



Trainers Training Program on Waste Management in Textile & Garment Industry in BGD

Promotion of Sustainability in the Textile and Garment Industry in Asia - FABRIC

giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

FABRIC Asia



GIZ FABRIC – Waste Management Course

Presentation 6: Dewatering of sludge from ETP



Contents

- Objective of sludge dewatering
- Sludge pre-conditioning
- Mechanical sludge dewatering
- Sludge drying beds

Objective of sludge dewatering



- Sludge generated like **watery slurry**
 - Make fit for handling before discharge or disposal.
 - Still polluted & hence cannot be discharged anywhere.
- **Reduce** sludge **moisture content** by
 - Sludge **thickening**
 - Sludge **dewatering** to turn into **dry cake**

Sludge treatment and handling



Gravity thickener



Proprietary mechanical thickener

Sludge thickening

■ Gravity thickening

- Most common
- Simple operation
- Low operating cost

■ Mechanical thickening

- Costlier
- It is 'Preliminary' mechanical dewatering

Overview of units and equipment



Common units in sludge management

- Sludge pumps and conditioning units
- Sludge thickeners
- Sludge volume reducing systems including digestors
- Sludge dewatering
- Sludge driers (thermal/natural)
- Sludge disposal/utilisation systems

Sludge pumps and conditioning units



Sludge pumps and conditioning units

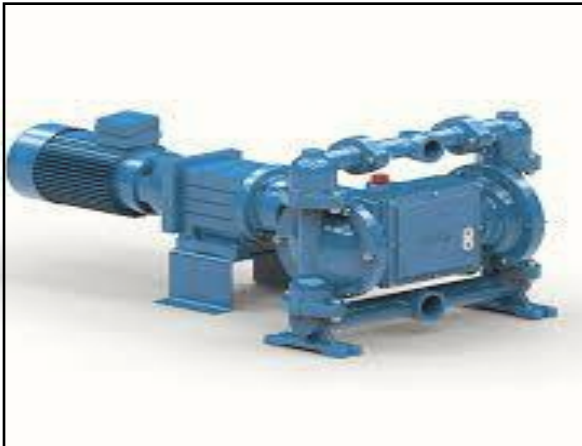


Designed to handle high solids content (1-7%)

Types of pumps

- **Centrifugal** pumps with open/semi open impellers
- **Submersible** pumps
 - For low solids content (e.g. thickener feed pump) and low pressure requirements
- Archimedean **screw type** pumps:
 - Designed to handle huge quantities
 - Not popular in small-medium ETPs
 - Not suitable for thick sludge

Sludge pumps and conditioning units



Types of pumps

- Progressive **cavity pumps** or ‘screw pumps’
 - Most common unit
- Air-operated **diaphragm pumps**:
 - Simple and comparatively cheaper
 - Need compressed air
 - Suitable for ETP with large pneumatic systems
- **Rotary lobe** pumps
 - Similar to air blowers used to pump thick sludge

Sludge pumps and conditioning units



Pumps for liquid sludge: Centrifugal

- Mainly for **low density sludge** from clarifier underflows and watery sludge settled in tanks
- Also for pumping **thickened sludge** (bio-sludge)
 - Good for high quantity pumping with moderate amount of **sludge consistency (1 - 4%)**
- With non-clog feature as open or semi open configuration
 - Open/semi open impellers reducing pumping rate
- Good for medium head (10 - 40 m, 1 - 4 bars)

Sludge pumps and conditioning units



Pumps for liquid sludge: Submersible

- Only for **low density sludge** such as in clarifier underflows and sludge settled in tanks
- Suitable for pumping **thickened sludge** for bio-sludge
 - Good for high quantity pumping with moderate amount of sludge consistency (**1 - 4%**)
- Equipped with cutter/grinder mechanism to prevent clogging
- Impellers made in stainless steel and pump casing in iron

Sludge pumps and conditioning units



- **Pumps for liquid sludge: Submersible**
 - Mostly **water cooled**
 - **Minimum level** to avoid loss of storage volume
 - Commonly installed in **pumping chamber** within sludge storage tank
 - **Not practical** for **small ETPs**
 - 10 or 20 m³ capacity for sludge tank needed
 - Water flushing arrangements to clear dried sludge blockages
 - Good for medium head (10 - 40 m, 1 - 4 bars)
 - Clarifier underflow to thickener

Sludge pumps and conditioning units

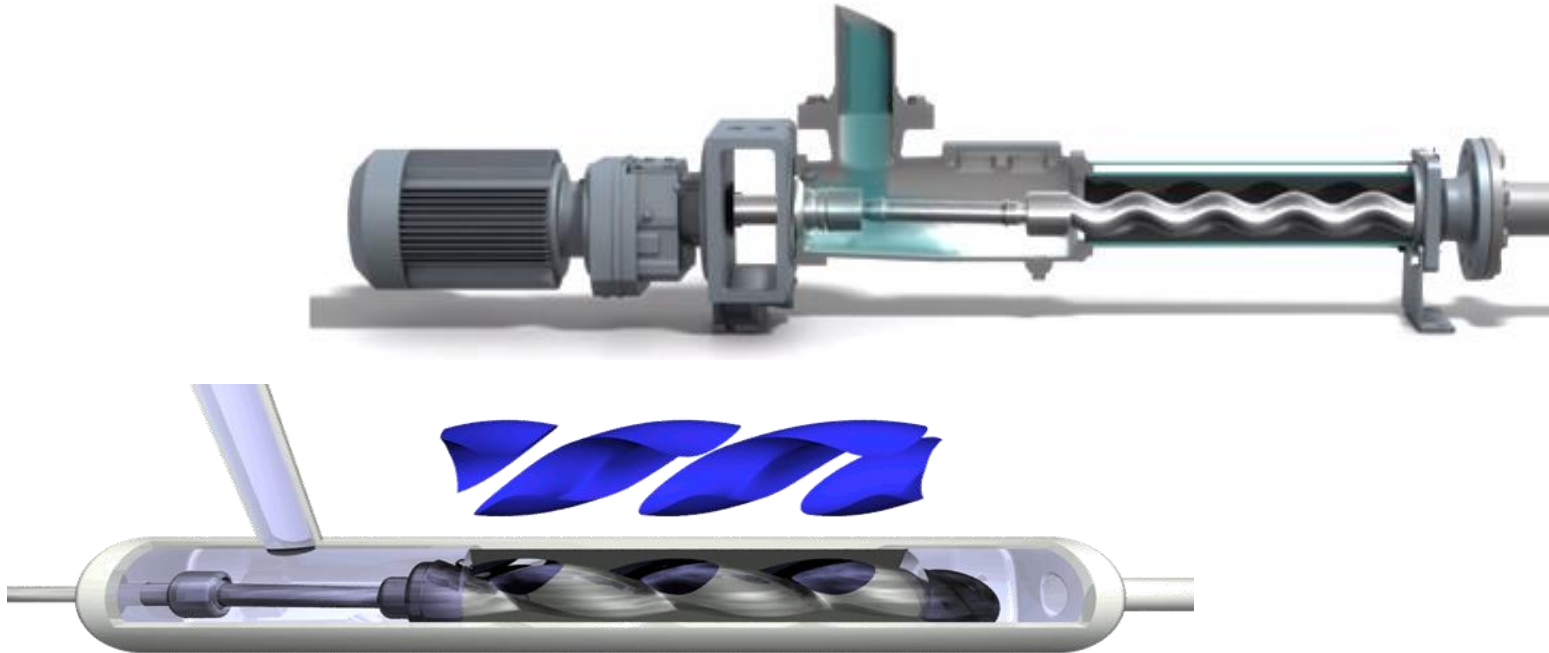
Pumps for liquid sludge: Progressive cavity pumps



- Most common, also called screw or helical rotor pumps
- Rotor and stator creating moving chambers to with fluid draw into and coming out with force
- Rotor: Stainless steel, Stator: EPDM rubber.
- Used for **filter press feeding** (7 - 16 bar)
- Efficiency increasing with higher liquid thickness
- Output flow control by increasing or decreasing speed
- Motors controlled by Variable Frequency Drive (VFD)

Sludge pumps and conditioning units

Pumps for liquid sludge: Progressive cavity pumps



Sludge pumps and conditioning units

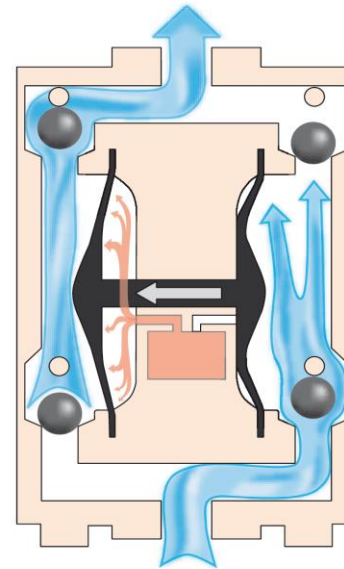


Pumps for liquid sludge: Air operated diaphragm pumps

- Positive displacement pump
 - Two pumping chambers alternately filled and discharged by flexible diaphragms movement
 - Compressed air filled and vented from two air chambers on opposite sides to create pumping action
- Diaphragm pumps leak-free with less maintenance and moving parts
 - General maintenance only for periodical replacement of diaphragms

Sludge pumps and conditioning units

Pumps for liquid sludge: Air operated diaphragm pumps



Sludge pumps and conditioning units



Pumps for liquid sludge: Air operated diaphragm pumps

- Suitable for handling **abrasive and concentrated sludges**
- No damage when running dry
- **Requiring compressed air** usually for lower pressure (up to 8 bar)
- Not suitable for filter presses for textile sludge (requiring 12 - 16 bar pressure)
- Noisy



Sludge thickening systems

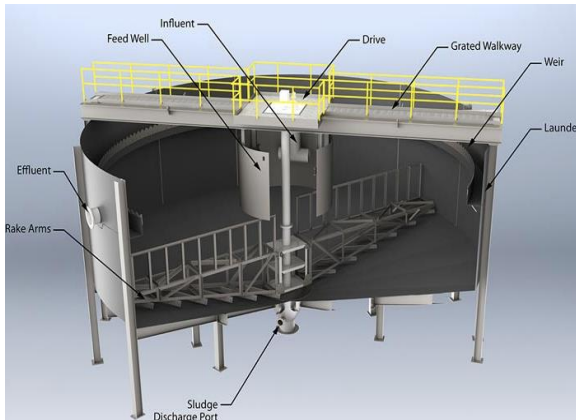
Sludge thickening



Gravity thickener

- To **concentrate solids** (2 - 5 times more) and **reduce sludge volume**
- Depending on required capacity
 - hopper bottom
 - rectangular
 - circular in shape
 - Common and similar to clarifiers with picket fences added to scrappers
- Seldomly used in Bangladesh except few units with hopper bottom thickeners or rectangular tanks

Sludge thickening



Gravity thickener

- **Loading rate** (solids load per m² of the tank):
 - Primary 100 kg/m²/day
 - Secondary 25 kg/m²/day
 - Combined ETP: 35 kg/m²/day
- **Retention time**: ≈ 1 day
- Clear **overflow** returned **to equalization** tank
 - Faulty operations resulting in thick sludge overflow (!)
- Effective with combined sludge, not effective with all-biological sludge

Sludge thickening



Dissolved air floatation (DAF) thickener

- Effective for **wasted activated sludge**
- Similar operation like dissolved air floatation in primary treatment:
 - (1) Sludge mixed with compressed air
 - (2) Thickened sludge rising to top
 - (3) Sludge scooped using scum scrapper
- Used for **thickening secondary sludge** (from 1% to 3%)
 - not for heavy primary sludges (!)

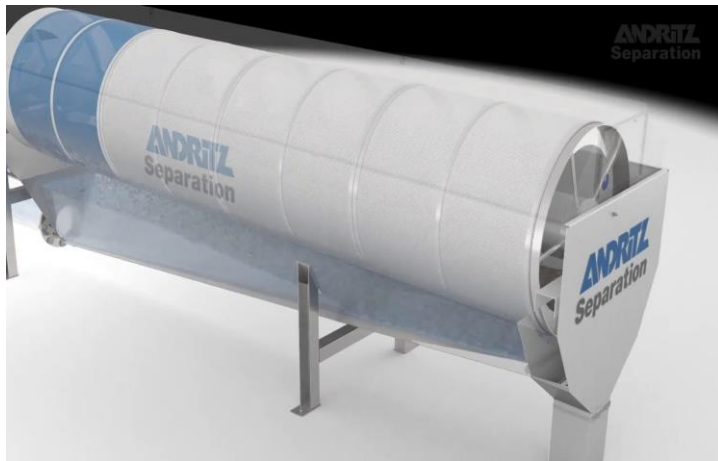
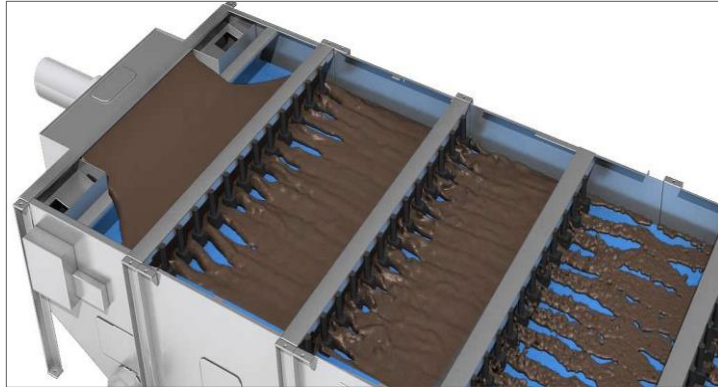
Sludge thickening



Dissolved air floatation (DAF) thickener

- **Conditioning chemicals** for enhancing thickening
 - Flocculants or polyelectrolytes (quite often)
- **Loading rate** for secondary sludge:
 - 50-120 kg/m²/day of surface without conditioning
 - 200-250 kg/m²/day of surface with conditioning
- **Advantage**
 - Low retention time
 - Sludge staying aerobic
 - Preventing putrefaction avoiding odor

Sludge thickening



Mechanical thickening

- Uncommon Bangladesh
- Common systems
 - **Gravity belt thickener** with sludge passing perforated belt
 - **Rotary drum thickener** with sludge fed into to slowly-rotating vessel with porous walls
 - **Screw thickener** with central screw pressing sludge through rotating multi-disk filters
- Spray system required to clean perforated platforms and prevent pores blockage



Sludge dewatering systems



Chamber filter press

- Most **popular** mechanical sludge dewatering unit for **small and medium ETPs**
- Simple, sturdy and reliable
- Filter plates used as cavities (recessed chambers)

Sludge dewatering



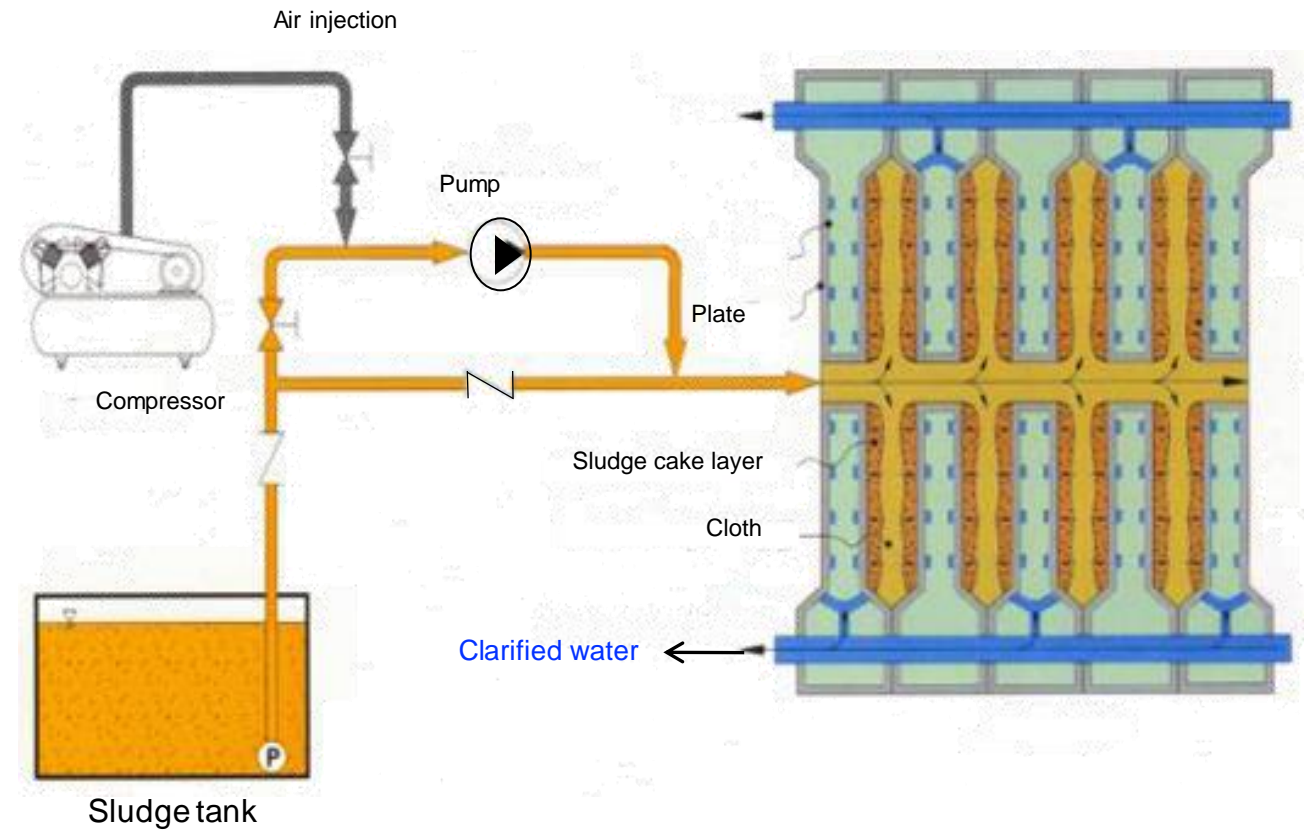
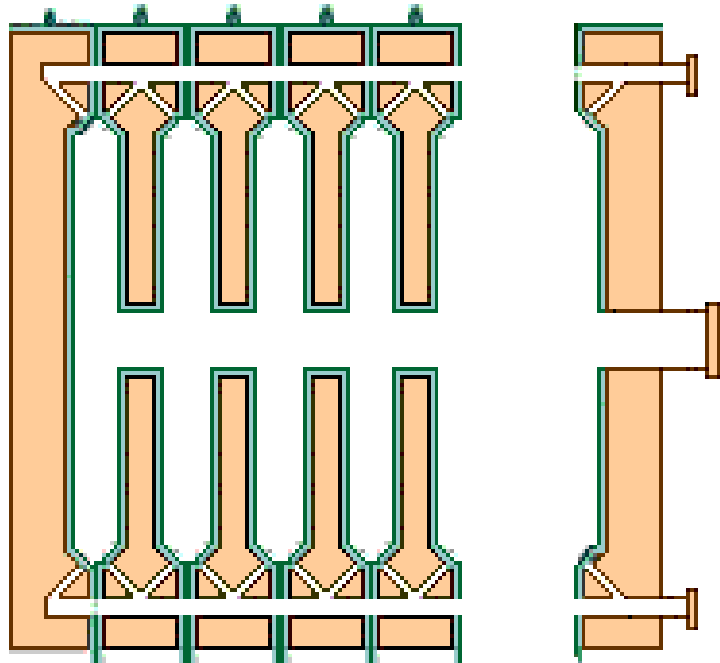
Chamber filter press

Operation – filtration cycle

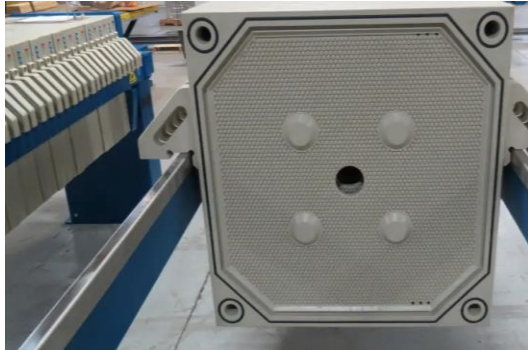
- Press with filter plates closed by hydraulic locking cylinder
- Chamber formed between individual filter plates with sludge pumped in under high pressure
- Cake forming by increasing thickness of sludge
- Plates opening and caking fall out
- Filtrate flowing through cloth and discharged through filtrate channel

Sludge dewatering

Chamber filter press



Sludge dewatering



Chamber filter press

- **Optional features**
 - Provision for air/steam passing through centre for drier sludge
 - Cake collector in trailer or container
- **Advantage**
 - **High level of dryness** (moisture reduction by 60-65%)
- **Disadvantage**
 - **Higher capital cost**
 - Higher **area requirement**
- **Conditioning using Ferric chloride/lime**



Sludge centrifuge

- Decanter centrifuges most popular in large ETPs
 - Models with vertical and specially horizontal mount
 - Cylindrical bowl rotating at 4000 - 6000 rpm
- Concept:
 - Heavier particles separated faster when rotating at high speeds
 - Slow moving screw conveyor within bowl to transport separated solids to collection bin

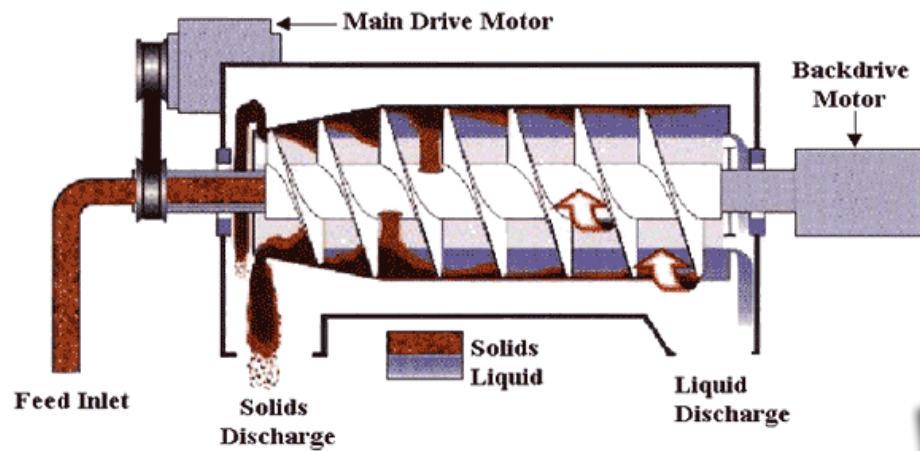


Sludge centrifuge

- Advantages:
 - no odor problem
 - very small area requirement
 - minimum labor requirement
- Disadvantages:
 - high **noise level** during operation
 - high power consumption
 - need for conditioning with polyelectrolyte
 - **high moisture content** in dewatered sludge (75%)

Sludge dewatering

Sludge centrifuge



Sludge dewatering



Belt filter press

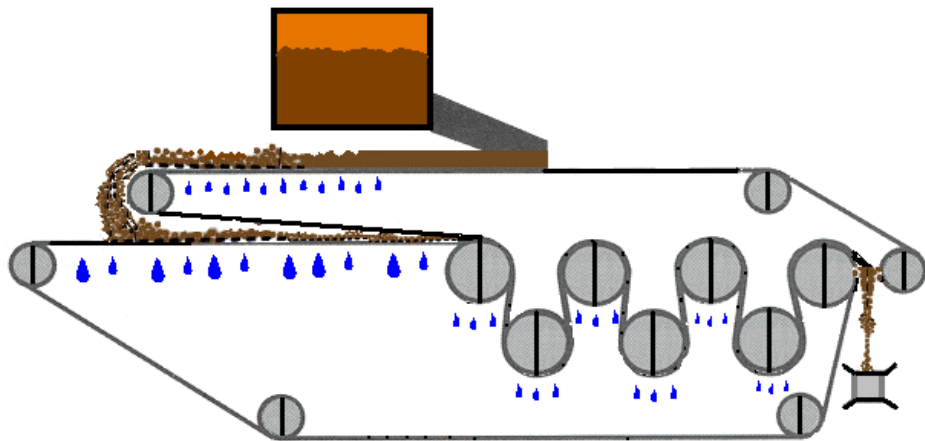
- Popular for medium and large ETPs
- Concept:
 - Two moving belts with sludge admitted between these
 - Sludge moving between series of rollers and squeeze
 - Water released and drained by gravity
 - Squeezed and dewatered sludge getting scraped by stationary blade

Sludge dewatering

Belt filter press

Important features

- **Jet spray** to wash cloth
- Arrangement to keep **alignment of belts**
- **Differential speed motors** to adjust the speed





Belt filter press

▪ Advantages:

- less pressure pumps required
- very little noise emission
- easy to monitor since open

▪ Disadvantages:

- odor problems
- issues with belt alignment
- lower dryness of sludge (25 - 30%)
- need for polyelectrolyte conditioning (operating cost!)

Sludge dewatering



Sludge drying beds

- Masonry units with no mechanical arrangements
- Suitable for small ETPs if space available
- Set-up:
 - Series of shallow tanks with sloped floor towards center
 - Perforated pipe to collect and drained water
 - Topped with gravel/sand media of different sizes (with finer sand on top)

Sludge dewatering



Sludge drying beds

- Process
 - Liquid sludge pumped in and spread on open bed of sand
 - Allowed to remain until dry
 - Drying through evaporation and gravity drainage
 - 1 week of drying => solids content 35-40%
 - Drained water pumped back to ETP

Sludge dewatering

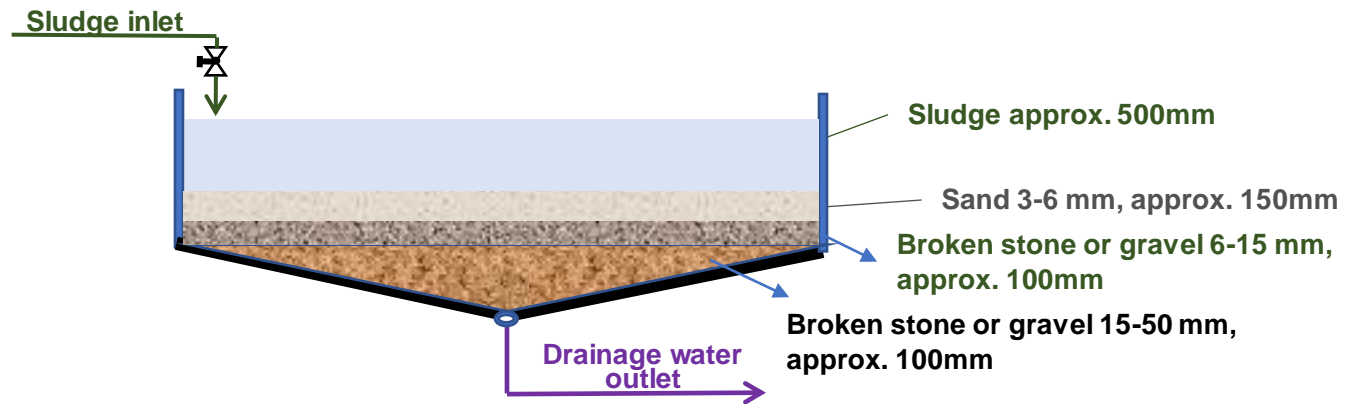


Sludge drying beds

- Advantages
 - **Simple** construction
 - **low maintenance**
 - comparatively **lowest drying costs**
 - **emergency standby** unit during any breakdown of mechanical dewatering equipment
- Disadvantages:
 - high **land requirement**
 - potential for **odor**
 - high **manual labor** requirement

Sludge dewatering

Sludge drying beds



Sludge dewatering

| | Decanter | Belt press | Chamber filter press | Sludge drying beds |
|---------------------------------|------------------|------------------|--------------------------------|--------------------|
| Way of operation | Continuous | Continuous | Batch | Batch |
| Sludge dryness | Low | Medium | High | High |
| Sludge conditioning | required | required | not required | Not required |
| Washing water | not required | required | not required | Not required |
| Labor | only supervision | only supervision | required during cake discharge | Required |
| Sensitive to sludge variability | very sensitive | very sensitive | less sensitive | Less sensitive |
| Energy required (electricity) | high | medium | low | NA |
| Maintenance | sophisticated | medium | low | low |

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