CHAPTER 11
SLUDGE TREATMENT AND DISPOSAL

Sludge

- The bulk of residual generated from wastewater by physical primary and biological (secondary) treatment processes must be treated and properly disposed of.

Characteristics of sludge

1. Sludge from primary sedimentation tanks

- - Contains 3 – 7 % solids and 60 – 80 % organic
- - Gray in color, fairly coarse, and with strong odors
- - It is more condensed and coarse in texture compared to the sludge from the secondary sedimentation tank

2. Secondary sedimentation tank

- Consist mainly of microorganisms (75-90% organic)
- Brownish in colour, flocculent appearance and an earthy odour
- Depends on the growth of microorganisms
  - ✓ Attached - big and condensed
  - ✓ Suspended – fine and light/less dense

SLUDGE TREATMENT

- Thickening
- Stabilization
- Drying
- Disposal

SLUDGE THICKENING

Objective

- reduce the sludge volume
- cut the cost

Method

1. Mechanical method

- Vacuum filter and centrifuge
- The sludge will become semi solid
- It is applied for sludge that is going to be burned (incineration)

2. Gravity thickener and/or air floatation

- The sludge is still in liquid form
- The percentage of solid volume increased two times
- It is apply for sludge that is going to be stabilized (Biologically treated)

Gravity Thickener

- Suitable for sludge from attached plant system
- Uses gravity forces to separate solids from the sludge
- The equipment is similar in design to a conventional sedimentation tank

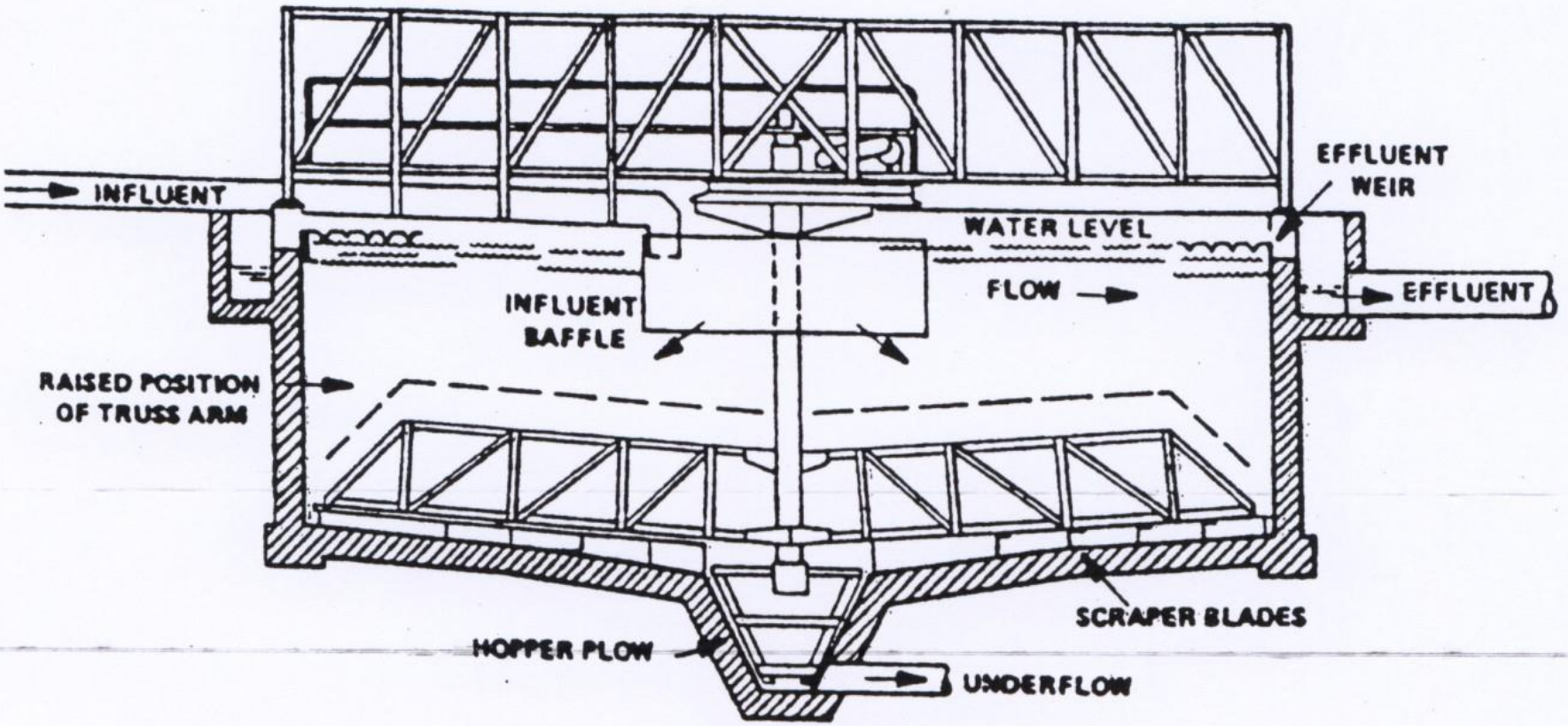
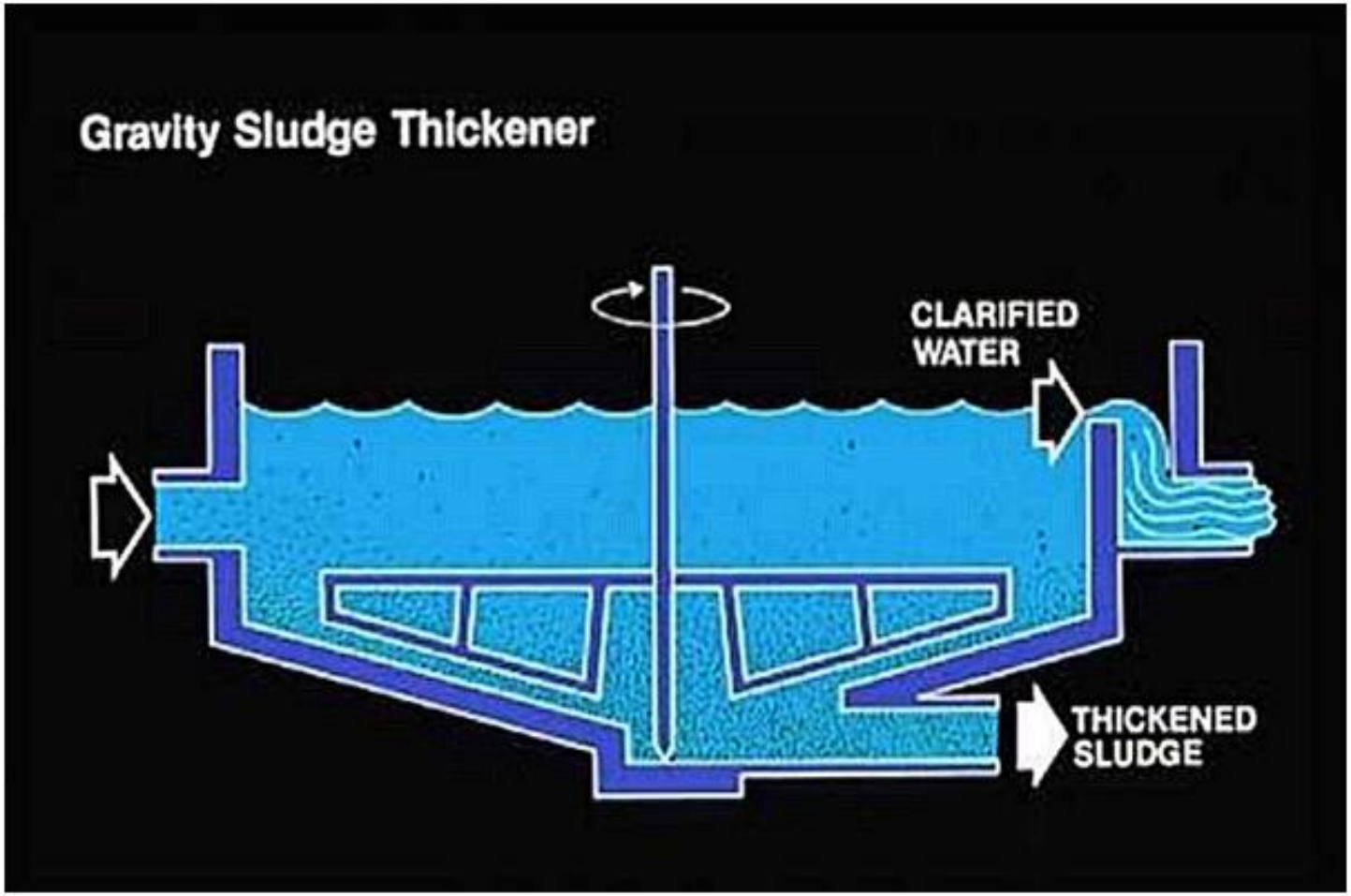


FIGURE 11.3
Gravity Thickener


Gravity Sludge Thickener
CLARIFIED WATER
THICKENED SLUDGE

Dissolved Air Floatation (DAF System)

- Suitable for light sludges such as activated sludge
- The sludge thickening is required if the sludge is going to be stabilized
- Separates solids from the liquid in an upward direction by attaching fine bubbles to particles of suspended solids which then float
- The thickened sludge is skimmed off at the top of the tank

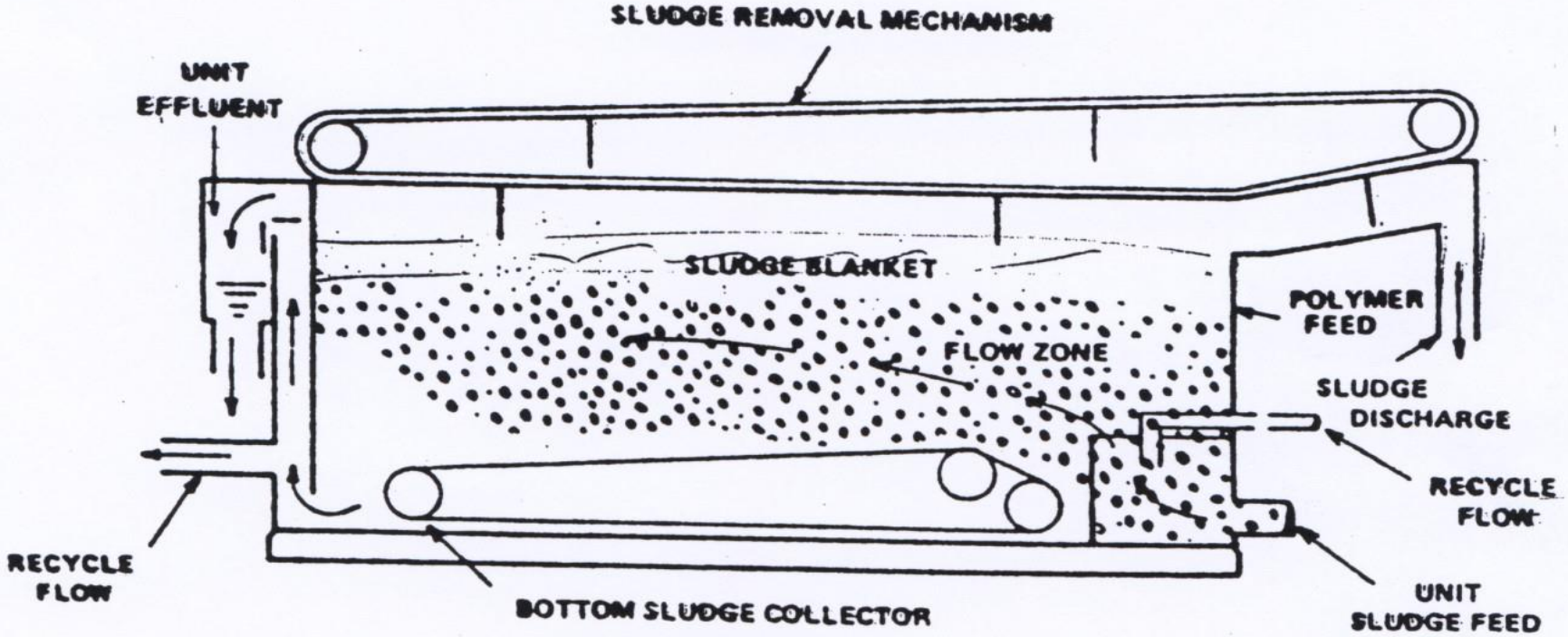


FIGURE 11.7

Flow Diagram of a Flotation Unit

SLUDGE STABILIZATION

Objective

- to convert the organic solids (sludge) to a more refractory or inert form

Methods

1. Anaerobic digestion
2. Aerobic digestion

Anaerobic digestion

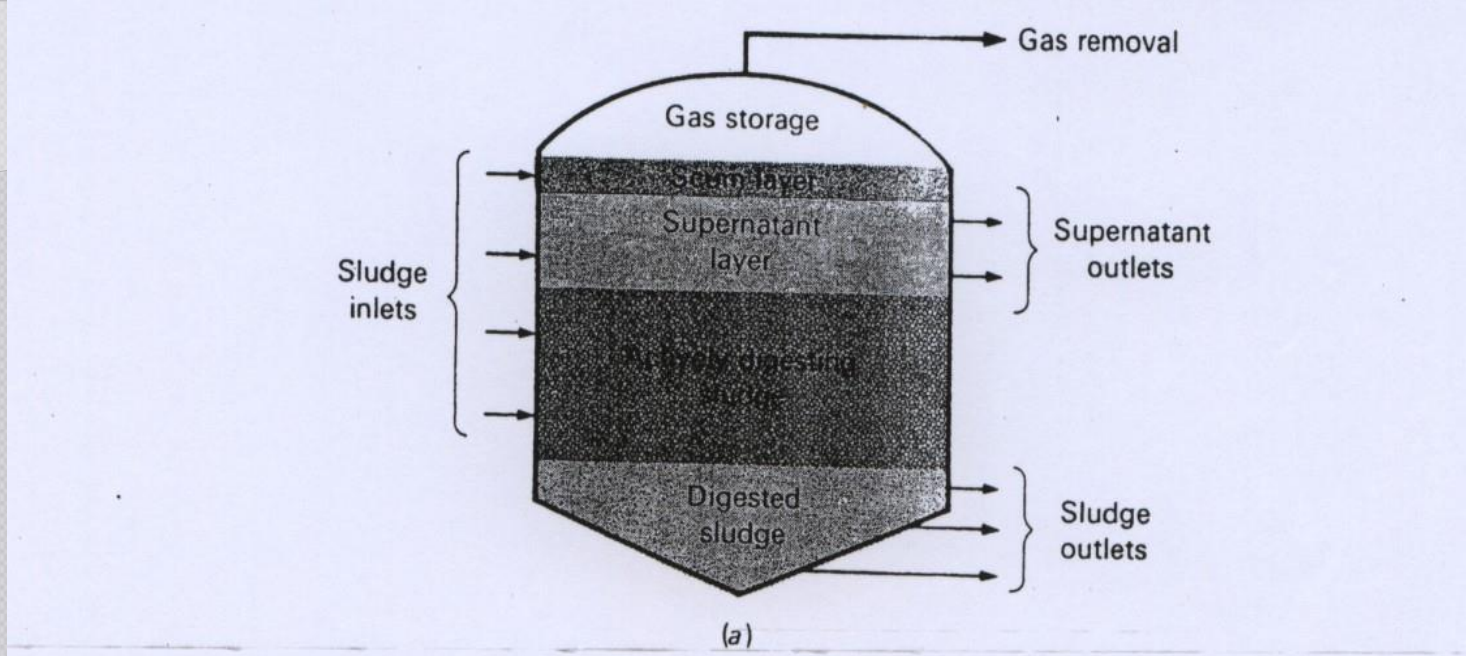
- one of the oldest and most widely used methods
- An anaerobic decomposition process took place
- The end product are liquid and gases (biomass is reduced as much as possible)
- The % where the biomass is being transformed from organic form is minimum

  - 50 – 60% decomposition of organic substances, only less than 10% of biomass is formed.
- Require proper maintenance

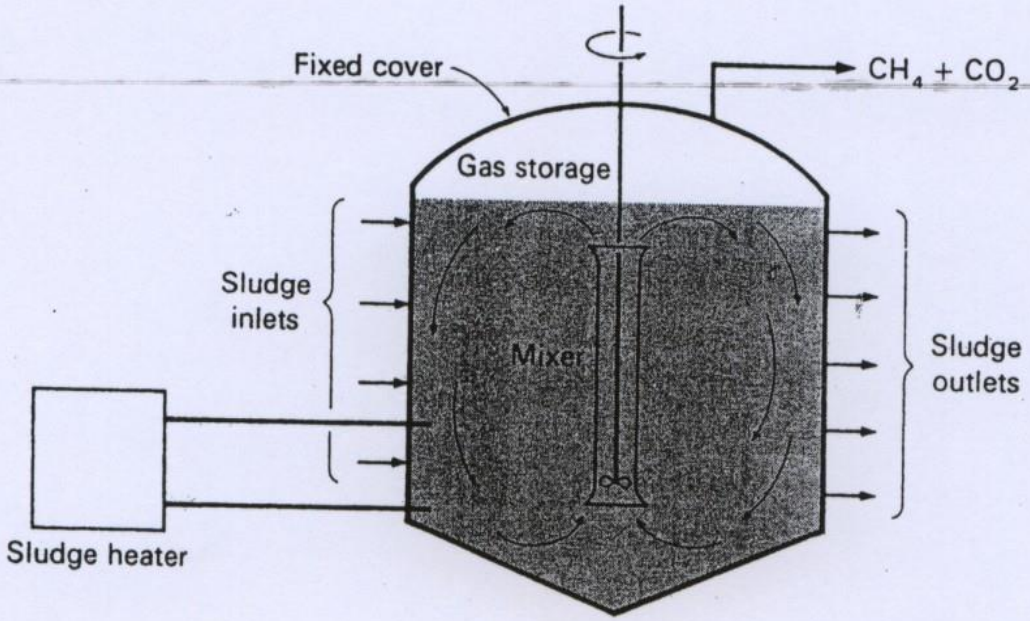
- There are two types of anaerobic digestion process:

1. Common digestion ratio (standard-rate)
   - t = 30 – 60h
   - No coagulation
   - Sedimentation occurred in reactor
2. High digestion ratio (High-rate)
   - t = 10 – 20h
   - More effective
   - Coagulation process occurred
   - The reactor is small
   - The sedimentation process need to be carry out in different reactor

- Produce gases, methane which is later used as source of energy for the plant
  - 65 – 70% - methane (1 m^3 gas/ 1 kg solid sludge)
  - 25 – 30% - CO_2

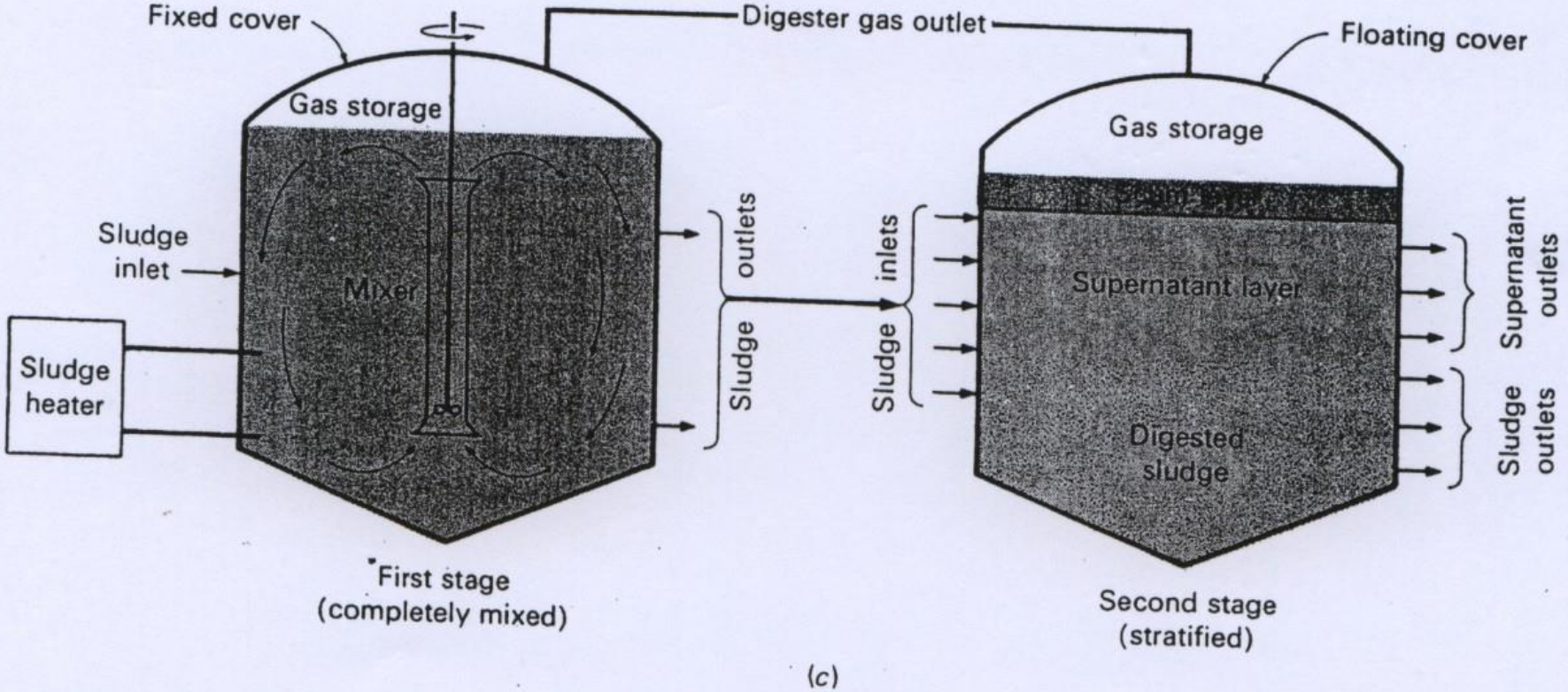


(a)



(b)

Standard Digester



High Rate Digester

Aerobic digestion

- Use for secondary sludge only
- The endogen respiration occurred for microorganisms (no external food supplied; microorganisms are forced to metabolize their own protoplasm)
- Easier for maintenance
- Difficult for releasing the water

DRYING PROCESS

Objective

- to reduce the water content before the sludge been disposed

Methods

- Drying bed
- Vacuum filter
- Centrifuge
- Pressure filter

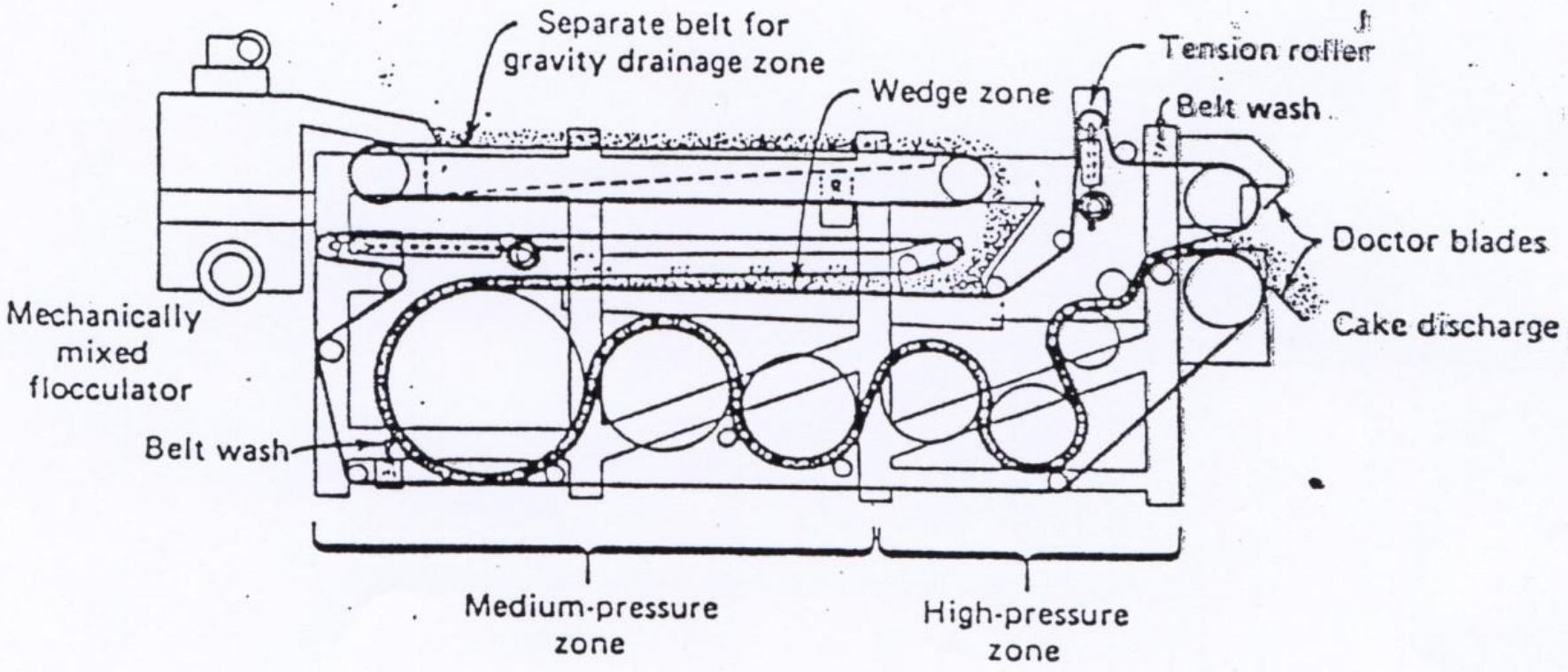
Sand Drying Beds

- Remove moisture by natural evaporation and gravity
- Consist of 10-23 cm of sand placed over a 20-50 cm layer of gravel
- The water drains to an underdrain system that consist of perforated pipe
- The digested sludge is discharged on the bed in a 30-45 cm layer and allowed to dewater by drainage through the sludge mass and supporting sand and by evaporation from the surface exposed to air

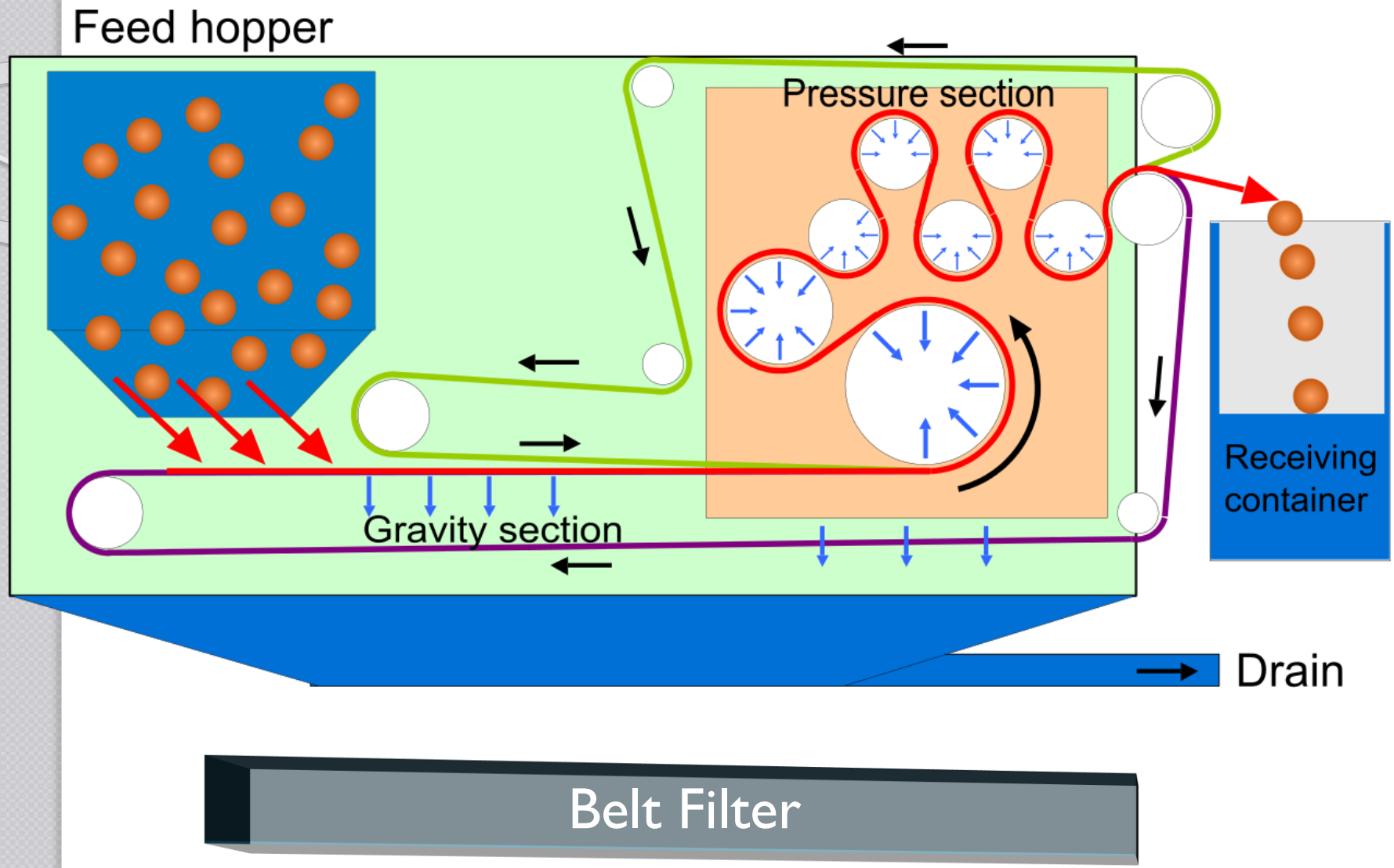
Sand Drying Beds

Sand Drying Beds

Sludge Cake



Pressure Filter


Feed hopper
Pressure section
Receiving container
Gravity section
Drain
Belt Filter

DISPOSAL

- Incineration
  - The sludge is not required to be stabilized
  - The sludge is not required to be dried
  - Required source of fuel for burning
- Disposal site
  - Sludge need to be stabilized
  - The leacheate must be controlled and treated
  - It is not exposed to the environment
- Fertilizer / Soil conditioner
  - The sludge contain high nutrient
  - The sludge is in solution form – spray
  - The sludge is dry
  - Limitation – toxic compound, high concentration of nitrate