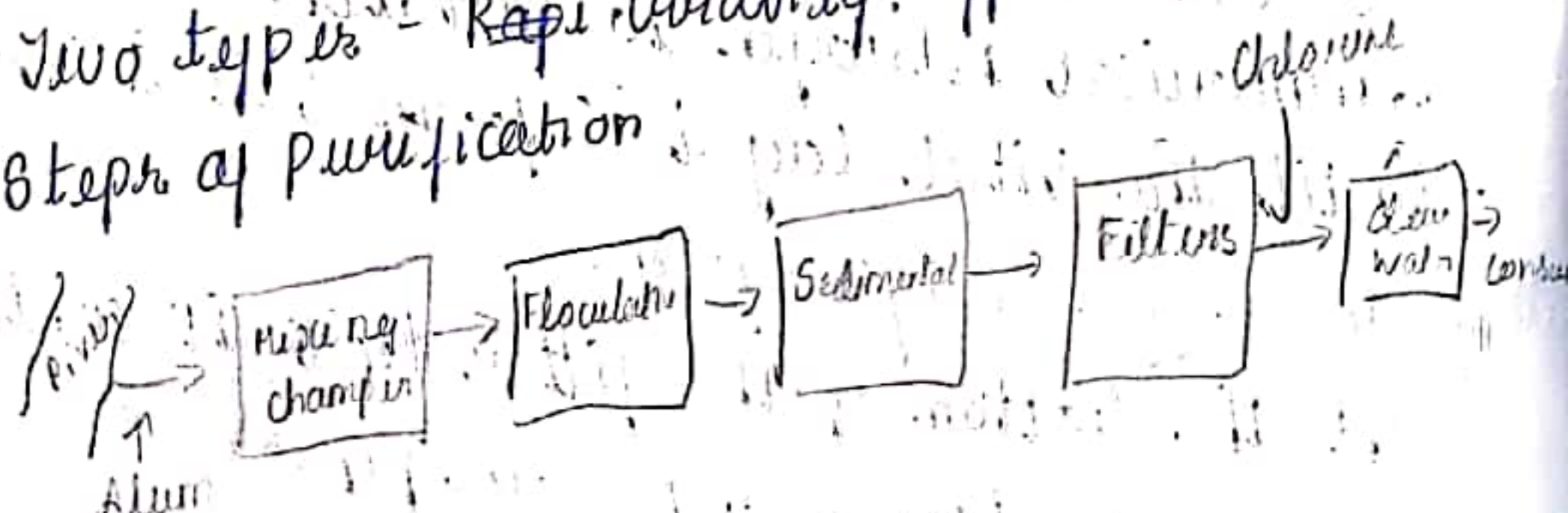
i) Large area ii) Slow process iii) Regular Scraping.



Rapid Sand or Mechanical filter

Two types - Rapid Gravity type & Pressure type

Steps of Purification



i) Coagulation:

- Raw water treated with alum depending upon colour, turbidity, pH of raw water

ii) Rapid Mixing

→ Mixing chamber → Thorough mixing of alum with water Rapidly

iii) Flocculation chamb

- Slow stirring of the water leading to thick, copious, floculant precipitant

iv) Sedimentation.

- The bacteria settle down and the bottom

has to be cleaned frequently. otherwise molluscs and sponges may form.

2) Filtration:

When the water is subjected to purification.

Filter bed

- Sand is the filtering medium
- Depth of 1 meter
- Below the sand bed there is gravel which support the sand bed and helps the water to move freely

- ~~The~~ Filtration
- As filtration proceeds; roma alum floc not removed forms the zoological layer and same like slow sand filter.
- When the impurities and bacteria clogs the filter and lose their efficiency so then subjected to backwashing

Backwashing

- Required daily or weekly depending on loss of head
- By reversing the flow of water it dislodges the impurities.
- The washing is stopped when the filter water is sufficiently clear.
- It required 15 minutes.

Advantages:

i) Can deal with raw water ii) less space iii) Rapid iv) washing easier v) Easy operation.

3) Disinfection

For a chemical to be a disinfectant

i) Destroy organism ii) Should not make the water dirty iii) Easy available & cost iv) Easy to use

1) Chlorination

- It is a supplement not a substitute to sand filtration.
- It kills pathogenetic bacteria but no effect on spores and viruses.
- It oxidizes Iron, Manganese, hydrogen Sulphide
- It destroys some taste & odour
- It controls algae and organisms

Action of chlorine:

$H_2O + Cl \rightarrow HCl + HOCl$ (Hypochlorous acid)

$HOCl \rightarrow H + O'Cl \rightarrow$ Hypochlorite ions

Hydrogen ion

Principles of chlorination:

- Water should be free from turbidity
- Chlorine demand should be estimated before
- The point at which the chlorine demand of water is met is called "break point"
- Contact period should be known
- Extra chlorine floats in water

Methods of chlorination:

i) Chlorine gas ii) Chloramine iii) Perchloron

Orthotolidine test

- It enable to find free and combined chlorine in water. When the reagent is added to water it turns to yellow colour.
- Amount of reagent, time of water - Yellow Colour Compared with the colour discs

orthotolidine arsenite test (OTA)

- It is used to find free and combined chlorine separately.

i) Coagulation ii) Membrane process are other

Air
Composition ⇒ Nitrogen-78%, O_2-21% CO_2-0.03%.
Discomfort → The air of occupied room ⇒ Indices of thermal comfort ⇒ Effective temperature.

Comfort zones
⇒ Defined as Range of ETs over which majority of adults feel comfortable.
⇒ There is no single zone of comfort because it is subjective depends upon physical, physiological and psychological factors.
⇒ Considering only environmental factors, it is thermal condition under which a person can maintain normal balance between production and loss of heat, at normal body temperature and without sweating.

Effective temperature at °C.

① Pleasant and cool. - 20 °C
② Comfortable and cool. - 20-25
③ Comfortable - 25-27
④ Hot and uncomfortable - - 27-28
⑤ Extremely hot - 29+
⑥ Intolerably hot - 30+.

Predicted four hour sweat rate.

① Comfort zone - 1-3 litres.
② Just tolerable - 3-4.5 litres.
③ Intolerable - 4.5+ litres.

Air Pollution

→ Presence in the surrounding atmosphere, of substance generated by the activities of man, in concentration that interfere with human health or safety or comfort. or injurious to vegetation and animals, or chemicals entering food chain or water.

Basic definitions.

Primary air pollutants ⇒ Emitted directly into the atmosphere, from the source through chimneys or exhaust pipe, and can be measured easily.

Secondary air pollutants ⇒ Formed within atmosphere itself; arise by chemical reaction of primary pollutants, with components of air like O_2.

Eg. Ozone is formed in atmosphere from reaction that differs in altitude.

- So they cannot be measured easily.

Physical state: — Gaseous ⇒ Taken by Respiratory.
\ Particulate — Solid
Liquid

Scales of Distribution of Pollutants

① Local scale → Short atmospheric life; usually concentrate at close to source eg. Burning of coal in mines.

② Urban scale → Not long, ↑ in city, ↓ rural.
Eg: Nitrogen oxide, Carbon Monoxide in traffic

③ Regional scale → Long atmospheric life, travel 1000's of km, covering national boundaries.
Eg: Ozone, sulphates.

④ Hemispheric and global state → Life time of years throughout globally. Eg:- Green house gases like CO_2, Nitrous oxide, methane.

Sources of air pollution

a) Automobiles → Motor vehicle emits Hydrocarbon, Carbon monoxide, Lead, NO, particulate matter.
Diesel engine → Black smoke.
→ Strong sunlight converts Hydrocarbon & NO to photochemical which are oxidizing pollutants.
b) Industries → Smoke, Sulphurdioxide, CO, etc. Discharge from chimneys at high temperature.
c) Domestic sources → Burning of coal, wood → smoke
d) Tobacco smoking → Passive smoking
e) Miscellaneous → Burning refuse, Pesticides Spraying, Incinerators, nuclear energy etc.

Air Pollutants

→ More than 100 substances which pollute air has been identified which diffuse in containment from place to place.
→ It may be solid, liquid or gas. The combination of smoke and fog is "smog".

① Carbon-Monoxide
→ Most common and widely distributed.
→ Due to incomplete combustion of fuel carbon containing materials like automobiles, industries, heating facilities, incinerators.
→ Concentration depends upon weather and traffic density (morning and evening rush hours).
→ Expressed as 8-hours average concentration
→ Slowly reflected in concentration of carboxyhemoglobin level in human (4-12 hrs).
→ Headache, Fatigue

② Sulphur dioxide

→ Colourless gas, with sharp odour. Due to combustion of sulphur containing fossil fuel, industries, ores etc.

→ It is the reason for acid rain when deoxygenation when mixed with water.

→ Affects respiratory system, cough, mucus, secretion, eyes, < asthma, < Cardiac mortality

③ Lead → Exposure through:

a) Inhalation → Burning materials of lead.

b) Ingestion → Lead contaminated dust, water, pipes

c) Use of some traditional cosmetics.

→ Children < 6 yrs are at ↑ risk, due to more outdoor activity, Immature BBB,

Haematological & Neurological effects at lower level

→ Placenta is not effective barrier, so high risk

④ Ground level ozone (O/D Upper atmosphere)

→ Major constituent of "Photochemical smog"

→ Formed by photochemical reaction of Sunlight with pollutants like Nitrogen oxides (NO) from which

→ Highest level in sunny weather.

→ Triggers asthma, ↓ lung function, ↑ Heart mortality.

⑤ Nitrogen Oxides

→ Coal most important source, others source are road traffic and electricity generation

→ ↑ Bronchitis, asthma ↓ Reduced lung function,

⑥ Polycyclic Aromatic Hydrocarbons (PAH)

→ Main component is Benzo-pyrene (BaP).

→ Incomplete Burning of carbon like wood, garbage, coal, oil,

→ Sources → Automobile, industries, Tobacco.

⇒ Capable of travelling long distances.
⇒ Carcinogenic → Inhaled (lung ca), ↑ in smokers
⇒ High exposure group are smokers. Roofers. Road builders.

⑦ Particulate matter

① Coarse particles > 2.5 μm
→ Dust from roads and industries
② Fine particles < 2.5 μm.
→ more dangerous reach bronchioles and interfere gas exchange, ↑ lung CA, ↑ cardiac mortality
⇒ No level is safe hence no threshold level.
⇒ PM_{10} is less than 10 μm, PM 2.5 is less than 2.5 μm
Both are human respirable particles but between PM_{10} - $PM_{2.5}$ ⇒ Thoracic Coarse fraction

⑧ Carbon dioxide → Not commonly regarded.

⑨ Hydrocarbon
→ man made sources of hydrocarbons include incineration, wood, processing & use of pesticides

⑩ Cadmium
→ Steel industry. Tobacco, Cigarettes

⑪ Hydrogen sulphide
- Coke production, waste water treatment. Live stock etc
- Bad odour, Conjunctival irritation.
Neurological symptoms.

Monitoring of air pollution ⇒ National air quality monitoring program sponsored 1990 sponsored by Central pollution Control Board

① Sulphur dioxide
② Smoke (soiling index)
③ Grit and dust measurement
④ Air pollution index

Effects of air pollution

⇒ Air quality in the developed countries has generally improved and many developed countries air quality has deteriorated because of ↑ Power generation congestion in streets and poorly maintained motor vehicles.

a) Health Effects:

1) Immediate:

⇒ Acute Bronchitis

→ Immediate death due to suffocation (Eg. London 1952)

2) Delay:

⇒ chronic Bronchitis, lung CA, BA, Emphysema, Respiratory allergies.

→ Lead poisoning ⇒ children developing Brain
lower IQ; Poor school performance.
Behavioural difficulti

→ Oxides of Nitrogen, Ozone, H_2S, Hydrocarbon from air pollutants,

⇒ Air pollution damages RS, CVS. Can If it is reduced it can prevent 5% of all injection & chronic respiratory diseases,

b) Social and economic aspects:

→ Destruction of plant and animal life.

→ Corrosion of metals.

→ Damage to buildings.

→ Cost of cleaning, maintaning.

→ Aesthetic nuisance

→ Smog reduces visibility

→ Soils damages clothing.

Indoor air pollution

→ People are exposed more to indoor air pollution, hence more critical.
→ Main source are combustion of solid fuel indoors. Tobacco, etc.
→ Female and children are more vulnerable and suffer with many diseases.

Prevention and control of air pollution

① Containment → Preventing air pollutant escape.
- Enclosure, Ventilation, Air cleaning.
- Converters.

② Replacement → of pollution causing technology
- Eg. electricity instead of coal & gas.
- unleaded petrol.

③ Dilution

"Green Belt" Between industry and residential & HE.
- Creating smokeless zones.
- AIR (Prevention & Control act - HE!

④ Legislation
- Regarding height of chimney, creating smokeless zones.
- Powers to local bodies for investigation
- WHO have lab for monitoring air pollution

Ventilation.

→ Not only replacement of vitated air by fresh outdoor air, but also control the quality of air incoming with temperature, humidity, purity and free from infection.

Standards of Ventilation

① Cubic Space :- Co_2 during respiration not exceeds more than 10,000 parts of air.

② Air change :- More important than cubic space.
- Calculated by Total hourly air supply by the cubic capacity of the room.

③ Floor space :- Height excess of 10 to 12 meters is ineffective, as the products of espiration accumulate at lower levels.

Importance of Ventilation

Stagnant air becomes warmer and humid.
↓
Surface, bedding, floor, wet.
↓
Concentration of dust, particulate matter, ammonia, microorganisms, gases.
↓
Diseases of Respiratory, enteric etc.

Types of Ventilation

① Natural Ventilation :-
- Relied upon certain forces which operate in nature usually small dwelling, schools & offices.

① The wind → It is an active force.
→ When it blows through a room it is called Percolation. When there is obstruction it bypass and exerts a suction action at tail end called Cell aspiration.

⇒ Doors and windows facing each other produ
"Cross ventilation". Back to back fowrings/doo
not permitted here.

② Diffusion :- Through small opening, slow process we not relied upon.

③ Inequality of temperature

⇒ Air flows from higher density to low, it rises when heated and escapes from opening up in the room.

⇒ Outside air which is cooler and more dense will enter through inlets placed low.

⇒ ↓ the temperature difference, ↓ the incoming velocity of air.

⇒ In tropics the outside air is more hotter so reve happens.

* Drawback of natural ventilation is not possib to regulate the velocity of incoming air or adjust the temperature or humidity.

(2) Mechanical Ventilation: (Artificial)

① Exhaust Ventilation

⇒ Air is extracted outside fan by an exhaust fan by electricity.

↳ Vacuum created → Draws fresh air through doors or inlets.

⇒ Usually fitted high up the room to remove the treated air.

⇒ Provided in large halls, auditorium etc.

② Plenum Ventilation

⇒ Fresh air by Centrifugal fans.

↓

Positive pressure created → Displace ventilated

(3) Balanced Ventilation

⇒ Combinated of exhaust and plenum ventila

(4) Air conditioning

⇒ It provides simultaneous control of all the physical and chemical constituents like temperature, humidity, airmovement, dust, distribution, bacteria, odours, toxic gases etc,

⇒ Air is filtered when drawn into air conditioner from the room.

↓

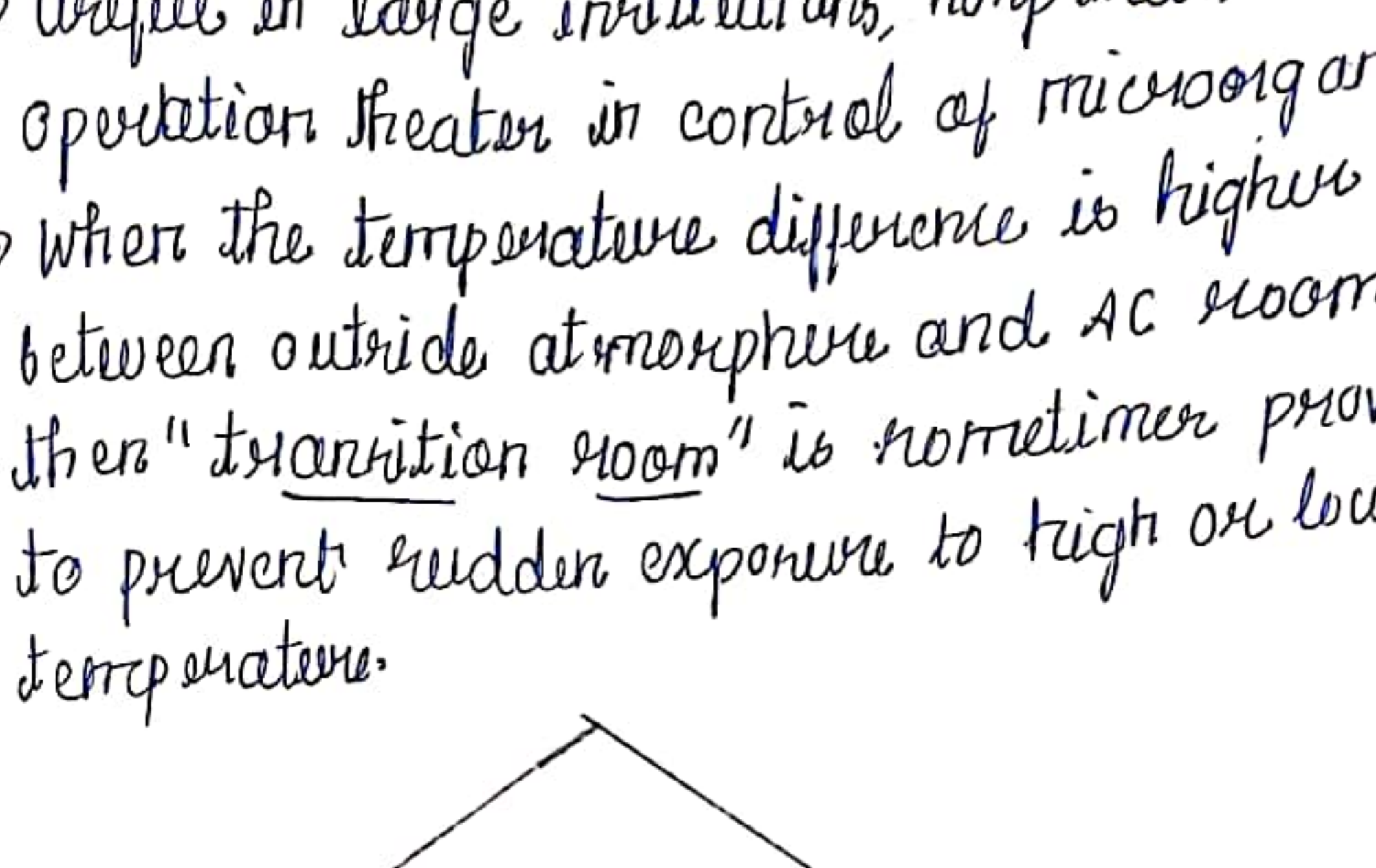
Excess humidity is removed and circulated back after heating or cooling according to comfort z

↓

Some fresh air is added with recirculated air

⇒ Useful in large institutions, hospitals, and operation theater in control of microorganisms

⇒ When the temperature difference is higher between outside atmosphere and AC room then "transition room" is sometimes provided to prevent sudden exposure to high or low temperature.



Air distribution or Air exchange

Insecticides

→ Insecticides are substances used to kill insects.

→ Pesticides → General term including insecticides, fungicides, Rodenticides, herbicides, other chemicals used for control of pests.

→ Insecticides have controlled many infectious diseases like plague, malaria typhus etc.

Classification

- Contact Poison
  - Natural
    - Pyrethrum
    - Mineral oils
    - Rotenone
  - Synthetic
    - Organo-chlorine compounds
      - 1) DDT
      - 2) HCH.
      - → Repellants (Benzyl benzoate).
    - Organo-Phosphorus Insecticides
      - 1) Fenthion
      - 2) Malanthion
      - 3) Abate.
    - Carbomates
      - Propoxur
      - Carbaryl
- Stomach poison
  - Paris green
  - Sodium fluoride,
- Fumigants. (given off vapours)
  - Hydrogen cyanide
  - Sulphur dioxide

1) DDT (Dichloro-Diphenyl-Trichloroethane).

Property → White amorphous powder with mild but not unpleasant smell; Insoluble in water.

Action → Contact poison → causing nervous paralysis and death, Takes several hours to kill.

Application → As a residual spray. 100-200 mg per sqm

→ It has become environmental pollutant causing

2) HCH (BHC) ⇒ Hexachlorocyclo - hexane
Property ⇒ Chocalate colour with musty smell.
Action ⇒ Direct contact poison.
Application ⇒ Same like DDT.

3) Malarthion:
- Heart toxicity ⇒ Yellow or clear Brown liquid.
⇒ Used in killing adult mosquitoes, to prevent dengue hemorrhagic fever.

4) Fenthion:
⇒ Brown colour with smell of garlic.
⇒ Useful in controlling culex, artilarval

⑤ Abate:
⇒ Brown viscous liquid
⇒ Used as adulticide.

⑥ Propoxur:
⇒ Carbamate insectide, active anopheliner than resistance to DDT and dieldrin.

⑦ Pyrethrum:
⇒ Insecticide of Vegetable origin.
⇒ Extracted from flowers of Chrysanthemum cinerariaefolium, a cultivated in Kashmir, Simla and Nilgris in India.
⇒ 4 active Principles → Pyrethrins I & II, Cinerins I & II. ⇒ Nerve poison
⇒ Prepared By soaking them in Kerosene for 12 hour
⇒ Used as Space spray killing adult mosquito and insects.
⇒ Disadvantage ⇒ Not a residual spray.

⑧ Mineral oils:
⇒ Oils like kerosene, crude oil, malarial have been used to kill mosquito larvae & pupae.

- Oils suffocate and poison the aquatic stages of the mosquito.
- ⇒ When improperly used injury to fish & vegetation on
- → Feeb killing power when added to DDT < HCH >

(9) Paris green (Copper aceto-arsenite).

- → It is a emerald green microcrystalline powder.
- → It is insoluble in water and soluble in ammonia and concentrated acids.
- → It is a stomach poison.
- → Used to control anopheline larvae.

Hardness of Water

→ Soap destroying capacity of water. ie less amount of soap required to produce lat

→ Due to 4 main components.

1) Calcium Bicarbonate 2) Magnesium Bicarbon
2) Calcium Sulphate 4) Magnesium Sulphate

→ Chlorides & nitrates of Ca & Mg can also cause

Classification.

i) Carbonate → Temporary → Ca, Mg Bicarbonate.
ii) Non-Carbonate → Permanent → Ca & Mg Sulphates.

Expressed in mEq/L.

a) Soft water → less than 1 mEq/L b) Moderately hard - 1-3
c) Hard water → 3-6 d) Very hard - > 6

→ Drinking water should be moderately hard.

Disadvantages

① Needs more soap & detergents.
② Furring, scaling, explosion of Boilers.
③ Affects cooking, ④ Fabric less life.
⑤ ↓ life of pipes ⑥ Unfit for Industries.

Special treatment

↙ ↓ ↘ 3) Defluoridation

1) Removal of Hardness. 2) Fluoridation

↙ ↘

Temporary — Permanent — a) Addition of Sodium Carbonate
b) Base exchange process

a) Boiling
b) Addition of lime
c) Addition of Sodium Carbonate
d) Permutit process.

1) Boiling ⇒ $Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$.

2) lime (Clerchi's method).

$Ca(OH)_2 + Ca(HCO_3)_2 \rightarrow 2CaCO_3 + 2H_2O$

3) Sodium carbonate.

$Na_2CO_3 + Ca(HCO_3)_2 \rightarrow 2NaHCO_3 + CaCO_3$.

4) Base Exchange process:

⇒ Sodium permuti is complex compound of sodium, aluminium, silica.

⇒ When passed through it it reduced the water to zero hardness.

- Reports showed soft water for the cardiac diseases.

b) Fluoridation of water.

⇒ Water is main source of fluorine and its depiciency causes dental, skeletal fluorosis etc.

- It is making the water to the optimum concentration of fluoride.

c) Defluoridation:-

⇒ Reducing the optimum levels.

Disposal of Refuse

Solid waste:

⇒ It includes garbage (Food waste) Rubbish (Paper plastic, wood, metal. Throw away glasses) demolition product (Brick mammary, Fire) Sewage treatment residue.

⇒ It should not contain Nightsoil But in India it is common.

⇒ If allowed to accumulate, ⇒ Favour fly breeding attracts rodents and vermins, creates foul pollution, Back to man by dust on fly. unsight appearance and odour of nuisance.

Sources of refuse

① Street ② Market (Vegetables, animal matter)
③ Stable litter (animal droppings) ④ Industrial.
⑤ Domestic (Ash, rubbish & garbage).

Storage

⇒ Galvanized steel bin with proper fitting cover.
⇒ Paper sack which removed everytime
⇒ Public bins with no cover as they dont like to in

Collection

① House to house collection.
② Dumping in Public bins
↳ Cannot the refuse to thrown out & Sweepers are needed.
⇒ Environmental Hygenic Committee (1949) recommend House to house collection.
⇒ Latest "Dustless Refuse Collector" has totally enclosed body.

Methods of disposal

→ No single method, depend upon situation, cost, land and labourers.

(1) Dumping

→ Disposal of dry refuse, which is fed in volume by the bacterial action & used for cultivation.

→ Drawbacks → Flies, Rodents, Nuisances, Pollution.

(2) Controlled Tipping or Sanitary Landfill

→ Differ from dumping by placing it in trench or prepared area.

a) Trench method → When level ground available, a long trench of 2-3m deep & 4 to 12m wide. depending upon need. Refuse is compacted and covered with excavated earth.

b) Ramp method: When terrain is sloping. Excavation is made to cover the material.

c) Area method → In depression, disused areas, quarries and clay pits. Refuse is packed and consolidated in uniform layers upto 2-2.5m with each layer by mud cover of 30cm thick.

→ After 4-6 months complete decomposition occurs and organic matter is got.

→ This control tipping is revolutionized by bulldozers for spreading & trimming top soil.

(3) Incineration

→ Burning or incineration hygenically when suitable land not present.

→ Hospital wastes are best.

→ Developped countries use this due to ↓ of land.

→ In it produces ash, and not manure India don't use it well.

④ Composting

⇒ Combined disposal of refuse, nightsoil or sludge
⇒ where it is breaken down by bacterial action and produces humus like material called compost..
⇒ The heat produces destroys eggs & larvae of flies and organisms makes it good soil builder..

i) Bangalore method (Anaerobic method)
Hot fermentation process.

⇒ Trench of 3ft deep, 5-8 ft broad, & 15-30ft long depending upon refuse & nightsoil.
⇒ First layer of Refuse of 15 cm nightsoil of 5 cm alternatively and above layer to be refuse and then covered with excavated earth.
⇒ If properly done manure will not sink
⇒ within 7 days heat (over 60°C and then at 4-6 months, decomposed odourless inoculum material of manure comes

3ft
- Refuse - 15cm
- 5cm
- Refuse - 15cm
- NS - 5cm
- Refuse - 5cm

⑫ Mechanical Composting

⇒ Raw materials are pulverized and to reduce size less than 2 inches
⇒ It is mixed with sewage, sludge or nightsoil in rotating machine & incubated.
⇒ It is completed in 4 to 6 weeks.

⑤ Manure pits

⇒ In rural areas no collection & disposal are thrown around houses causing soil pollution.

⇒ In this "Manure pits" by individual houses, the dumps them and cover with earth.
⇒ 2 Pits are needed when one is not in use.
⇒ 5-6 months the manure will be ready.

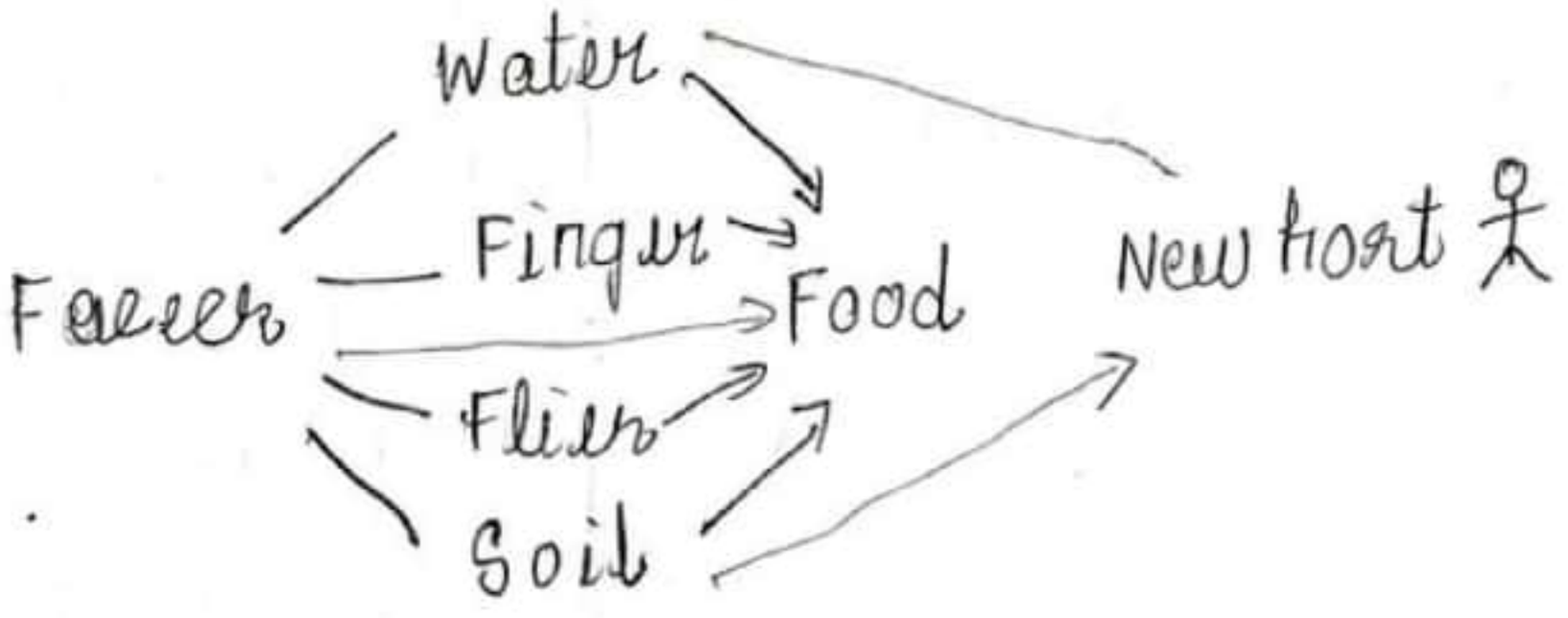
⑥ Burial

⇒ Suitable in small camps.
⇒ Trench of 1.5m wide & 2m deep and at end of every day require covered with 20 to 30 cm of earth.
⇒ When 40cm from grounds level it is closed. and new one used.
⇒ 4-6 months ⇒ Manures.
⇒ Trench of 1m for length. 200 persons filled by 1 week.

Excreta Disposal

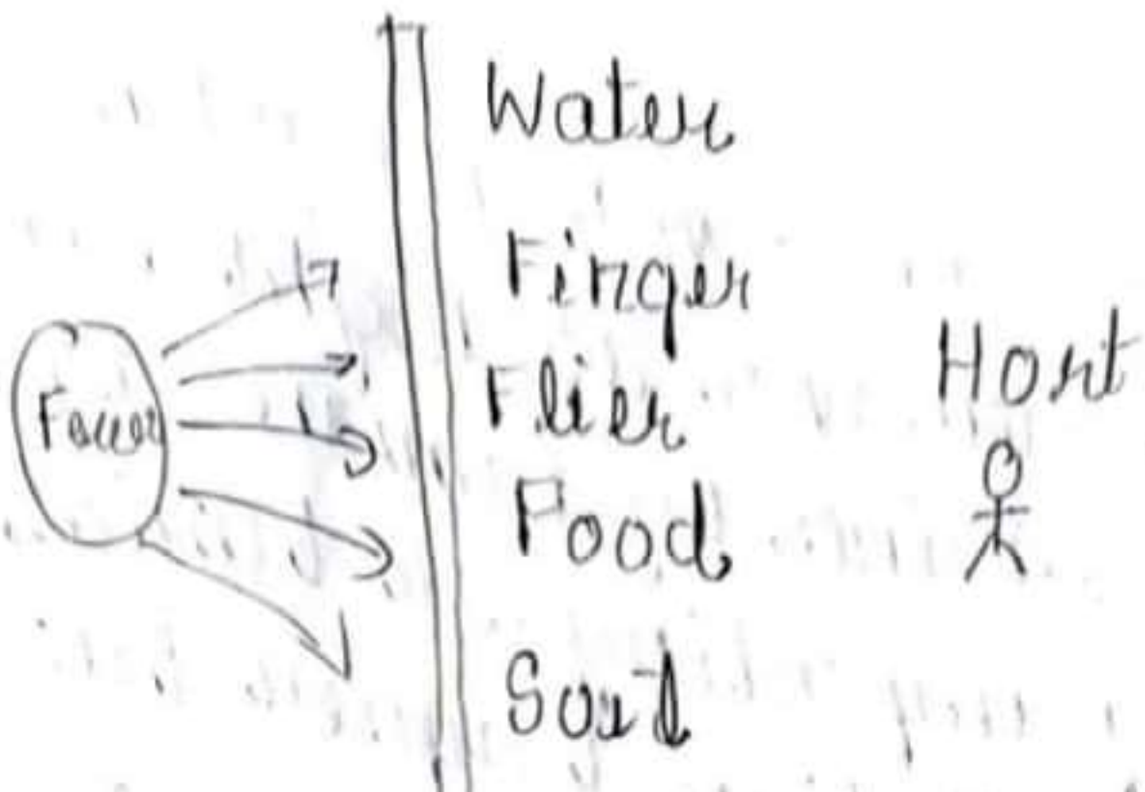
→ Human excreta is a source of infection. Causes environmental pollution. It cause health hazards By i) Soil pollution ii) Water pollution, iii) Food contamination iv) Propogation of flies.
↳ Causing typhoid, paratyphoid, dysentries, diarrhea; cholera, hookworm, ameabiasis, other parasitic & intestinal infestations.

How disease is carried from excreta:-
- Let us consider fecal born disease transmit to a new host.
→ Excreta of sick person or carrier is the focus of infection.
→ It gets transmitted through 5 channels:



Sanitation Barrier

→ Community medicine aims at breaking disease cycle at vulnerable points
→ Disease cycle may be broken at various levels by segregation of faeces, protection of water, food, personal hygiene, control of flies,
→ Most important is @ segregation of faeces. so disease agent is destroyed. By imposing a barrier called "Sanitation Barrier".
→ In simple, By providing 'sanitary' latrine and a 'disposal pit'.



↳ Sanitation Barrier

Methods of Excreta disposal.

(I) Unsewered area

(1) Service type latrines (conservancy system)

(2) Non-Service type (Sanitary latrine)

a) Bore hole latrine

b) Dug well or pit latrine

c) Water seal type latrine

i) P.R.A.I type

ii) RCA type

iii) Sulabh Shauchalaya

d) i) Septic tank

ii) Aqua privy.

(3) Latrine suitable for camps and temporary use

a) Shallow trench latrine

b) Deep trench latrine.

c) Pit latrine

d) Bore hole latrine.

(II) Sewered area

(1) Water carriage system and sewage treatment.

a) Primary treatment

- Screening
- Removal of grit
- Plain sedimentation

b) Secondary treatment

- Trickling filters
- Activated sludge process.

c) other methods.

i) Sea outfall

ii) River outfall

iii) Sewage farming

iv) oxidation ponds.

① Unsewered area

(1) Service type (Conservancy system)

→ Collection and removal of night soil from bucket or pail latrines by human agency and disposed by composting or burial.

→ It makes the sanitation barrier break-

→ Needs large members, if sweepers go strike then entire machinery collapses.

→ Environment on Hygiene committee (1949) has recommended to sanitary latrines.

(2) Non Service type of latrines (Sanitary latrines)

→ Sanitary latrine should fulfil the criteria of not contaminating ground or surface water, pollute soil, accessflies, rodents, animal, or odour

a) Bore hole latrine

→ Circular hole of 12-16 inch in diameter and depth of 20 ft.

→ Equipment of auger is used to dig a hole.

→ In loose and sandy soils, hole lined by bamboo matting or earthen ware rings to prevent caving of the soil.

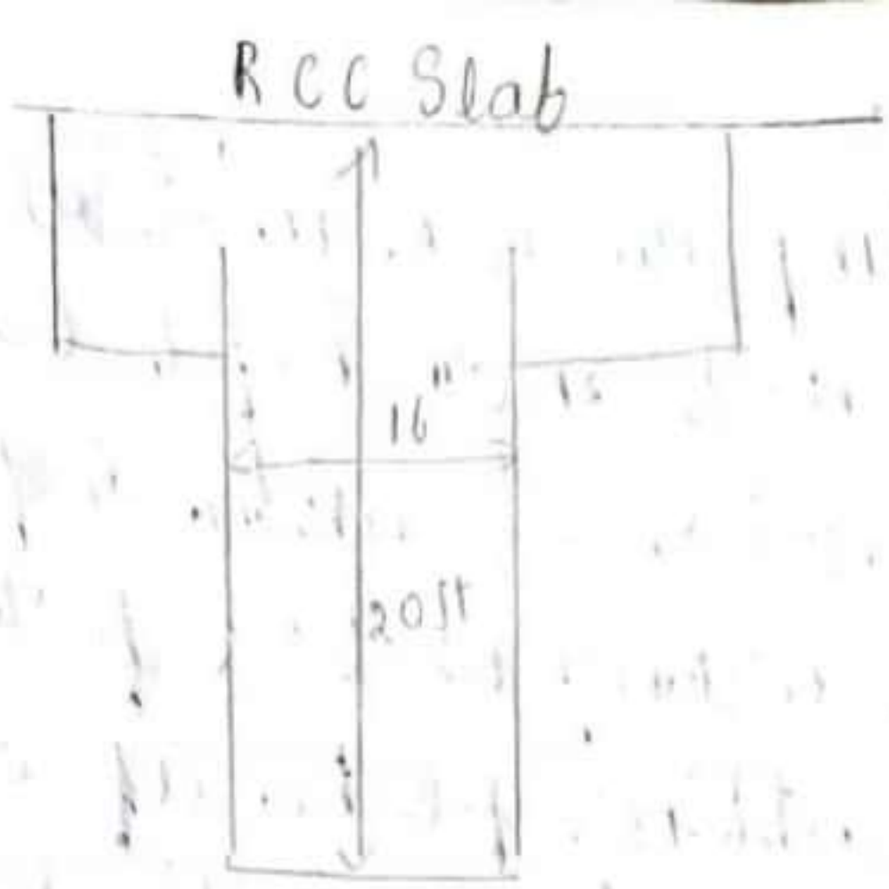
→ Concrete squatting plate, with foot rests, and central opening is placed and enclosure for privacy.

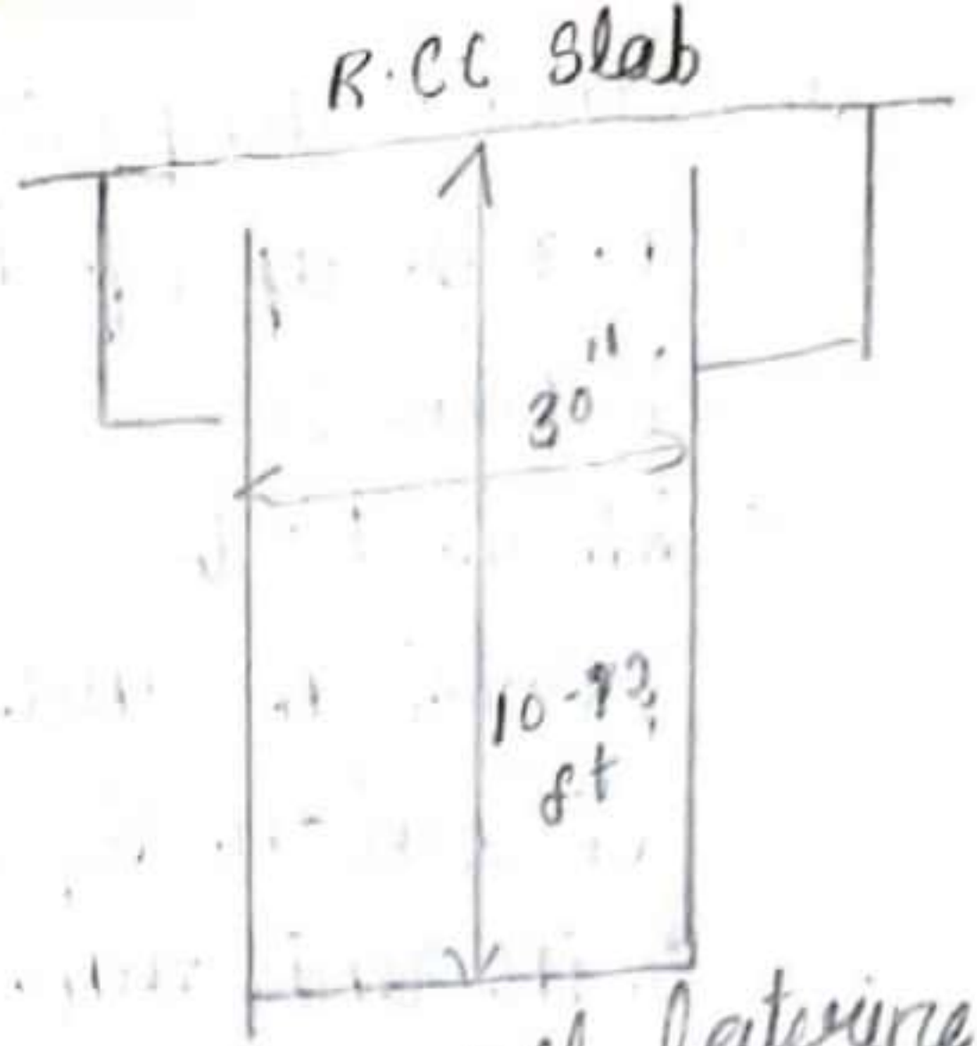
→ For family of it useful for 5-6 years.

→ Nightsoil undergoes anaerobic digestion and converted to harmless mass.

Merits → 1) No sweepers 2) No fly breeding 3) No water contamination.

Demerits → 1) Fills rapidly 2) Special equipment of auger needed 3) Difficult to dug deep





Bore hole latrine

Dug well latrine.

b) Dug well latrine or Pit latrine

→ Improvement over bore hole latrine.

→ Circular pit of 30 inch diameter, 10-12 ft depth.

→ Pit lined by Pottery rings prevent caving.

→ Concrete squatting plate, enclosure are provided.

Merits → i) No special equiment 2) Last for 5 years.

c) Water Seal latrine

→ Further improvement of latrine; where the squatting plate is fitted with water seal. which has 2 (X) function i) Prevents access to flies. ii) Prevents escape of odours.

→ once the latrine is flushed it is no longer visible.

i) PARAI → Planning and research action Institute, Lucknow (UP), 2) RCA type → Research cum action in Environmental sanitation of ministry of health.

→ PRAI and RCA are essentially the same with minor matter of engineering details.

→ RCA latrine

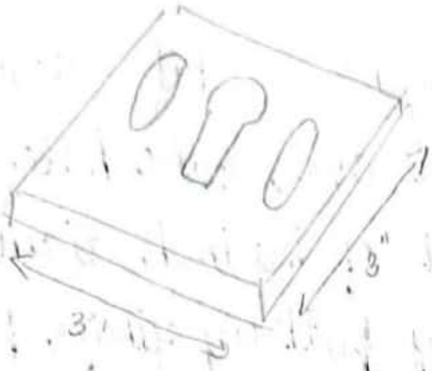
① Location →

→ 15 m away from water supply.

→ Lower elevation to prevent bacterial contamination.

② Squatting plate

→ Made up of impervious material so that it can be washed and kept clean & dry.
→ It is to be considered with squatting position and using water for anal washing
→ Circular squatting plate of 3ft and 2 in uniform thickness with rained footrest

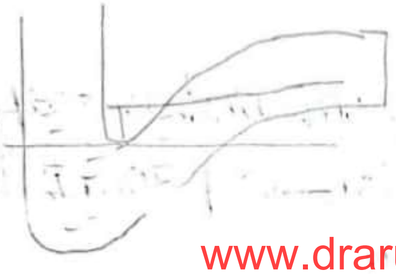


③ Pan

→ It recieves the night soil, urine, wash water
→ Length of 17 inch and uniform slope from front to back of pan with smooth finish

④ Trap

→ It is a bent pipe, about 3 inch in diameter, and connected with pan.
→ Holds the water necessary for water seal
→ Water seal is the distance between level of water in trap and lowest point of the upper concave surface of trap (3/4 inch)
→ Prevents flies & nuisance.

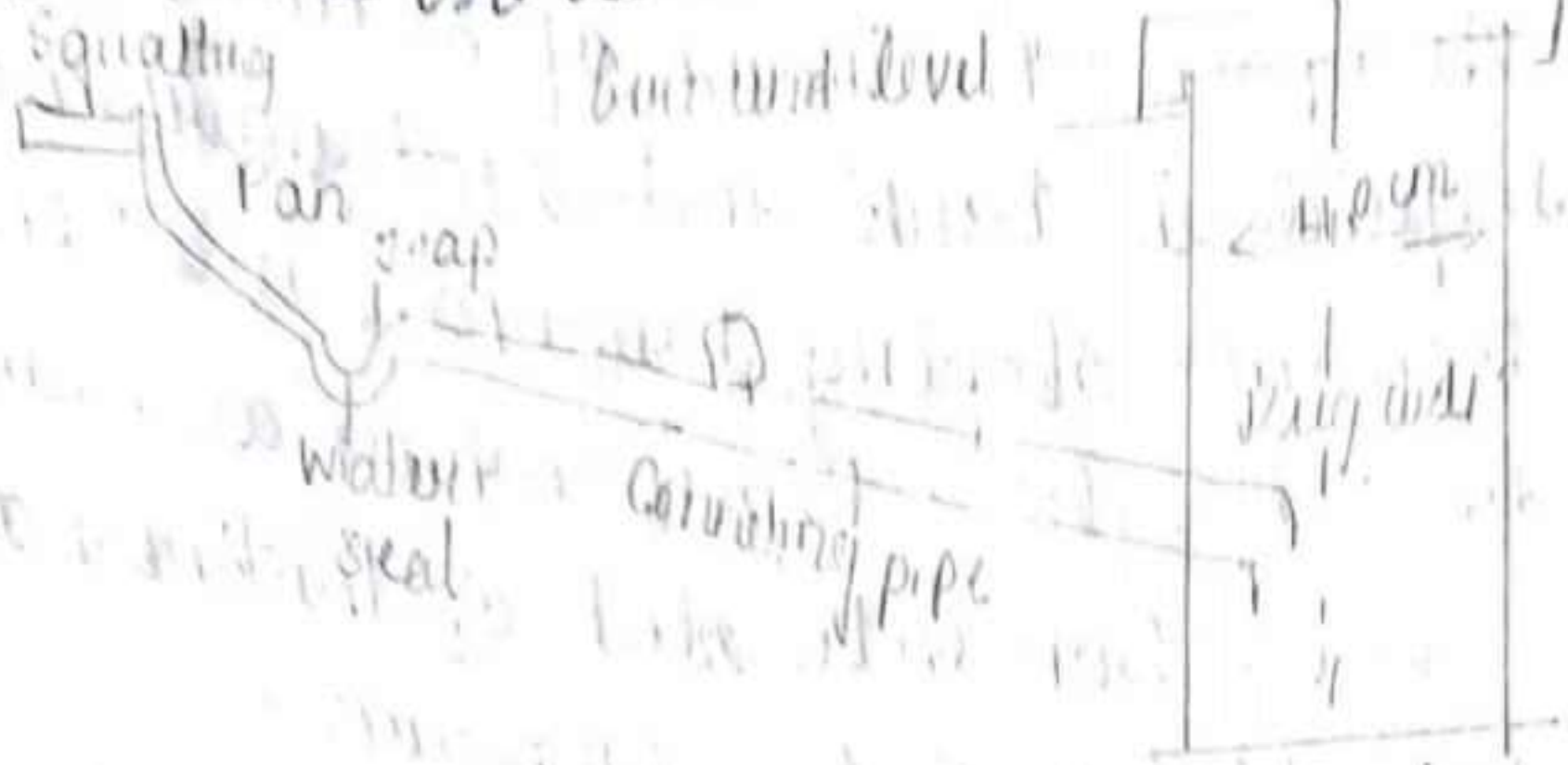


(5) Connecting Pipe

→ When pit is dug away from squatting plate. the trap is connected by connecting pipe.
→ It is called as Indirect type.
→ Merits → If pit fill up, then new can be dug & connected

(6) Dug well

→ 30 inch in diameter & 10-12 feet deep, lining of earthenware or bamboo is used.



(7) Superstructure

→ Privacy & shelter.
→ Neat finish is desirable to be maintained.

(8) Maintenance

→ Squatting plate should be washed & Clean, dry.
→ Flushing with adequate water
→ One to 2 litres needed for RCA latrine.
→ Health education is needed for this.

(9) Septic Tank

→ It is water-tight masonry tank into which household sewage is admitted for treatment
→ It is satisfactory means of disposing excreta and liquid wastes from individual dwellings, small group of houses, and institutions, and do not have access to Public sewerage System.

7 Design features.

→ They are single chambered or multiple chambered.

1) Capacity → Capacity depends upon the number of users. Minimum capacity of 500 gallons and 20-30 gallons per person.

2) Length → Twice that of depth.

3) Depth → 5-7 ft. 4) Liquid depth → 4 ft.

5) Airspace → Minimum of 30 cm between the liquid in tank and undersurface of cover.

6) Bottom → Sloping towards inlet end.

7) Inlet & outlet → Pipes which are submerged

8) Cover ⇒ Concrete slab of thickness and marke

9) Retention period ⇒ 24 hours.

⇒ Working of Septic tank

⇒ Solids settle down, lighter solids rise

↓ ↓

Called "Sludge" Called "scum"

↳ Attacked by anerobic bacteria & fung

Anaerobic digestion

↓

In Septic tank

↓ Broken down into simple compou

↓ volume, Inoffensive, stable-

Portion of solid converted to liquid and gas (Methane) and forms bubble

⇒ Liquid comes outlet pipe called as "effluen

Contains Bacteria, ova, cysts etc; Organic m

↓

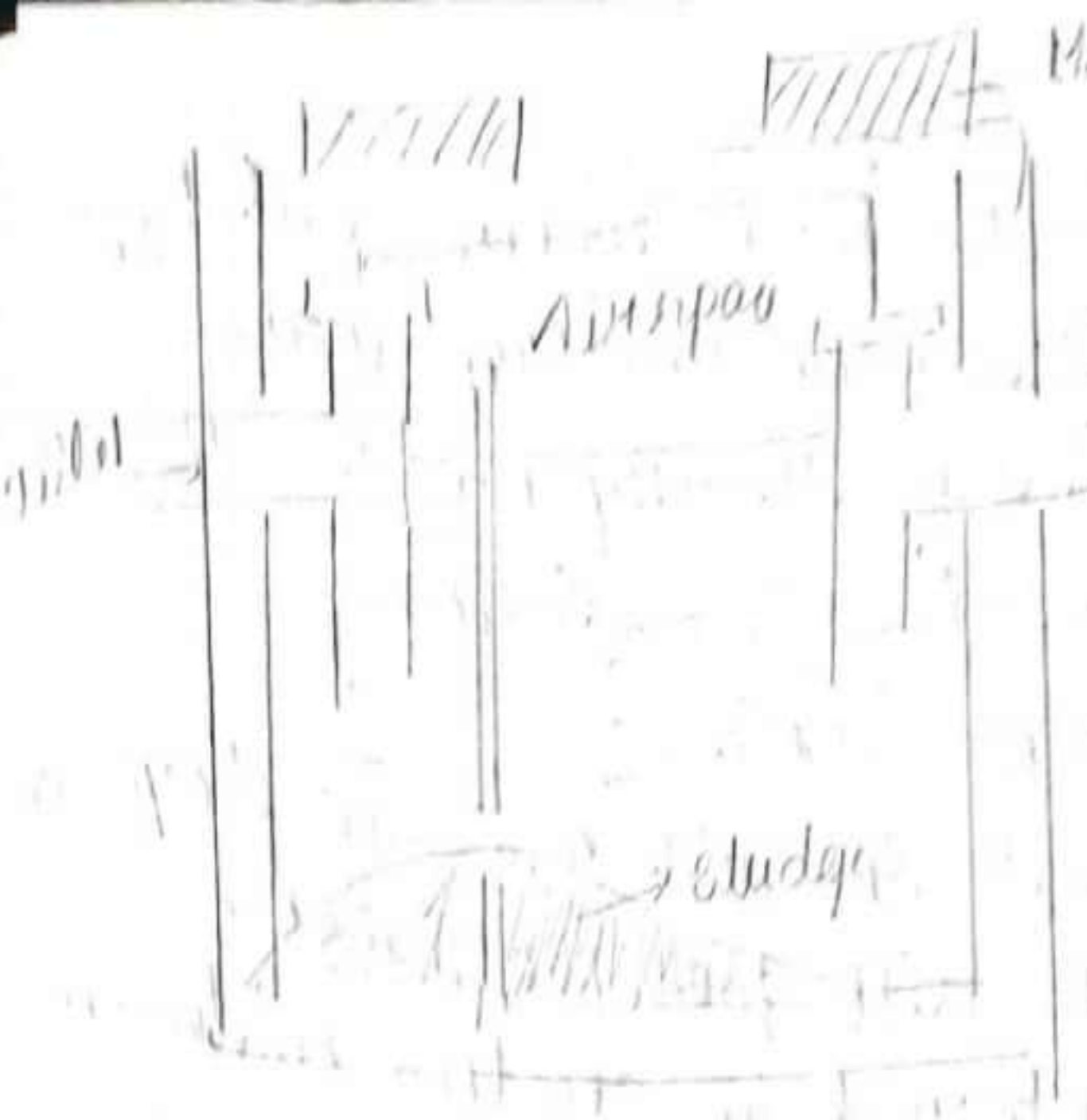
percolated to subsoil → Covered with So

Aerobic oxidation → Attacked By Bacteria in soil.

↳ Subsoil

In ↓

Nitrate, CO_2 & H_2 formed.



Operation and maintanence

→ Use of soap water, disinfectants & phenals are avoided as they kill bacteria in septic tank.

→ Sludge should be removed atleast one a year

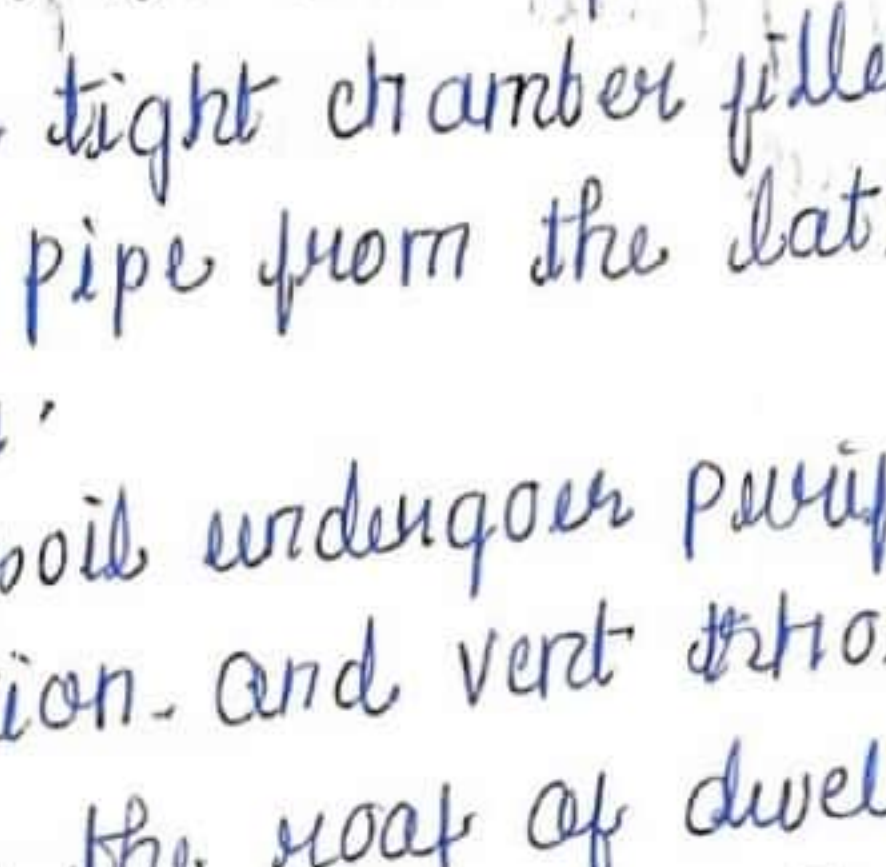
→ Newly built septic tank are filled with sludge from other septic tank to provide right type of bacteria.

e) Aqua Privy

→ Functions like septic tank. It consists of water tight chamber filled with water.

→ Short pipe from the latrine floor dips into water.

→ Nightsoil undergoes purification by anaerobic digestion and vent should be present above the roof of dwellings.



Suitable Sanchalaya.

→ Low cost pour flush, water seal type latrine
→ It uses less amount of water.
→ It is Basically an improved version of standard handflush latrine.

(3)(1) Shallow trench latrine

→ Trench of 1ft and wid & 3-5ft deep, and length of 10-12ft foot 100 users.
→ Earth soil should be on the side and should cover feces everytime they use.
→ May need sweepers to cover them up.
→ Ablution water is provided.
→ When below 30 cm closed and new trench is dug.

(2) Deep trench latrine

→ Camps of long duration.
→ 6-8ft deep, & 30-35 in wide.
→ Superstructure is provided, and seat on squatting plate according to the local customs.

Water Carriage System.

Human excreta and wastewater are removed away by a network of underground sewers to the sewage disposal plant

Components:

Household Sanitary fittings → Soil pipes → House drain

Sewage treatment plant. ← Public sewer

Sewage accessories:

i) Manhole :- When they are used for repair and clearings, placed in the changes of direction and 100 m from other sewers.
- Person entering there may get gets poisoning and asphyxiation.

ii) Traps :- Trees preventing foul gases from entering the house.

Sewage :-

- It is the waste water from the community containing solid and liquid excreta from house. street, factories.

Sewage Treatment

The aims of this is to convert an offensive and injectious hazard to inoffensive effluent and sludge which can be safely disposed to sea, land or River.

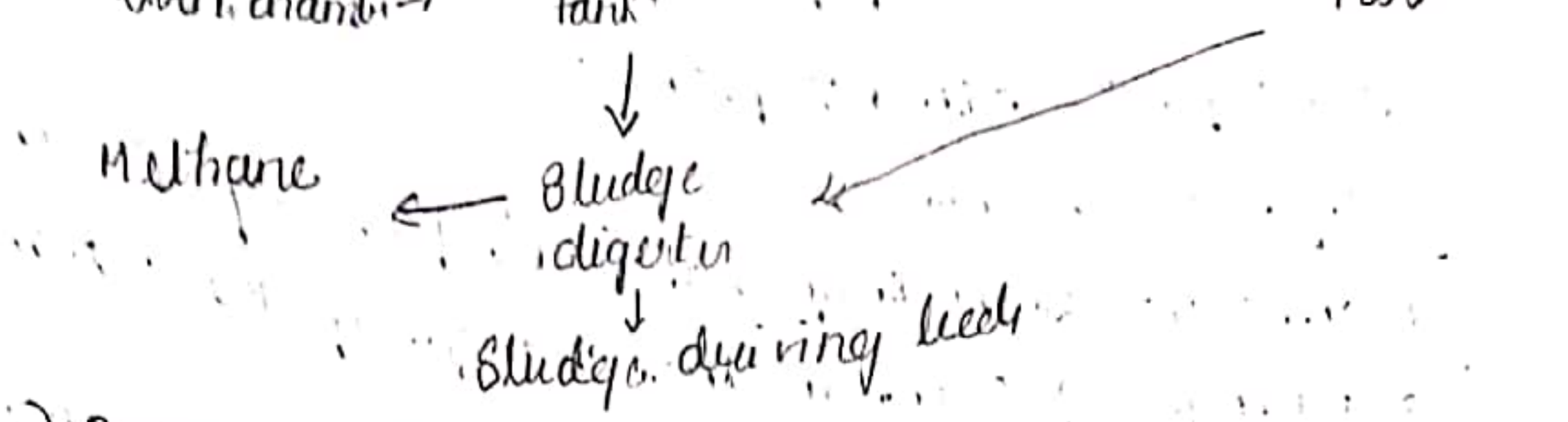
i) Aerobic : Whole sewage.
- Needs continuous supply of oxygen.
- Aerobic bacteria breaks the organic matter into CO_2, NH_4 water, nitrate.

ii) Anaerobic - Only sludge.
- End product is methane, Ammonia, CO_2.
- The methane can be used for heating and lighting purpose.

Two stages: (Modern sewage treatment)

i) Primary treatment → Screening, Grit removal, Primary sedimentation

ii) Secondary treatment → Trickling filter, activated Sludge process, Secondary sedimentation



i) Primary treatment

i) Screening :-

- Sewage is flowed through metal bars screen.
- Screen retains large floating objects like woods, dead animals.
- Screening are removed manually and disposed.

ii) Grit chambers: (Detritus chamber)

- A long narrow chamber.
- Principal of this is make heavier solids sand and gravel to settle down and other organic matter to flow through.
- The grit is removed manually and disposed.

iii) Primary sedimentation tank:

- Huge rectangular tank.
- Sewage moves slowly and solids settle down called as sludge.
- Sludge is removed mechanically and directed to sludge digesters.
- Fat and grease rise to surface to form scum and removed mechanically.

2) Secondary Treatment.

- Involves oxidation of organic matter by aerobic bacteria of the effluent of primary sedimentation tank.

1) Trickling or Percolating filter.
- It is a bed of crushed stone.
- There is a revolving device which uniformly sprinkles the effluent from the primary tank to stone
- The effluent trickles down the filter.
- With time a slimy "Zoogleal Layer" forms which contains aerobic bacteria, fungi and algae and it oxidizes the effluent as it trickles down.
- The zoogleal layer sloughs off called as humus
- The oxidized sewage is lead to Secondary tank.

ii) Activated Sludge Process.
- Aeration tank is the modern method and is the heart of the process.
- The effluent from the primary sedimentation tank is mixed with the sludge (Aerobic bacteria).
70% effluent + 30% sludge.
- Aeration is produced from the bottom
- It kills organism into nitrate, CO_2 H_2O.
- Then led to secondary sedimentation
- It is less space, costly, require skill operator

2) Secondary Sedimentation
- Oxidized sewage from the trickling filter or aeration chamber is led to secondary sedimentation.
- Sludge formed from the secondary is called Activated or aerated Sludge
- It is inoffensive and are rich in nitrates and phosphorus Bacteria. It can be used as valuable Manure

Sludge digestion
- A thick, black mass with bad odour. They are disposed by
1) Digestion → Sludge digestion tank Liquid,

Sludge Digestion:

→ It is one of the main problem, because it produces the sludge which is a thick black mass containing 95% water and odour.

a) Digestion

→ Undergoes anaemobic auto digestion in which complex solids are broken into H_2O, CO_2, methane and ammonia. The volume is reduced.

→ Resulting non-offensive, sticky. it away used is the great manure.

→ Methane which is a by product can be used for heating and lighting purposes.

b) Sea disposal → Sea coast towns pump them into sea

c) Land → Disposing by comporting them with town sepure.

Disposal Effluent

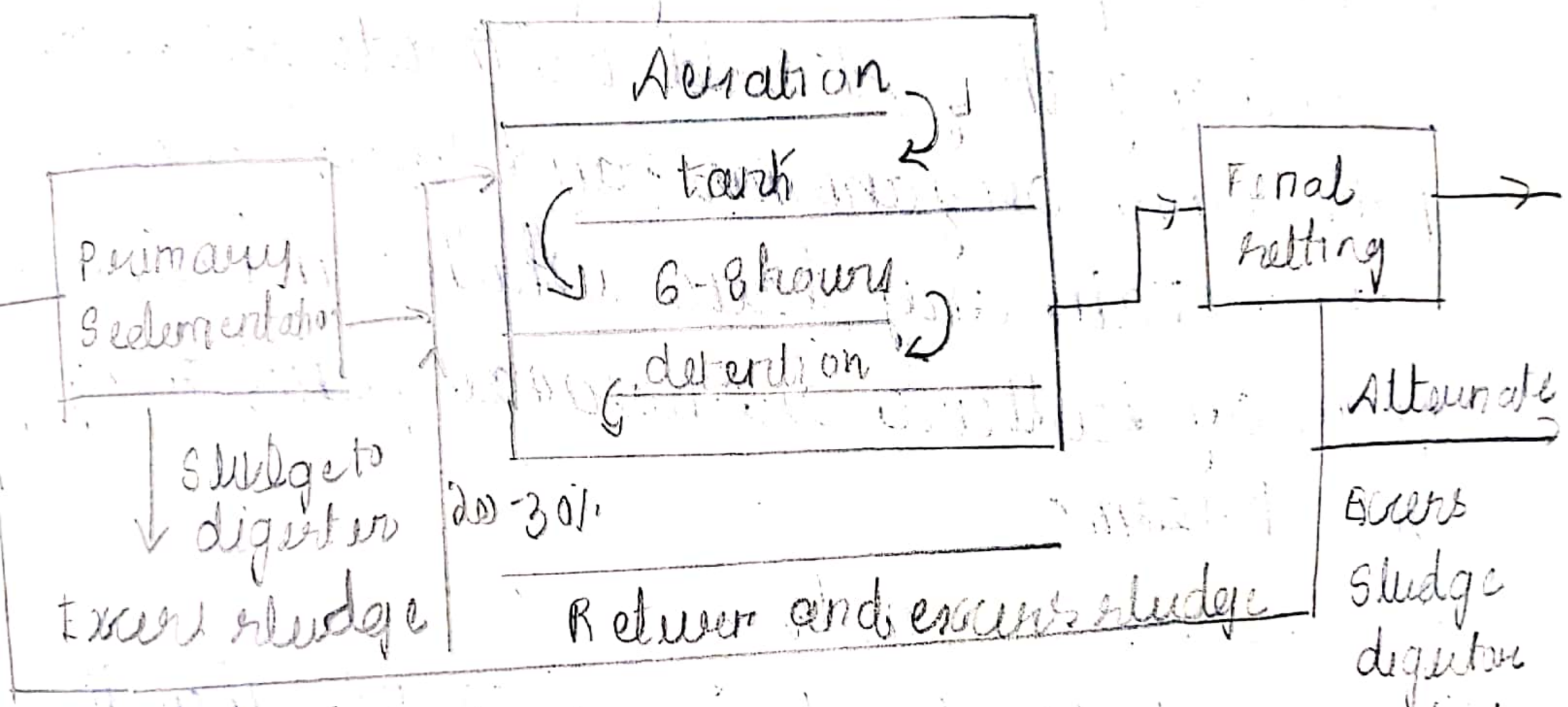
a) Disposal by dilution:-

→ By disposal into water courses like rivers and streams.

→ Since people are using river water for drinking they should be made free from pathogenic organisms and also should not contain any toxic which can kill man, fish, agriculture or normal functioning of the stream.

b) Disposal on lands:-

→ If suitable land is available then it can be used for irrigation purposes.



Activated sludge process

other methods of Sewage Disposal.

a) Sea outfall

- Sea coast town and cities may dispose of their sewage directly into the sea.
- Purification takes place by the large body of sea water, and solids gets oxidized.
→ Drawback is offensive solid matter washed off to shore causing public nuisance.

b) River outfall

→ Raw sewage is never discharge it is purified before. Purification on flow for it carry on aeration and self purification.

c) Land treatment (Sewage farming)

⇒ If suitable and sufficient land is available then sewage is applied to land after grit removal
⇒ It is called Sewage Farming or Broad Irrigation
→ Crops are grown in that but they are not had direct contact. Mainly Fodder grasses and potatoes, Fruit trees high above ground,
→ During rainy season it is difficult and might cause sewage sickness.

d) Oxidation ditches:

⇒ Other methods recommended are.
① Oxidation ditches and ② aerated lagoons.
⇒ It uses mechanical rotors for extended aeration..
⇒ They are low cost treatment methods for purification of sewage.

Oxidation Pond

- A cheap method of sewage treatment is the oxidation pond. It is also called as water stabilization pond, redox pond, sewage lagoons etc.
- The term "waste stabilization pond" is more appropriate as an oxidation pond there must be presence of
  1) algae 2) certain types of bacteria which feed on decaying organic matter. 3) sunlight.
- The organic matter contained in the sewage is oxidized by bacteria (here oxidation pond) to simple compounds like CO_2, Ammonia and water.
- The algae with the help of sunlight utilize CO_2 and other compounds for their growth.
- Thus they are mutually beneficial biologically.
- oxygen that is needed for oxidation is derived to small extent from atmosphere and mostly from the algae which liberate O_2 under sunlight.
- So sunlight is important, cloudy weather decreases the process.
- It is aerobic in sunshine and part of night and anaerobic in night so it is done by both aerobic and anaerobic bacteria.
- The effluent may be used for growing crops and may be discharged into rivers.
- Mosquito nuisance to avoided by keeping weed growth.
- There is no odour nuisance if is properly maintained.
- It is an established method for small communities.