EWCE 333
Wastewater Engineering and Sanitation

Lecture 16

Instructor

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Lecture Outline

Topics	Reference
• Sewage Effluent Disposal Methods • Sludge Treatment and Disposal Methods	Water Supply and Sanitation - Feroz Ahmed and Mujibur Rahman ITN -BUET

Sewage Effluent Disposal

Sewage and sewage effluent is disposed of by two methods:

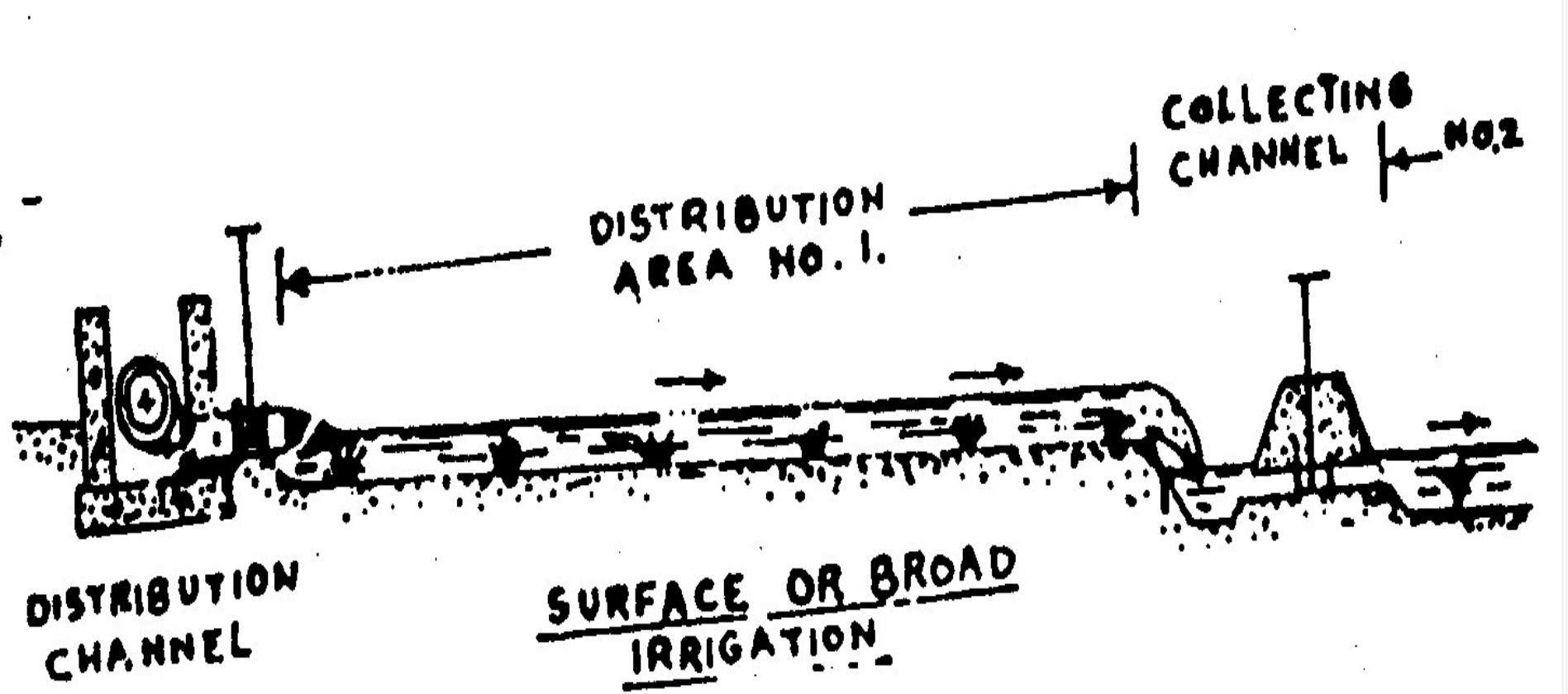
1. Disposal on Land by Irrigation
2. Disposal by Dilution in Water Bodies

1. ***DISPOSAL BY IRRIGATION***
   a. Surface or Board Irrigation
   b. Sub-Irrigation or inundation or Flooding
   c. Ridge and Furrow Method
   d. Sub-surface Irrigation

Sewage Effluent Disposal

DISPOSAL BY IRRIGATION

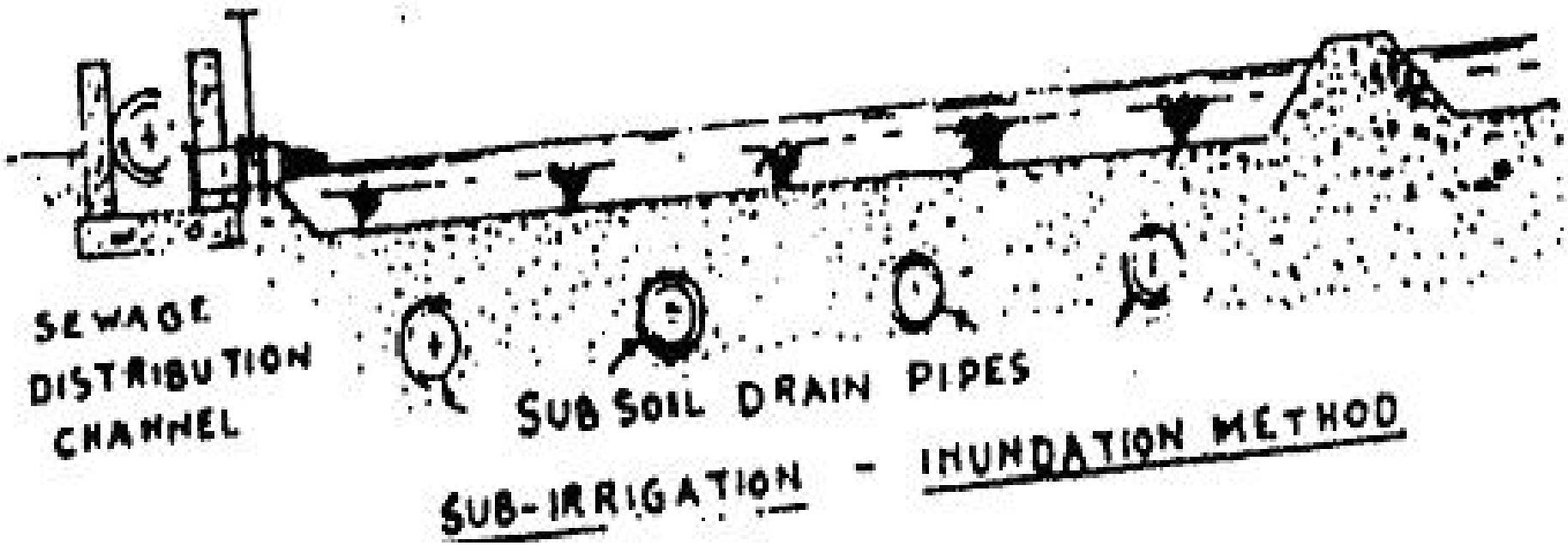
Surface or Board Irrigation



Sewage Effluent Disposal

DISPOSAL BY IRRIGATION

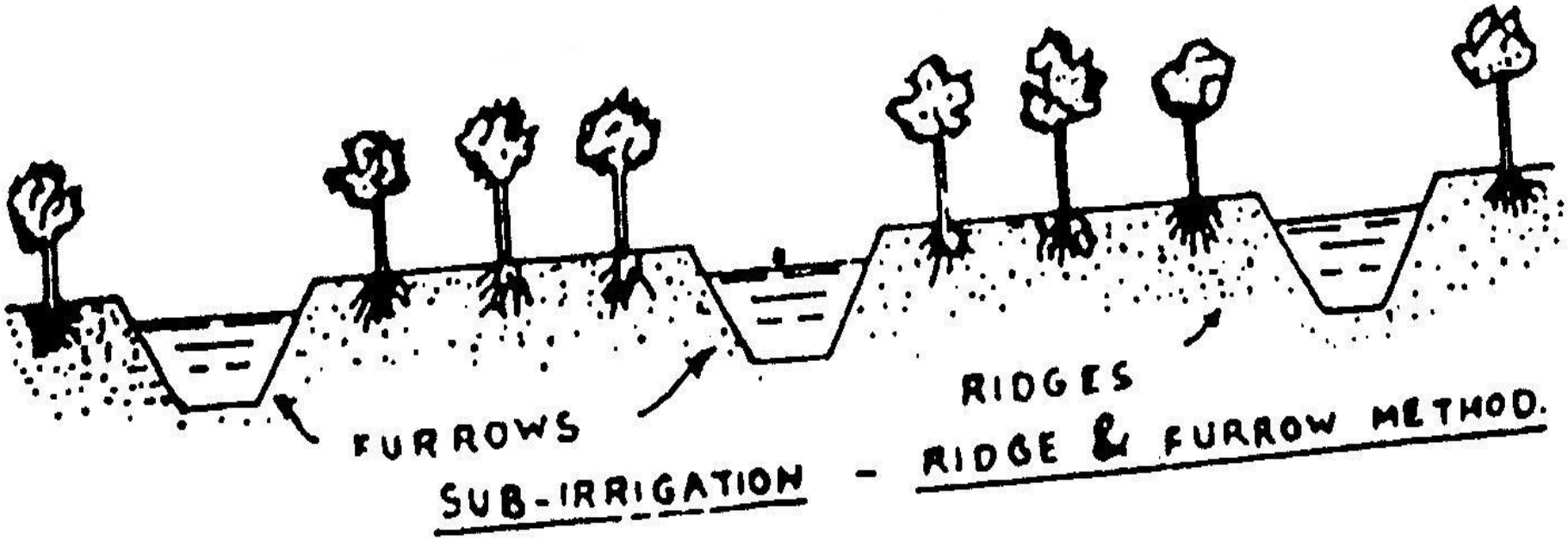
Sub-Irrigation or inundation or Flooding



Sewage Effluent Disposal

DISPOSAL BY IRRIGATION

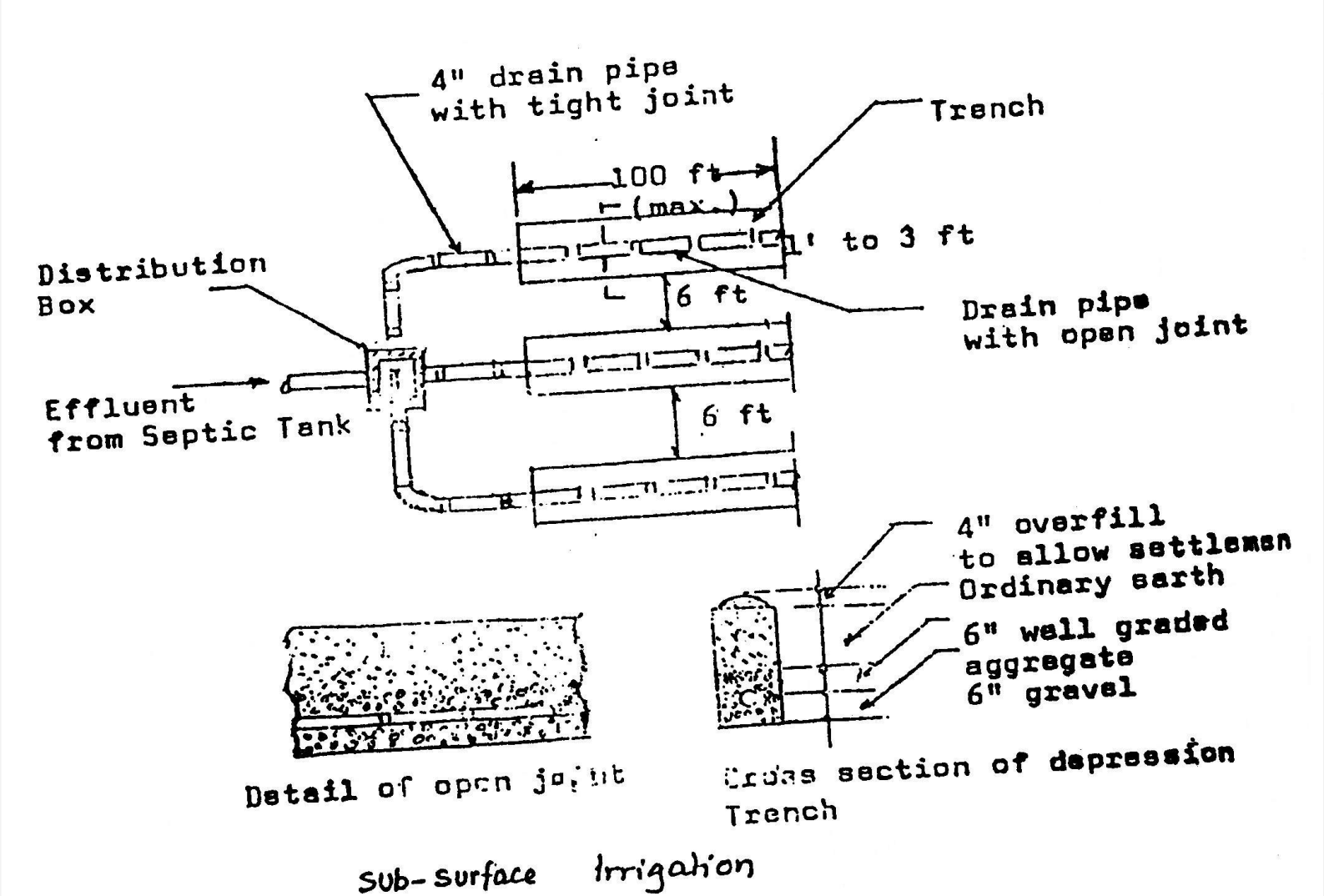
Ridge and Furrow Method



Sewage Effluent Disposal

DISPOSAL BY IRRIGATION

Sub-surface Irrigation



Sewage Effluent Disposal by Irrigation

Advantages

- Provide disposal option in the absence of big water bodies
- Disposal is accompanied by natural treatment
- Fertilizing value of sewage/effluent is returned to the land
- Does not require installation of costly machinery or skilled operator
- No surface water pollution

Sewage Effluent Disposal by Irrigation

Disadvantages

- Large area of land is required
- Not suitable in rainy season or wet climate
- The method is not efficient in case of clayey soils
- Possibility of spreading diseases through crops grown in sewage irrigated lands
- If not properly supervised, the land may become sewage sick

Sewage Effluent Disposal

2. ***DISPOSAL BY DILUTION***

- Disposal of sewage into a body of water or watercourse is known as disposal by dilution.
- In this method the advantage of self- purification capacity of receiving water body is utilized.

Sludge Treatment and Disposal

Sludge:

- Sludge is defined as the solid matter separated from the domestic and the industrial wastes in the process of biological treatment.

- It is an important by-product of waste treatment.

Depending on the degrees and method of treatment sludge can more specifically be termed as:

1) Raw or Primary Sludge
2) Secondary Sludge
3) Activated Sludge and
4) Digested Sludge

Importance of Sludge Management

- Sewage is the waste product of the community.
- Sludge is derived as a by-product from sewage in the process of treatment.
- Safe and proper treatment and disposal of sludge is important for maintaining the health of community and that of the overall environment.

Importance of Sludge Management

- Sludge treatment and disposal is important in view of the following considerations:

1) Sewage contains a large volume of suspended solids. This solid part derived out of biological treatment is objectionable and detrimental to health. So it needs to be handled at some point as a part of the overall sewage treatment processes.

Importance of Sludge Management

2) The sludge from domestic sewage, may contain pathogenic organisms may transmit diseases as well as organic and inorganic contaminants.

3) The sludge may sometimes become hazardous or toxic to human or have detrimental effect on the environment.

Collection of Sludge

Sludge is collected from -

- Primary clarifier
- Intermediate clarifier
- Secondary clarifier
- Sedimentation tanks of trickling filters
- Activated sludge unit
- Oxidation pond

Characteristics of Sludge

1) Sewage sludge contains both organic and inorganic solids as in the raw sewage.
2) Raw sludge is odorous and highly putrescible. It turns into objectionable mass if not properly treated and disposed of.
3) Sludge contains moisture in it. The amount of moisture depends on the processes involved in the treatment.

- Trickling filter plus primary sludge may range from 5 to 10% solids.
- Activated sludge plus primary sludge forms 2 to 5% solids.
- Activated sludge by itself contains less than 1% solids.

Methods of Sludge Treatment and Disposal

- The common methods of sludge treatment and disposal are:

  ✓ Digestion in a heated tank with subsequent dewatering by air drying or sand bed or by vacuum filtration.
  ✓ Centrifugation
  ✓ Wet oxidation
  ✓ Incineration
  ✓ Composting
  ✓ Sanitary landfill
  ✓ Water disposal

Sludge Digestion

Sludge digestion may be accomplished in both anaerobic and aerobic conditions of which the former is widely used.

Anaerobic Digestion of Sludge:-

- It is the sludge digestion in anaerobic condition.
- This is usually done in closed tank known as *Sludge Digester*.
- It is the process which liquefies sludge, produces gases and stabilizes the organic matters.

Anaerobic Sludge Digestion

Sludge digestion is adopted, because

1) It breaks down the complex organic matters of sludge into simple compounds.

2) It transforms a portion of solid content into liquid and gases. It thus reduces the volume of sludge.

- The volatile matter of sludge reduces to 65 to 85% in dry weight.
- The total reduction of the suspended solids ranges from 45 to 55%.

Anaerobic Sludge Digestion

3) Digested sludge may be used as a fertilizer or soil conditioner. Gases produced in digestion are used as fuel.

4) Coliforms are reduced by 99.9 percent by digestion for a period of 30 days at a temperature of 95 to 100º F.

Anaerobic Sludge Digestion

Process of Anaerobic Sludge Digestion:-

Anaerobic digestion is a two-stage process where -

- the complex organics in the waste solids are first broken down to simpler compounds specially the short chain fatty acids by the action of facultative microorganisms.

- These intermediates are then further reduced by a separate group of bacteria to methane and carbon dioxide.

Anaerobic Sludge Digestion

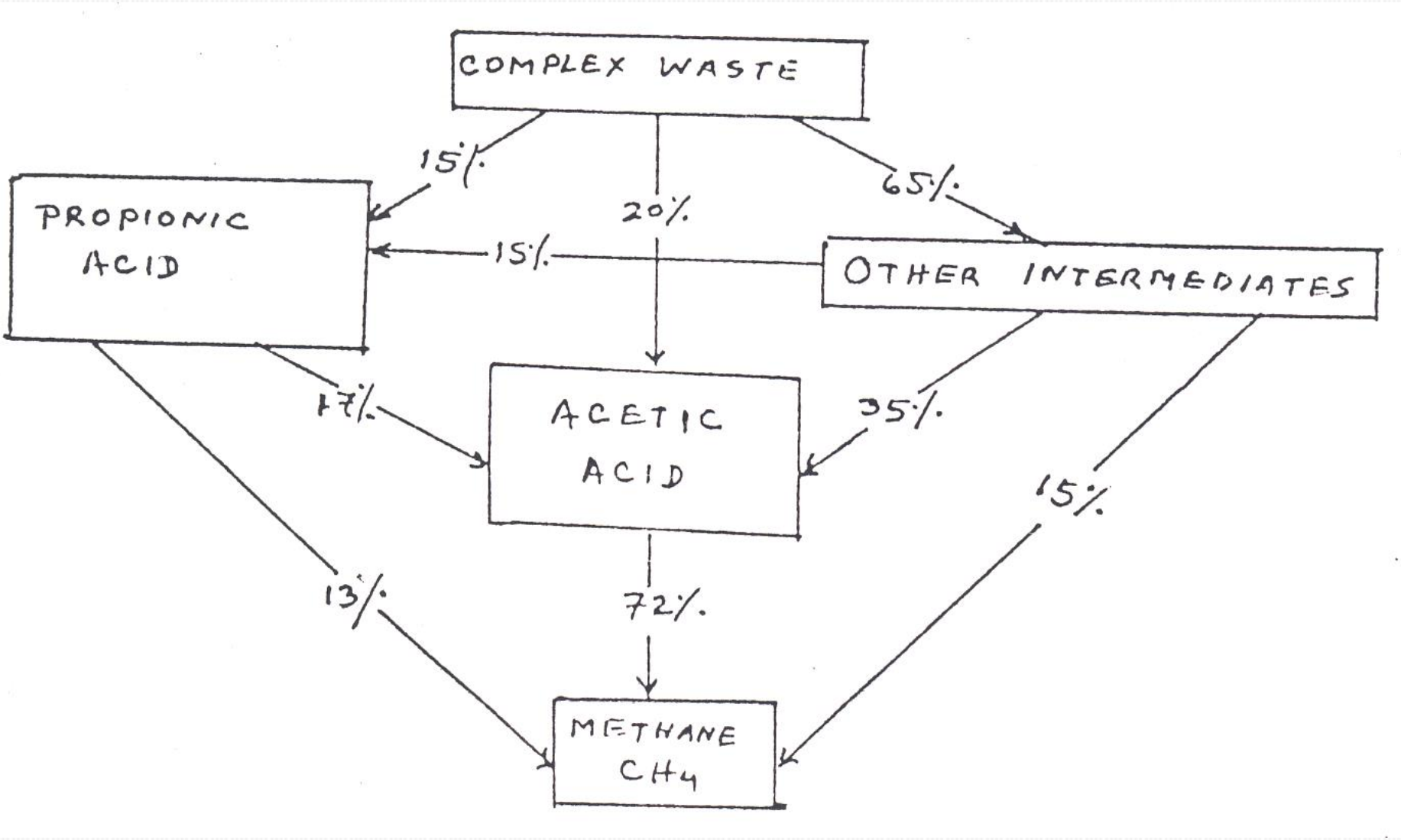


Figure: Metabolic Pathways in Anaerobic Digestion

Anaerobic Sludge Digestion

1st stage:

- Intermediate organic acids can lead to toxicity problem due to either pH or the cations associated with the acid.

- Heavy metals may exhibit toxic effect in anaerobic systems, being solubilized under the chemically reduced conditions therein.

- The metals may be precipitated as sulphides by chemical addition if they are present.

Anaerobic Sludge Digestion

2nd stage:

- The obligate anaerobes convert organic acids to methane and carbon dioxide.

- The microorganisms are more sensitive to the surrounding environment than are the facultative organisms which affect the first step.

- Toxic constituents will affect them first and cessation or slowing of their activity can lead to pickling of the digester.

Anaerobic Sludge Digestion

- Methane gas produced in anaerobic digestion is mostly used to heat the digester.
- Sometimes it is used to provide mechanical power for other plant process.
- Heat needed depends upon climate, construction of digester walls and retention time.
- The digested solids from anaerobic processes may be dewatered without further treatment upon open or covered drying beds.
- It may be necessary to add chemicals for satisfactory mechanical dewatering.

Anaerobic Sludge Digestion

Control of Digestion:-

To have control over the digestion process it is necessary to have control over some conditions in the operation of digestion tanks. These are:

- ✓ Control of temperature
- ✓ Control of alkaline range of pH of sludge
- ✓ Control of seeding of digested sludge.

Anaerobic Sludge Digestion

Control of Temperature:-

Digestion process is accelerated at high temperatures.

a) **Zone of thermophilic digestion**:

- Temperature range - 100° to 131°F (38 to 55ºC).
- Not used because of odor and other operating difficulties.

b) **Zone of mesophilic digestion**:

- Optimum temperature - about 85°F(29°C) with a digestion period of 4 weeks.
- Further heating to 120°F (49°C) or so would reduce the digestion period to 15-18 days

Anaerobic Sludge Digestion

Control of Alkaline Range:-

- pH value should be maintained at 7.2 to 7.4, if raw sludge is added.

- To maintain optimum pH value, added raw sludge ≤ 3 to 5% by weight of the digested sludge.

Control of Seeding:-

- Seeding is the addition of fresh sludge with the previously well digested sludge under controlled condition of temperature.

- Seeding is also important for successful operation of the digestion tanks.

Aerobic Sludge Digestion

- Sludge digestion may also occur at aerobic condition.
- Under such situation different organisms oxidize complex organics using different biological pathways.
- They are not readily affected by toxic substances.

Aerobic Sludge Digestion

Aerobic digestion has got the following characteristics :—

- volatile solids reduction is much more than in anaerobic digestion
- has lower BOD in the supernatant
- has less operational problems
- involves lower capital cost requirement

Sludge Treatment

Centrifugation

- It is the process of dewatering moist sludge by continuous centrifugation where solids get separated from the liquid in the treatment plant.

- A solid bowl horizontal centrifuge is generally used. The screw conveyor or scroll rotates at speed slightly more than that of the bowl and thus carries the solids through the device and up the ramp to sludge cake outlet.

Sludge Treatment

Centrifugation

The variables which are involved in the process are –

the bowl diameter
the ram slope and length
the scroll speed and pitch
the feed point of sludge and chemicals
the retention time
the sludge conditioning

- This method is satisfactorily used in dewatering paper mill waste, packing house waste, foundry sludge, refinery wastes and also sewage sludge.

Sludge Treatment

Wet Oxidation

- In this process, sludge is treated by incineration i.e., heating at high temperature that uses the principle of wet combustion to degrade the organic matter in sludges.

- To support the combustion process, oxygen is supplied by injection of air into the system.

- The combustion temperatures in wet oxidation are considerably lower than the temperatures in normal dry combustion.

- This process may be used in disposal of organic waste sludge.

Sludge Treatment

Incineration

- It is the process of burning sludges at high temperatures.
- Clinical and hospital wastes are generally considered too difficult to handle in a landfill site.
- To dispose of these wastes safely they are burnt.
- Sludge from some difficult wastes as dioxines should only be disposed of by burning at high temperatures.
- Incinerators are very high capital projects though they have less operational problems.

Sludge Treatment

Composting

- Composting is a biological process of decomposition of organic solid wastes to a relatively stable end product.

- The sludge that has been composted properly is sanitary nuisance-free, humus like material.

- Approximately, 20 to 30% of the volatile solids are converted to carbon dioxide and water.

- In addition, as the sludge is usually processed in the thermophilic temperature range, the product sludge is essentially pasteurized.

Sludge Treatment

Composting

- The composted sludge may be used as a soil conditioner.

- Most composting operations consists of three basic steps:-

  Preparation of wastes to be composted

  Decomposition of the prepared wastes

  Preparation and marketing of the product

Sludge Dewatering Methods

Sludge Drying Bed

- Beds are 6 to 10 m wide and upto 40 m long.
- At least two beds are necessary even for a small plant.
- Dewatering occurs as a result of drainage and evaporation and is heavily dependent on climate.

Sludge Dewatering Methods

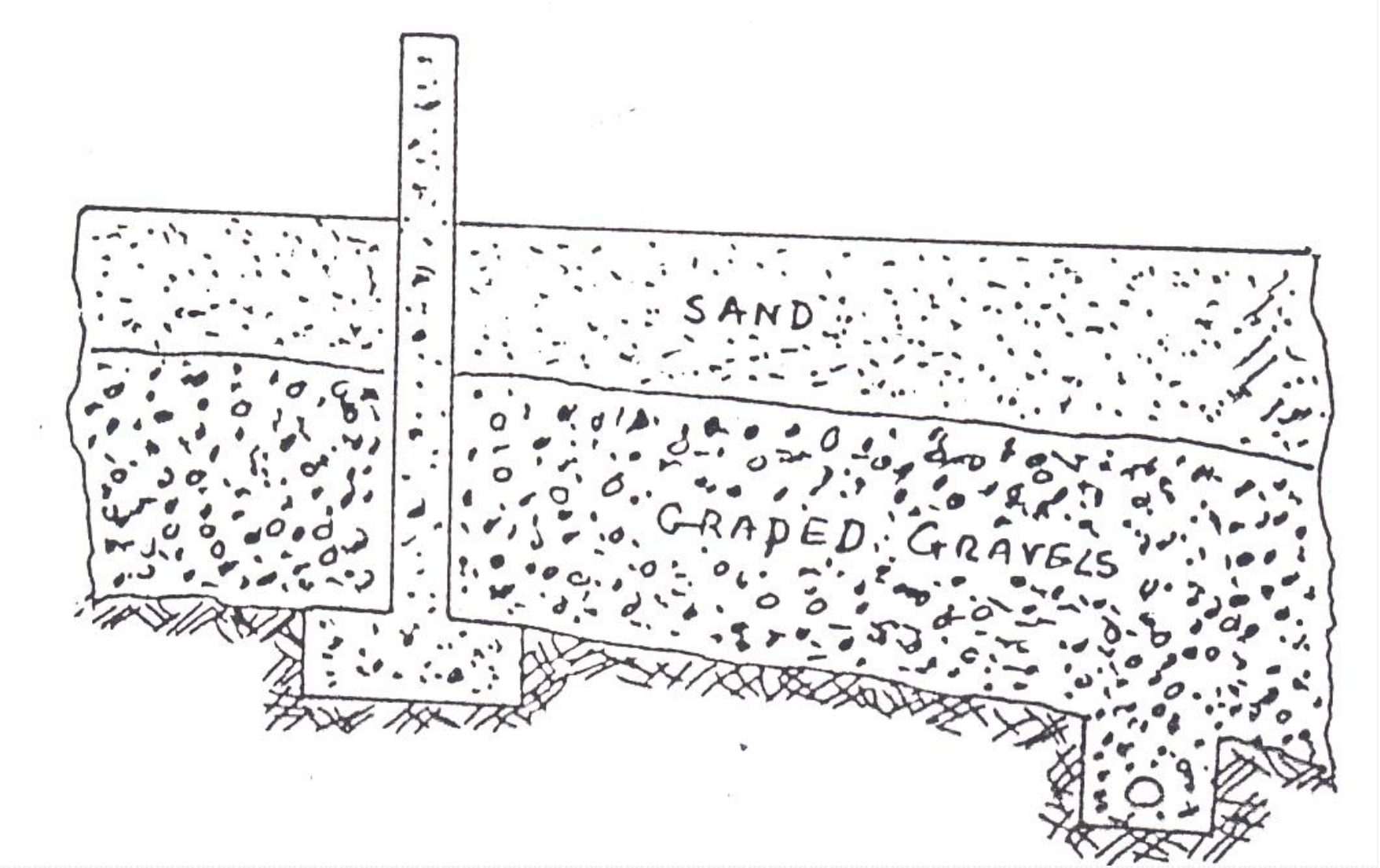


Figure: Section of Sludge Drying Bed

Sludge Dewatering Methods

Sludge Drying Bed

- In wet climate it is convenient to cover beds by glass or translucent plastic.
- Beds are operated by filling them with digested sludge to a depth of 200 to 300 mm.
- After dewatering, the volume will be reduced to 60%. The cake may be removed with appropriate mechanical device.

Sludge Dewatering Methods

Vacuum Filtration

- Vacuum filters are also used for dewatering digested sludge.
- This is done by means of drum set horizontally and covered with the filter media.
- The drum is rotated in the tank about one quarter of drum submerged in the wet digested sludge.
- Valves and pipings are arranged in such a way that as the drum rotates, a vacuum applied on the inner side of the filter media draws water from the sludge and holds a layer of sludge to the drum.

Sludge Dewatering Methods

Vacuum Filtration

- The application of vacuum is continued as the drum rotates out of the sludge into the atmosphere. This pulls additional water away from the sludge mat leaving a moist cake of sludge on the outer surface.

- The sludge mat is scraped blown or lifted away from the drum just before it enters the sludge tank again.

Sludge Disposal Methods

Landfill

- It is the method of disposal of sewage sludge and solid wastes on land without creating nuisance or hazards.
- If a suitable site is found, a sanitary landfill can be used for disposal of sludge, grease, grit and other solids whether it is stabilized or not.

Sludge Disposal Methods

Landfill

- In a true sanitary landfill, the wastes are deposited in a designated area, compacted in a place with a tractor or roller and covered with a 30 cm layer of clean soil.

- This prevents creation of nuisance conditions such as odors and flies. But in this process drainage from the site (known as leachate) would cause pollution of ground water supplies or surface streams should be guarded against.

Sludge Disposal Methods

Disposal to Water Bodies

- Sewage sludges are sometimes disposed of at the sea from coastal cities and towns.
- But the outfall should be at a greater depth so that the sludge does not rise to the water surface.