



# 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



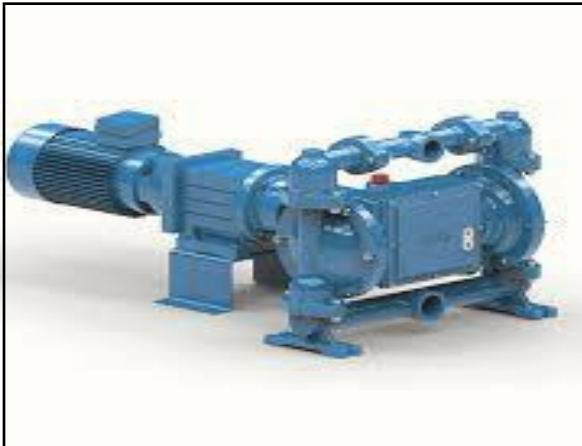
Designed to handle high solids content (1-7%)

## 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 m<sup>3</sup> 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

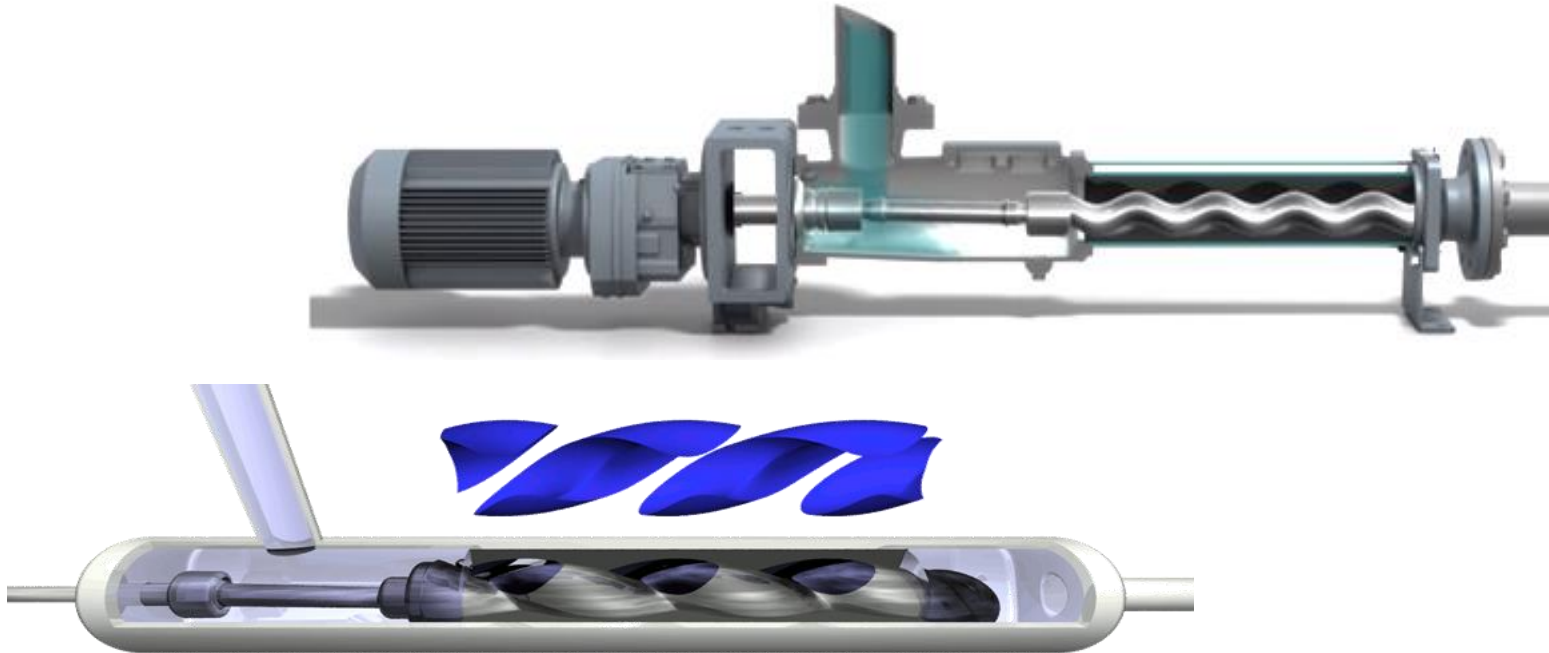
## Pumps for liquid sludge: Progressive cavity pumps



- 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

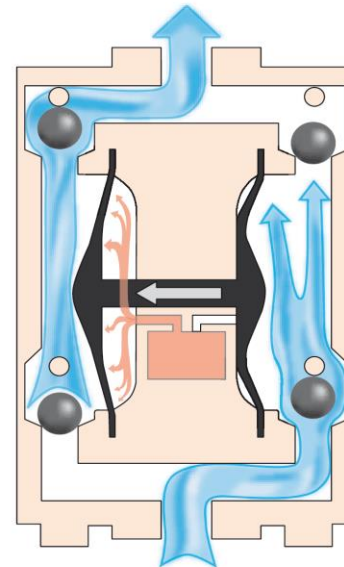


## Pumps for liquid sludge: Air operated diaphragm pumps

- 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

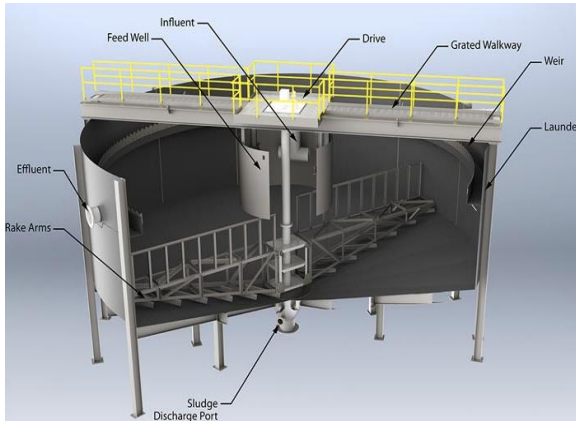
# Sludge thickening



## 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 m<sup>2</sup> of the tank):
  - Primary 100 kg/m<sup>2</sup>/day
  - Secondary 25 kg/m<sup>2</sup>/day
  - Combined ETP: 35 kg/m<sup>2</sup>/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 flotation (DAF) thickener

- Effective for **wasted activated sludge**
- Similar operation like dissolved air flotation 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 (!)

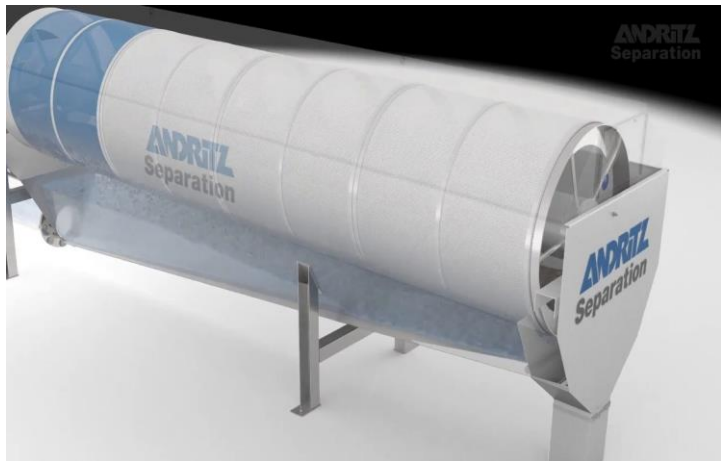
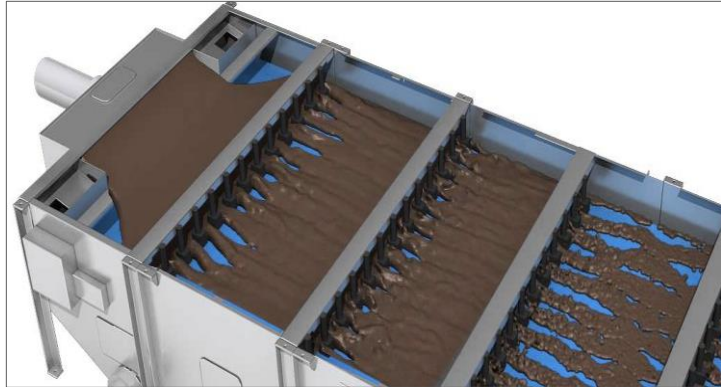
# Sludge thickening



## Dissolved air floatation (DAF) thickener

- **Conditioning chemicals** for enhancing thickening
  - Flocculants or polyelectrolytes (quite often)
- **Loading rate** for secondary sludge:
  - 50-120 kg/m<sup>2</sup>/day of surface without conditioning
  - 200-250 kg/m<sup>2</sup>/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



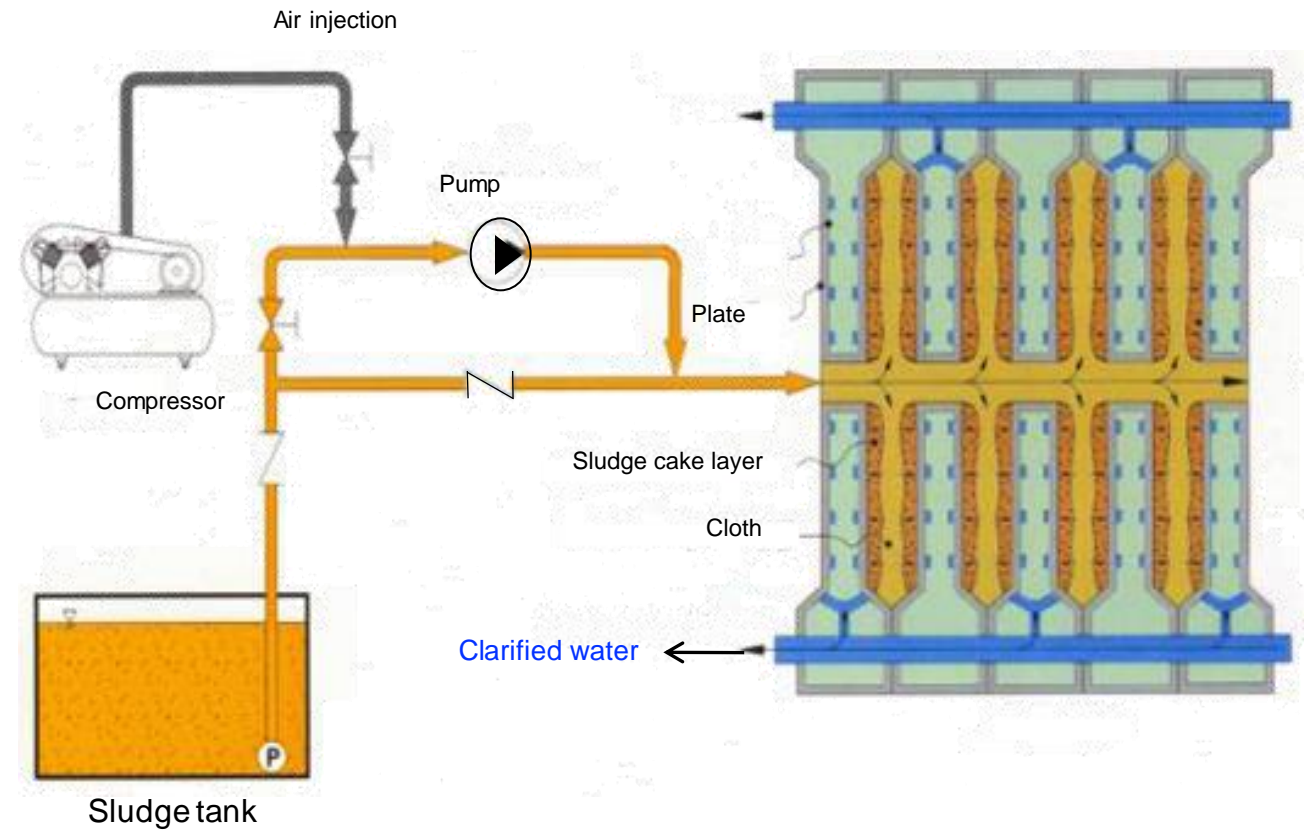
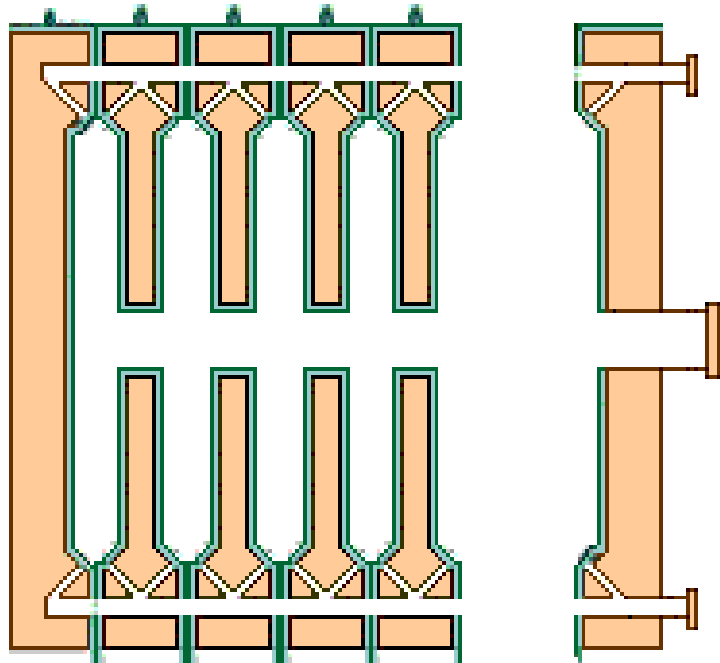
## Chamber filter press

### Operation – filtration cycle

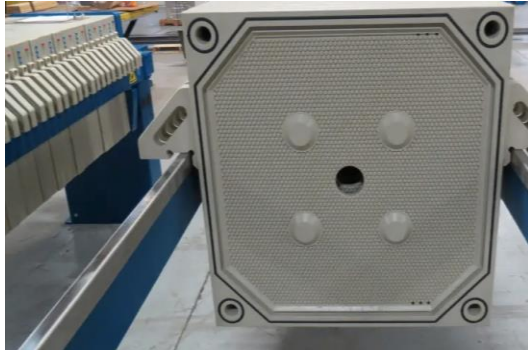
- Press with filter plates closed by hydraulic locking cylinder
- Chamber formed between individual filter plates with sludge pumped in under high pressure
- Cake forming by increasing thickness of sludge
- Plates opening and caking fall out
- Filtrate flowing through cloth and discharged through filtrate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



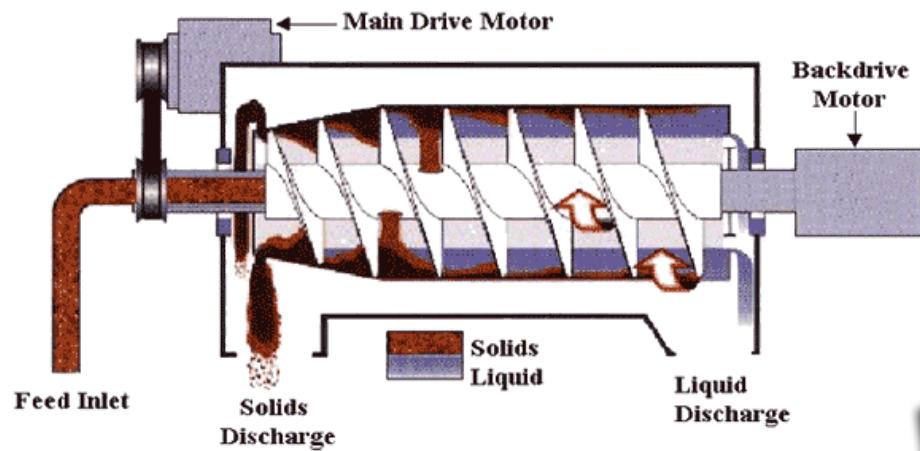


## Sludge centrifuge

- 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

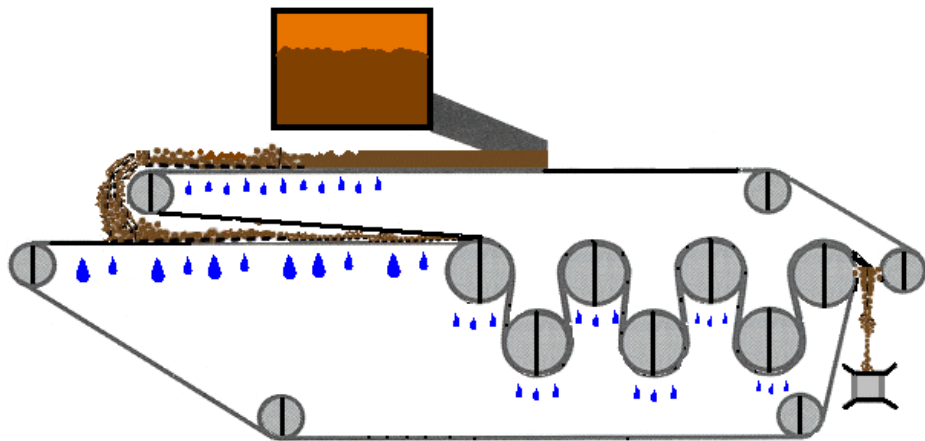
- Popular for medium and large ETPs
- Concept:
  - Two moving belts with sludge admitted between these
  - Sludge moving between series of rollers and squeeze
  - Water released and drained by gravity
  - Squeezed and dewatered sludge getting scraped by stationary blade

# 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

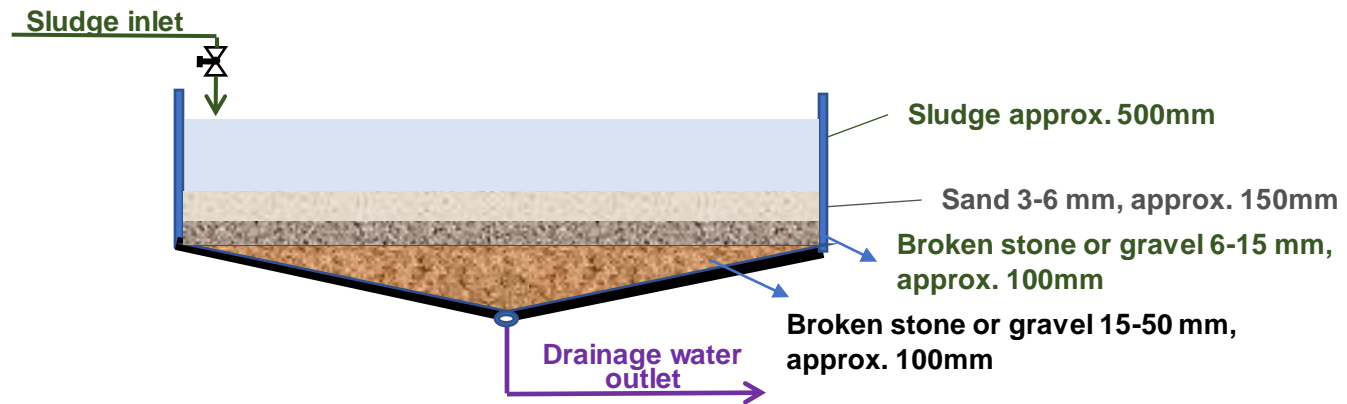


## Sludge drying beds

- 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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