Training Program for Operators of Effluent Treatment Plants in Textile Factories

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

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

Primary treatment – Operation of chemical treatment units

GIZ FABRIC – ETP Operator Course

Contents

- Preparation and dosing of chemicals
- Mixing, coagulation and flocculation
- Sedimentation and settling

Key aspects of chemical treatment

- **Chemical treatment second** part of primary treatment
- Essential for **removal** of contaminants like **heavy metals**
- Specific units
  - chemical slurry preparation
  - chemical dosing units
  - flash mixer
  - flocculator,
  - solids separation unit

Chemical slurry preparation and dosing

Chemical slurry preparation and dosing

- Chemical preparation in **2 or 3 separate small tanks** with agitators:
  - Coagulant
  - Neutralising agent
  - Polyelectrolytes
- Good to have **two set of** such **tanks**
  - One for ongoing dosing operation
  - One for preparing next batch of chemical

Chemical slurry preparation and dosing

Preparing treatment chemicals

- Mostly in powder form
  - Follow **safe chemical handling practices** and check **safety data sheet** (SDS)
  - Use respiratory protection against dust and skin protection as recommended in SDS
- Add to small tanks, chemical and filled up water
- Keep agitator running to create smooth chemical slurry ready for dosing.

Chemical slurry preparation and dosing

Preparing treatment chemicals

Polyeletrolytes (PE)

- PE solutions highly viscous => direct dosing not possible
- Stock PE solution to prepared with 0.5-1% concentration and diluted 10 times before dosing.
- Two set of tanks needed for PE - one for stock solution preparation and one for actual dosing.

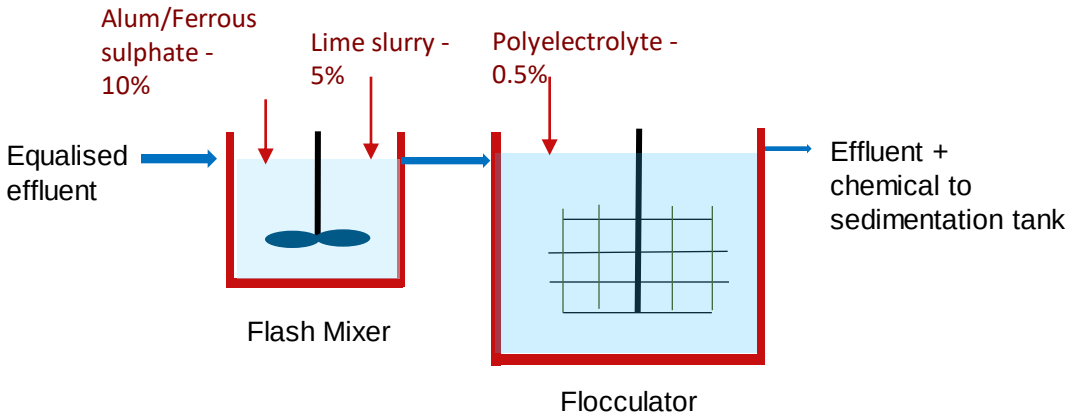
Mixing, coagulation and flocculation

Mixing, coagulation and flocculation

Mixing, coagulation and flocculation

Operational steps

- Mixing of chemicals with effluent
- Blending of miscible liquids
- Flocculation of wastewater particles
- Continuous mixing of liquid suspensions



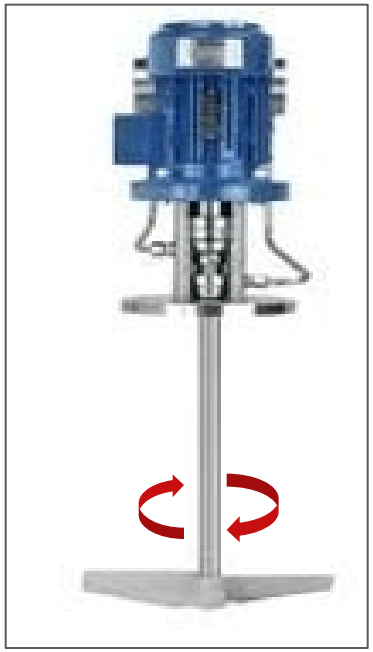
Mixing, coagulation and flocculation

Flash-mixing

Equalised effluent pumped into flash mixer tank and mixed with coagulants (chemical slurry)

Flash mixer

- Small tank (5-10 minutes retention time)
  - Constructed in concrete;
  - Often plastic barrels of few hundred liters in small ETPs
- Paddle agitator with one or two rotating blades and long shaft with drive system and motor coupled with gear box
  - speed range of about 60 - 150 RPM.
  - incomplete mixing if rotation speed too low or high rotation



Mixing, coagulation and flocculation

Dosing methods

- Dosing (metering) pump (preferred option)
- Gravity dosing from barrel of chemical slurry, controlled with valve.

Mixing, coagulation and flocculation

Mixing, coagulation and flocculation

Flocculator – set up

- Concrete tank with about 30 minutes retention time with special paddle agitator
  - shaft with two arms with fixed vertical bars
  - horizontal paddles in newer flocculators
  - Wooden paddles in conventional systems
- FRP tanks used in small ETPs

Alternative

- Effluent channels with half width barriers (made of bricks) for ensuring zig-zag flow.

Mixing, coagulation and flocculation

Flocculator

Mixing, coagulation and flocculation

Flocculator – operation

- Agitator about **20 - 30 RPM speed**
  - Higher speed preventing floc formation
  - Sludge settling at lower speed
  - Variable speed setting in modern flocculators
- ETP operator to **determine optimum speed**
  - Run different agitator speeds
  - Take beaker sample to check level of flocculation
  - Identify optimum speed for good floc formation to be used on regular basis
  - Reverify if change in coagulation chemicals

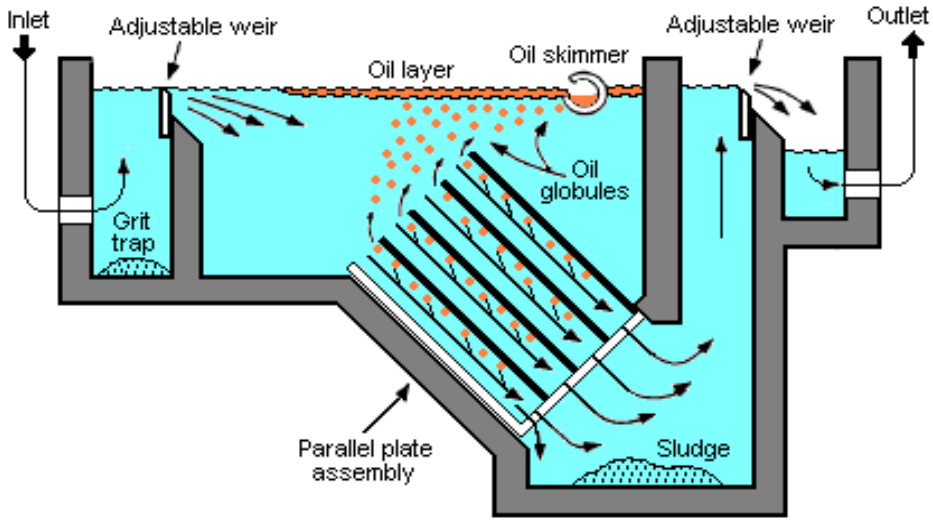
Mixing, coagulation and flocculation

Vertically and horizontally rotating flocculator paddles

Mixing, coagulation and flocculation

Flotation – Basic concept

- Special process for removing suspended matter
  - oil & grease
  - lighter solids
- Many types of floatation devices available



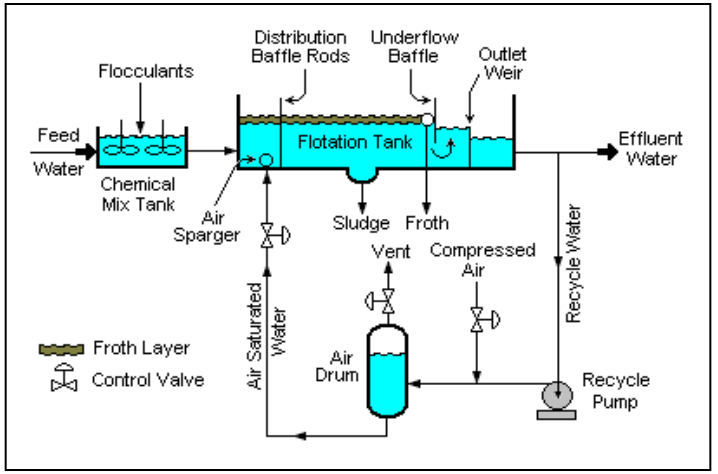
Typical parallel plate separator used for oil and grease removal

Mixing, coagulation and flocculation

Flotation – Dissolved Air Flotation (DAF)

Enhanced sludge formation by addition of flocculants and floatation by dissolved air.

- Solids removal by mixing air and water
- Mixture released under pressure in flotation tank or basin.
- Released air (tiny bubbles) adhering to suspended matter
- Suspended matter floating surface and forming foamy sludge.
- Skimming or scooping of sludge at surface



Mixing, coagulation and flocculation

Flotation – Dissolved Air Flotation (DAF)

Krofta type DAF

Mixing, coagulation and flocculation

Flotation – Dissolved Air Flotation (DAF)

- Better for effluent with lighter suspended solids than with lot of chemical sludge (e.g. lime)
- Good option for textile effluents
- Challenging process control
- Also available as horizontal units with travelling skimmer scooping floating sludge

Mixing, coagulation and flocculation

Flotation – Dissolved Air Flotation (DAF)

Rectangular DAF

(1) Travelling arm scooping sludge pushing to sludge trough

(2) Then sludge taken for dewatering

Mixing, coagulation and flocculation

Flotation – Dissolved Air Flotation (DAF)

Advantage

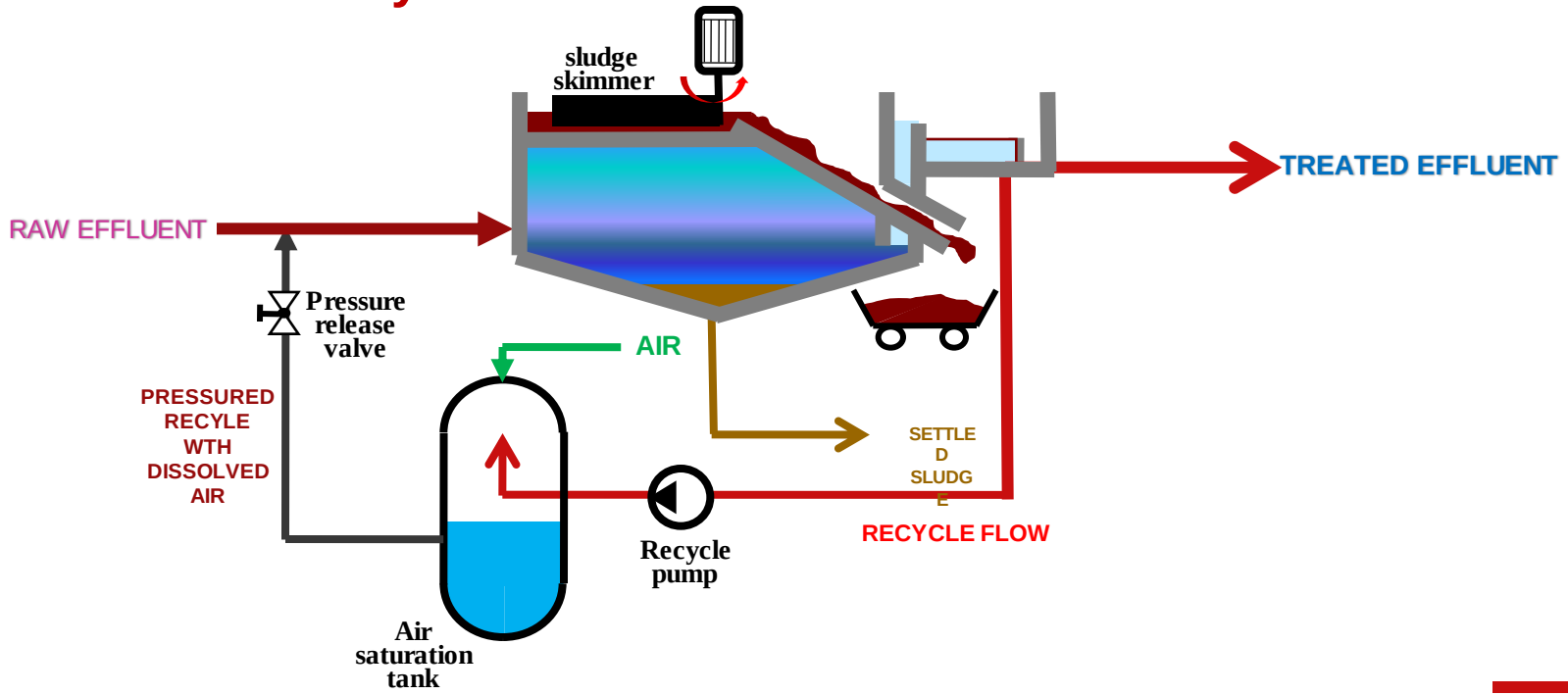
- Less space required compared to sedimentation units.

Disadvantage

- Relatively lower solids consistency in sludge
- Higher operation and maintenance costs
  - higher chemical dosage required

Mixing, coagulation and flocculation

Flotation – Summary



Sedimentation

Sedimentation

Sedimentation

To **remove suspended solids** from effluent

- Based on density difference between liquid bulk and solid particles resulting in settling solids
- Both in primary and secondary treatment (biological sludge)

Sedimentation

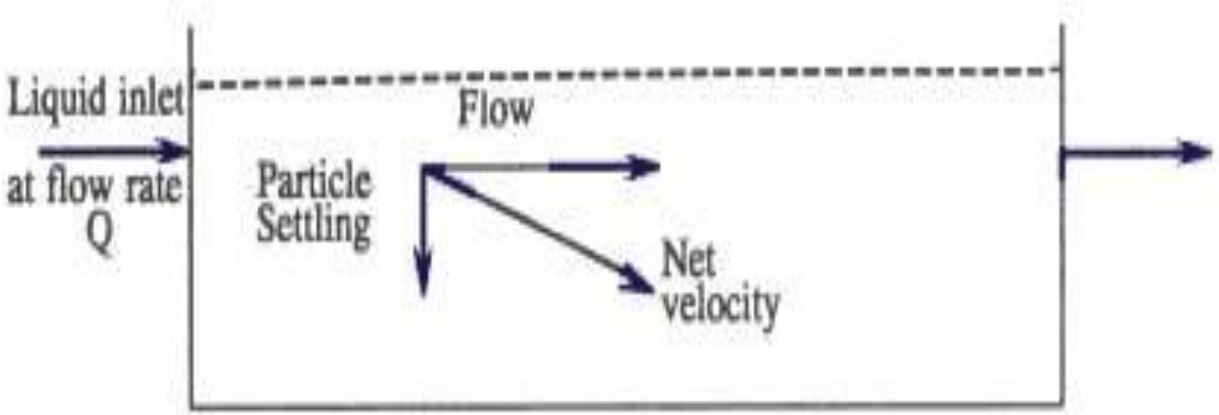
Types of sedimentation

- **Discrete settling**: Effluent relatively diluted and particles not interacting
- **Flocculent settling**: Flocculated particles of larger mass and faster settling rate.
- **Zone settling** (also hindered settling): Particles adhering together and settling as blanket.
  - Example: Sludge setting in secondary clarifiers

Sedimentation

Discrete settling

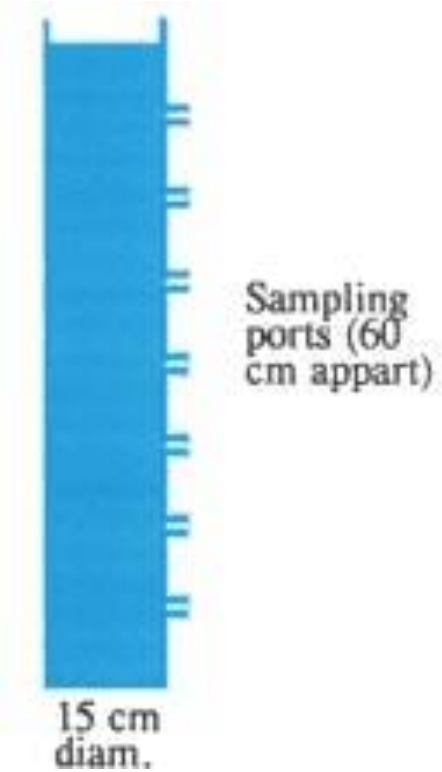
- Calculations made on settling velocity of individual particles.
- Particles moving both downwards (settling) and towards outlet zone with waterflow.



Sedimentation

Flocculent settling

- Formation of larger particles due to coalescence
- Depending on several factors
  - Nature of the particles
  - Rate of coalescence
- Settling column used to evaluate settling characteristics of flocculant suspension.



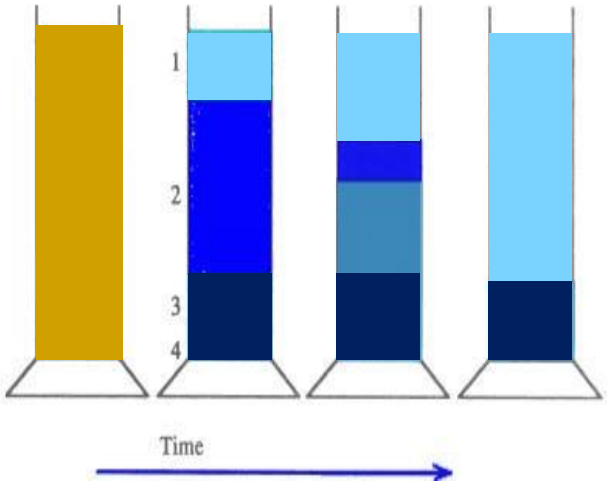
Note

- Same kind of column with only one sampling port also for studying discrete settling.

Sedimentation

Zoned or hindered settling

- When particles not settling independently
  - Effluent initially uniform in solids concentration
  - If allowed, settle in zones



(1) First zone = clarified water
(2) Interfacial zone: Solids concentration considered uniform.
(4) Compaction zone: Compact sludge developing at bottom
(3) Transition zone between (2) and (4)

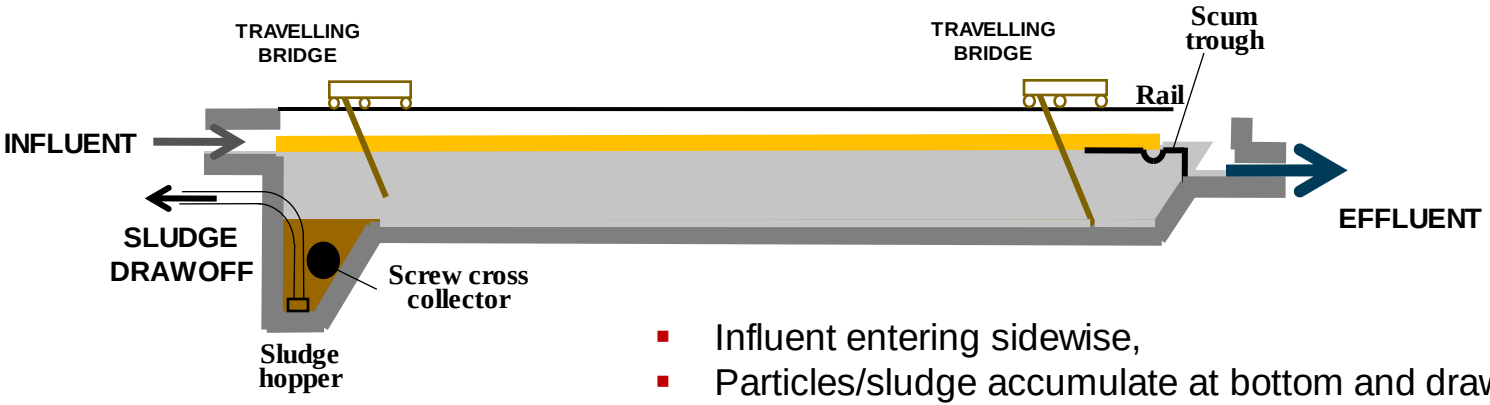
Sedimentation

Settling units

- **Rectangular** or **circular** configuration of **sedimentation tanks**
  - Rectangular used when several tanks required and space constraint
- **Size** based on **settling time**
  - clarified effluent and compaction zones increase
  - two intermediates decreasing and eventually disappearing
- Removal of solids with chain-driven scrapers:
  - Spanning width of settling tank and regularly spaced
  - Moving at 0.5 to 1 m/min.
- Sludge collected in hopper in end tank and removed by screw conveyors or pumped out.

Sedimentation

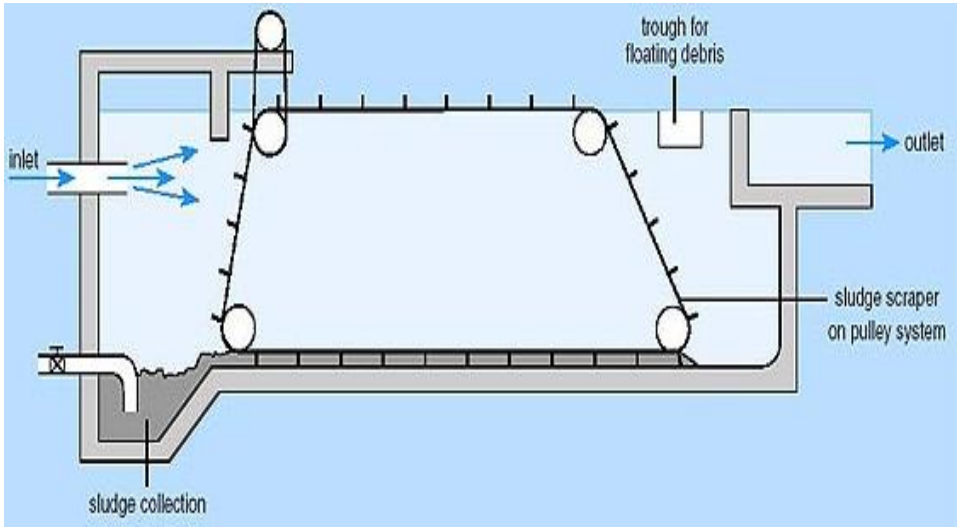
Rectangular sedimentation tank with travelling bridge



- Influent entering sidewise,
- Particles/sludge accumulate at bottom and drawn away
- Effluent leaving at right hand side
- Bridge slowly traveling to and fro and pushing sludge at bottom
- Scum (removed at the top)

Sedimentation

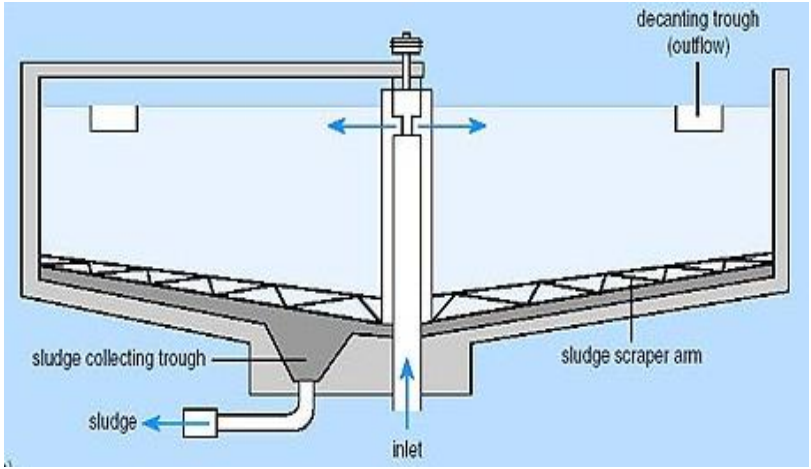
Horizontal flow settling units



Sedimentation

Circular clarifiers

- Effluent circulating radially with water let in at periphery or from centre
- Reported to be more effective.
- Solids removal from near centre
  - Slope of 10% required at tank´s bottom
  - Sludge forced to outlet by two or four arm scrapers spanning radius of tank.



Sedimentation

Circular clarifiers

- Flow in all directions provided in both types:
  - Circular well for centre fed tanks
  - Baffle for rim-fed tanks with effluent entering tangentially.
- Even distribution of inlet and outlet flows important
  - Avoid short-circuiting in tank reducing separation efficiency.
- Circular clarifiers most common in world; in Bangladesh tube settlers more popular

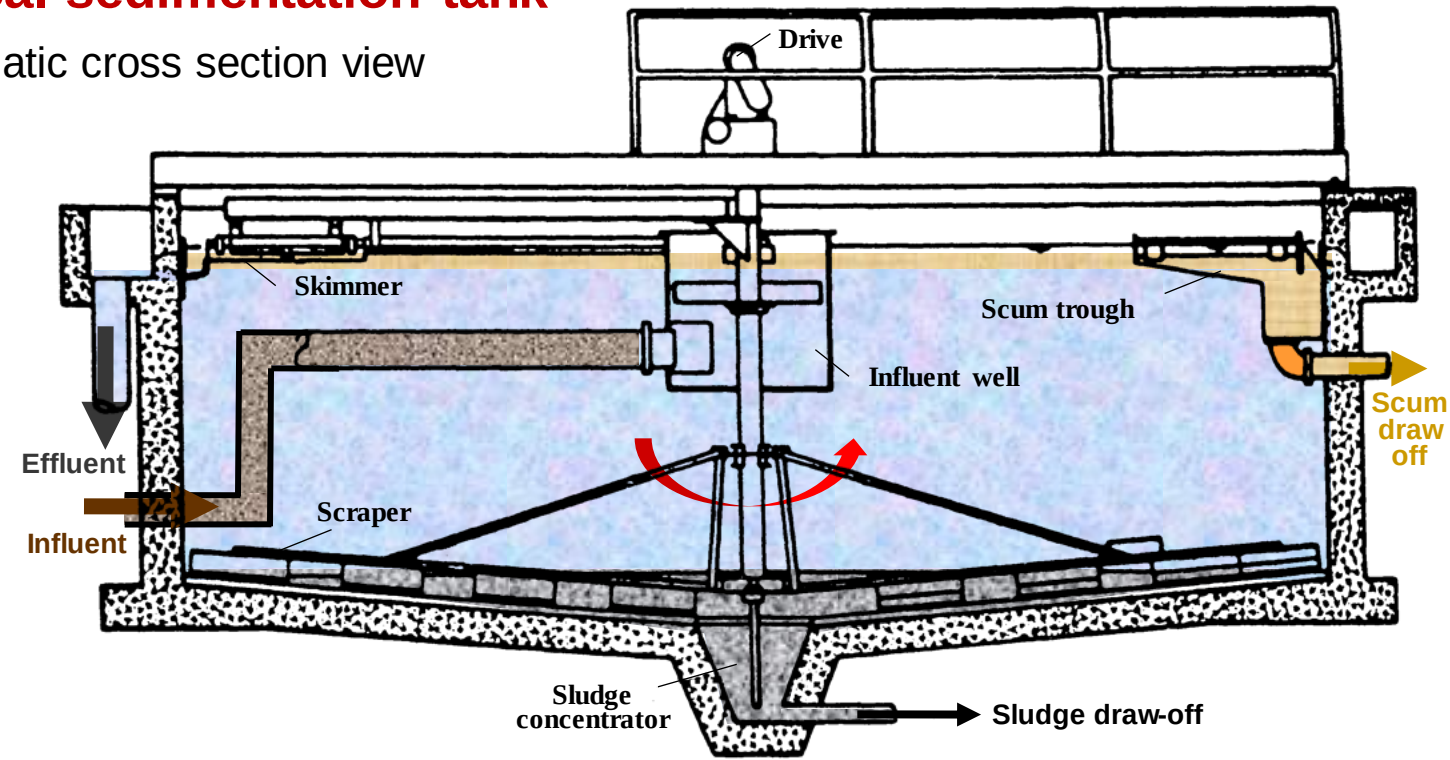
Sedimentation

Primary clarifier

Sedimentation

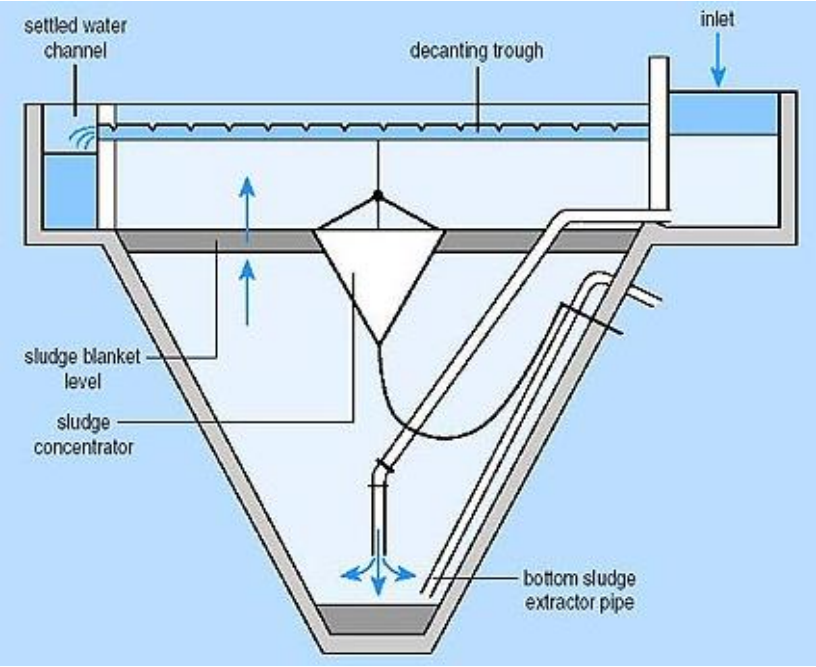
Typical sedimentation tank

Schematic cross section view



Sedimentation

Hopper-bottomed, upward-flow settling tanks



Advantage of sloped bottom sedimentation tank:

- No rotating sludge scraper required.

Sedimentation

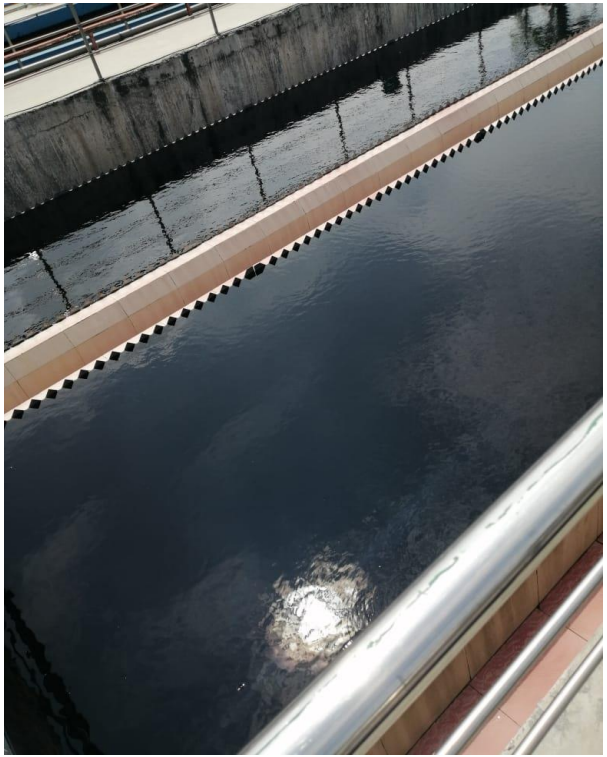
Tube settlers

- Tubular channels placed adjacent to each other.
  - at 60 degrees
  - combined to increase the effective settling area
- Settling area less deep than in conventional clarifier.
  - easier for floc to settle
- For fine particles use of fine floc managing to go past clarification zone.

Sedimentation

Tube settlers

- Larger particles reaching bottom in better shape due to fast floc formation
  - Creating sizeable mass going down channel with ease.
- Used to treat settleable solids in effluent operating on principle of settling velocity.
- Tube media of lightweight PVC adjacently placed and joined at angle increasing settling area.
- Different from plate settler, although functions similar.



Sedimentation

Advantage

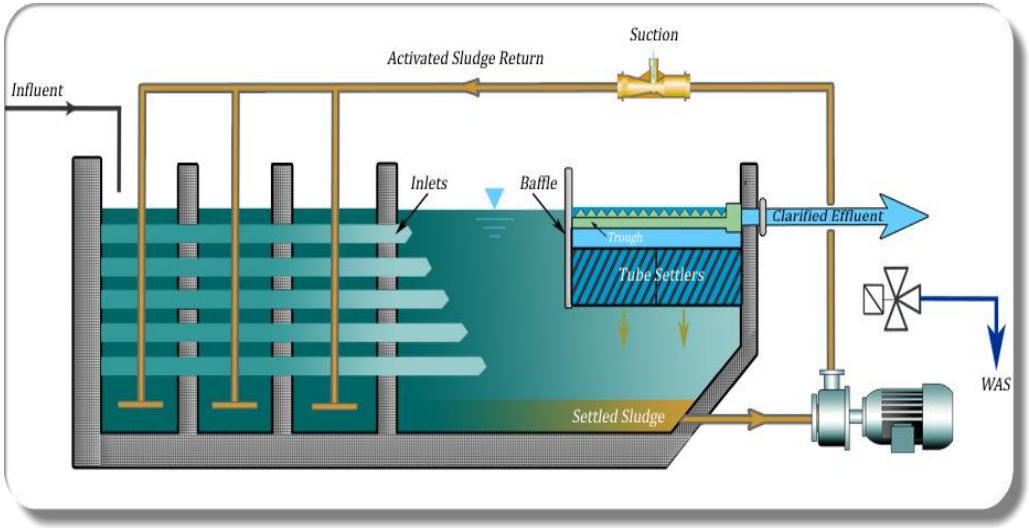
- **Smaller** than conventional clarifiers
- PVC lightweight material **easily portable**.
- **Quicker installation**
- Fitting in **different sizes and shapes in tanks**

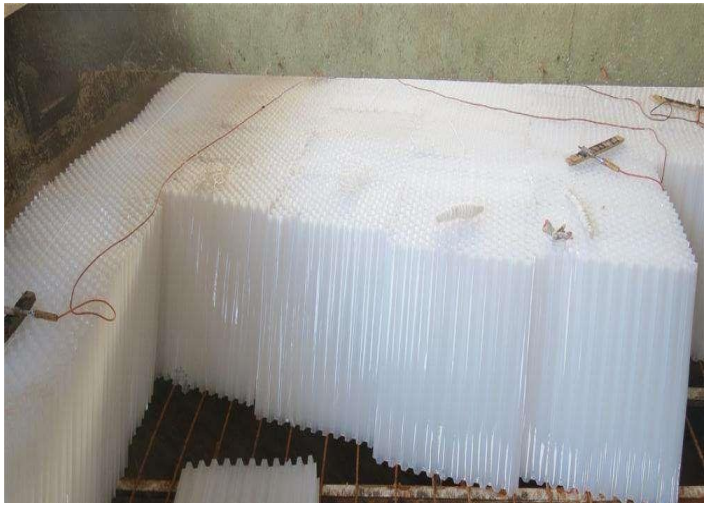
Disadvantages

- More **frequent sludge withdrawal**
- **Sludge overflows** in case of inefficient sludge evacuation
- If used as pre-treatment to ZLD, **break down of PVC** and clogging of expensive membrane by chards

Sedimentation

Tube settler





Sedimentation

Plate settler

- Very similar to tube settlers
- Usually deeper than tube settlers
- Heavier plate media
- Capital costs usually higher than tube settlers.

To remember

- Good understanding of chemical treatment important since used in large number of ETPs in Bangladesh (primary only and combined)
- Selection of chemical treatment unit depending on many factors including space availability, ease of operation and precision control.
- Use of corrosion resistant material (e.g. stainless steel) important . In view of corrosive materials
- Proper painting/coating of units (including walkways/handrails) if mild steel construction
- Important to ensure adequate retention times in flash mixer, flocculator and primary settling units for optimum performance.

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonnand Eschborn

GIZ Bangladesh
PO Box 6091, Gulshan 1
Dhaka 1212, Bangladesh
T +880 2 5506 8744-52, +880 9666 701 000
F +880 2 5506 8753
E giz-Bangladesh@giz.de
I www.giz.de/bangladesh

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH