CE 356
Environmental Engineering-II

SLUDGE TREATMENT

Engr. Ghulam Hussain

SLUDGE TREATMENT

- ***Sludge***, or residual solids, is the end product of wastewater treatment, whether biological or physical/chemical treatment.
- Sludge contains pathogens and organic/inorganic contaminants and nutrients.
- Sludge handling accounts for;
  - 30 – 40 % of capital costs
  - 50 % of operating costs, and
  - 90 % of the operational problems at WWTP.

SLUDGE TREATMENT

Purposes of Sludge Treatment:

- reduction of moisture content of sludge
- reduction of sludge volume
- removal of pathogens.
- recovery of methane.
- its use as fertilizer/soil conditioner.

SLUDGE TREATMENT

Amount and Characteristics of Sludge:

Sewage sludge consists of;

- the organic and inorganic solids present in raw sewage and removed in primary clarifier, and
- organic solids generated in secondary treatment and removed in secondary clarifier.

Specific gravity;

- inorganic particles = 2.5
- organic particles = 1.01 – 1.06

SLUDGE TREATMENT

Solids generated in primary treatment:

- app. 60 % of the solids in raw wastewater.

The biological solids generated in secondary treatment:

- 0.4 to 0.5 kg/kg BOD applied in attached growth processes.
- 0.2 to 1.0 kg/kg BOD applied in suspended growth processes.

SLUDGE TREATMENT

Moisture Content and Volume of Sludge:

- Effect of moisture content on sludge volume is enormous.
- Sludge handling techniques are, therefore, directed towards reducing the moisture content of sludge.
- Most common treatment is ***Sludge Digestion*** followed by ***Sludge Dewatering***.

SLUDGE DIGESTION

- Through digestion, the water content reduces significantly as shown in table below.

Source of Sludge	% Moisture Content (Raw Sludge)	% Moisture Content (Digested Sludge)
P.S.T	94 – 96	88 – 94
A.S.P	98.5 – 99.5	94 – 96
T.F	96 - 97	90 – 94

- Sludge digestion may be aerobic or anaerobic.
- Anaerobic digestion offer following advantages, and is preferred commonly over aerobic digestion:
  - require no oxygen supply
  - produces methane

SLUDGE DIGESTION (Cont…)

Theory of Anaerobic Digestion:

1. Acid forming bacteria break down complex organic substances to simpler compounds, notably fatty acids.

   Carbohydrates ⟶ fatty acids

   Proteins ⟶ Amino acids ⟶ NH_3 + fatty acids

2. Products of the first stage are further broken down, by methane forming bacteria, to methane and carbon dioxide.

   NH_3 + fatty acids ⟶ CH_4 + CO_2

- Methane forming bacteria work in pH range 6 to 8 (better in 7.2 – 7.4).
- Lime is added to adjust pH.

SLUDGE DIGESTION (Cont…)

- Modern digesters are two-stage high rate processes.
- In first stage heating and mixing is provided.
- Second stage is quiescent and works as thickener.

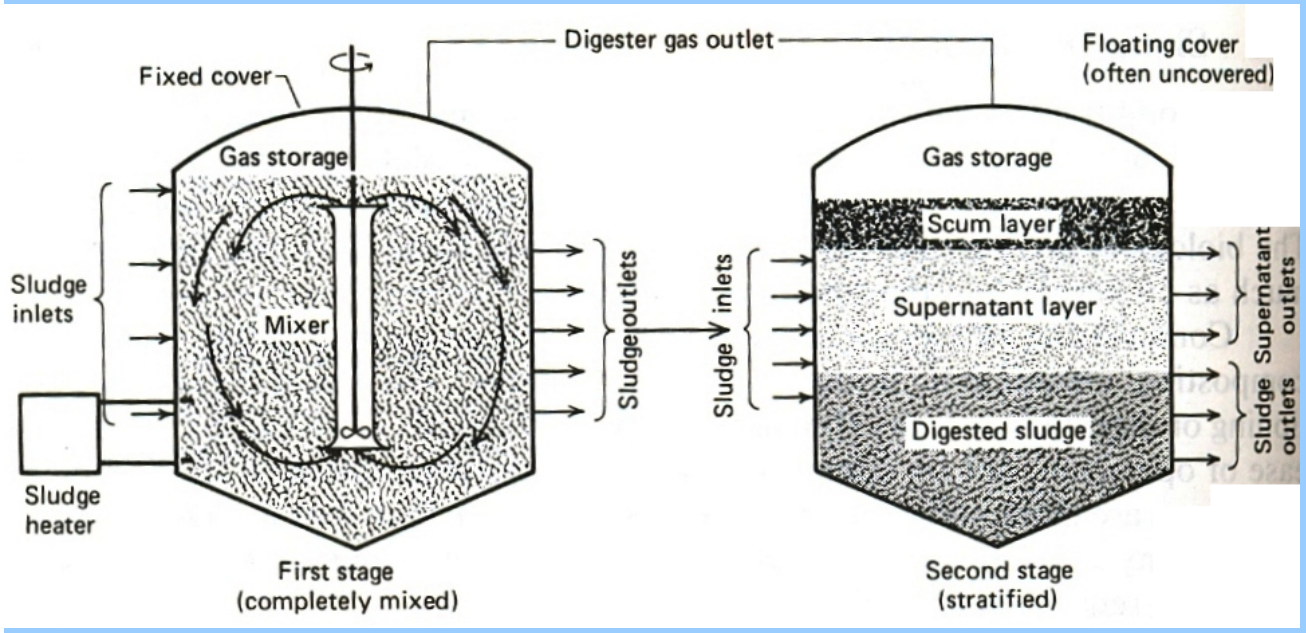


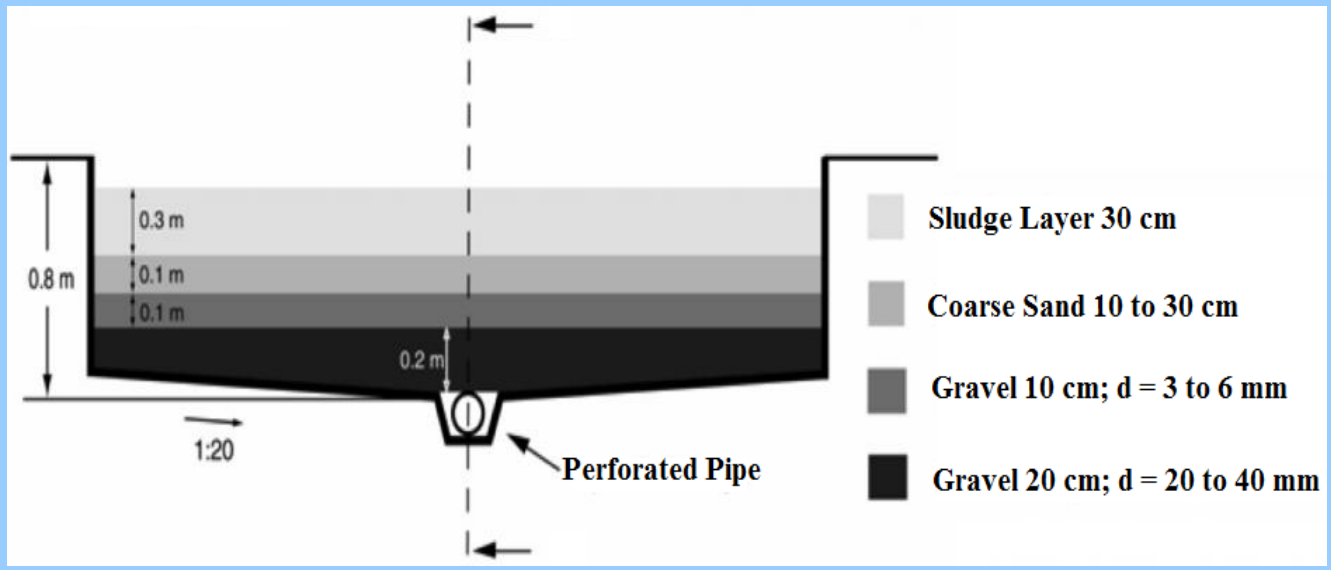
Fig: High Rate anaerobic digester

Sludge Dewatering

May be achieved by either of the following;

- air draying (sludge drying beds)
- mechanical methods (belt filters)

Sludge Drying Beds/Sand Beds:



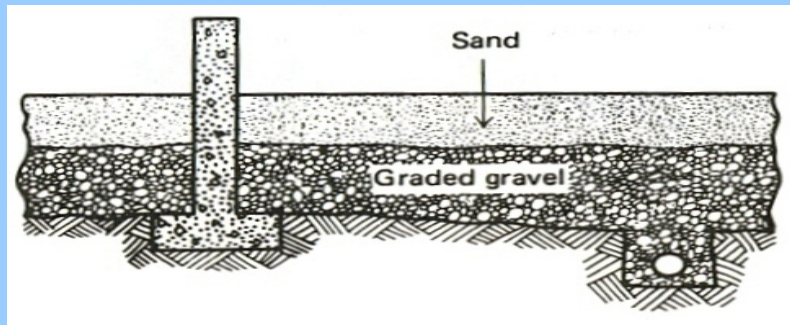


FIGURE
Section of a sludge drying bed

SLUDGE DEWATERING (Cont…)

Sludge Drying Beds/Sand Beds:

Common Dimensions:

- L = 40 m
- W = 6 to 10 m
- Multiple no. of beds used

Loading rates:

- 60 to 200 Kg/m^2-year for digested sludge

- Drying takes from few days to few months depending on climate and season.
- After dewatering sludge solids content will range from to 25 to 35 percent, and volume will have been reduced from 80 to 85 percent.

SLUDGE DEWATERING (Cont…)

Belt Filters:

- Most popular technique in new installations.
- These machines are made in a variety of configurations consisting of one or more endless woven belts which pass over and around a number of cylinders.

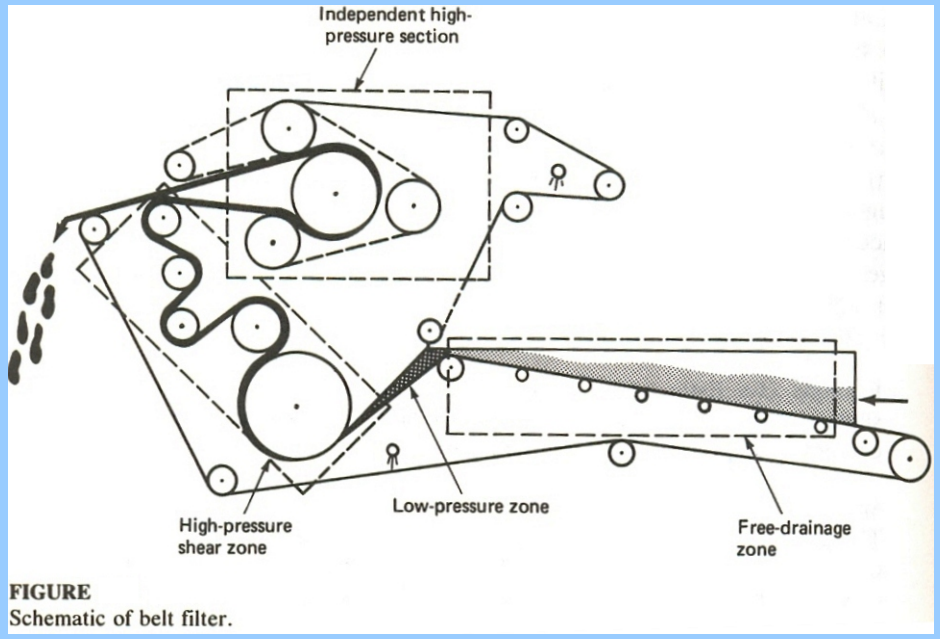


FIGURE
Schematic of belt filter.

SLUDGE DEWATERING (Cont…)

Belt Filters:

- Chemical additives are used to improve sludge dewaterability.

  Chemicals commonly used for this are;

  - ferric chloride ($FeCl_3$),
  - lime (CaO), and
  - Organic polymers.

- The product from a belt filter can be expected to have a solids content range of 12 to 40 percent (20 percent typical).
- Loading rates (Kg/h per meter belt width) and performance of belt filters vary depending upon type of sludge and pretreatment applied.