TRAINING PROGRAMME FOR ETP OPERATORS IN TEXTILE INDUSTRY

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

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

Primary treatment – Objective, function and operations

GIZ FABRIC IS – ETP Operator Course

Contents

- Purpose and overview of primary treatment
- Overview of primary treatment units and their performance
- Function and operation of primary treatment units

Purpose and overview of primary treatment

- To make effluent fit for treatment ETP operations and machinery
- Involving physico-chemical treatment of wastewater.
- Specific aims:
  - Equalise different waste streams from production
  - Remove suspended solids
  - Reduce colour
  - Precipitate heavy metals
  - Removes portion of organics.

Primary treatment produces sludge equivalent to the suspended solids in the effluent & the chemicals dosed.

Overview of primary treatment units and their performance

Unit operation	Functions	Common units used
Screening	• Removal of large particles (suspended or floating) above screen size.	Bar racks and screens of various description
Grit Removal	• Removal of sand like materials from the effluent.	Grit chamber
Equalization	• Homogenizing the characteristics of the effluent to maintain the efficiency of the chemical and biological treatment. • Flow balancing.	Equalization tank Aerators, mixers
Coagulation/ flocculation	• Facilitating settling of colloidal solids & allowing the small solids to join together to make it big, facilitating solids separation.	Flash mixer & flocculator
Primary Sedimentation	• Removal of organic/inorganic settleable solids	Primary sedimentation tank (clarifier)

Purpose and overview of primary treatment

Outputs and performance of chemical treatment

- BOD removal: 25-50%
- COD removal: 50 -60%
- TSS removal: 70 – 80%
- Oil & grease removal: 60 – 80%
- Heavy metals removal: 80 -90%

- Primary treatment producing sludge equivalent to suspended solids in effluent & chemicals dosed.

Primary treatment in Bangladesh Textile ETPs

ETPs in Bangladesh

- 40% primary treatment only.
- 35% primary & secondary treatment
- 25% biological treatment only.

Primary treatment units commonly including

- Screens
- Equalisation
- Chemical dosing
- Primary settling
- Sludge dewatering
- Effluent filters.

Screening

Screening

Purpose

- To protect following treatment units against large objects
- To **prevent obstructions, blockages and clogging** (e.g. pumps, mixers)
- To ensure efficiency of subsequent treatment process
- To easily **separate and remove large matter** in raw effluent

Manually cleaned screen

Screening

Concept

Efficiency depending on spacing between screen bars:

- **Fine screening** (spacing under 10 mm)
- **Medium screening** (spacing between 10 to 40 mm)
- **Coarse screening** (spacing more than 40 mm)

Fine screening usually preceded by manually cleaned screen for purposes of protection.

Manually cleaned screen

Screening

Approach

- Separating coarse and medium size solids at inlet to avoid sedimentation in next treatment stages
  - **Manually or mechanically cleaned screens**
  - **Several subsequent screens**
- Increasingly automated screening to reduce manual operations
  - Essential where large amounts of plant matter in waste water
- Collecting and storage of refuse container for final disposal

Mechanically cleaned screen

Screening

Challenges

In factories effluent channels commonly used as a disposal place of any waste

- Yarn or fibers released or blown into gutters
- Deliberate or accidental dumping of large waste materials
  - gunny bags
  - plastic cups and bottles
  - Packaging materials

Mechanically cleaned screen

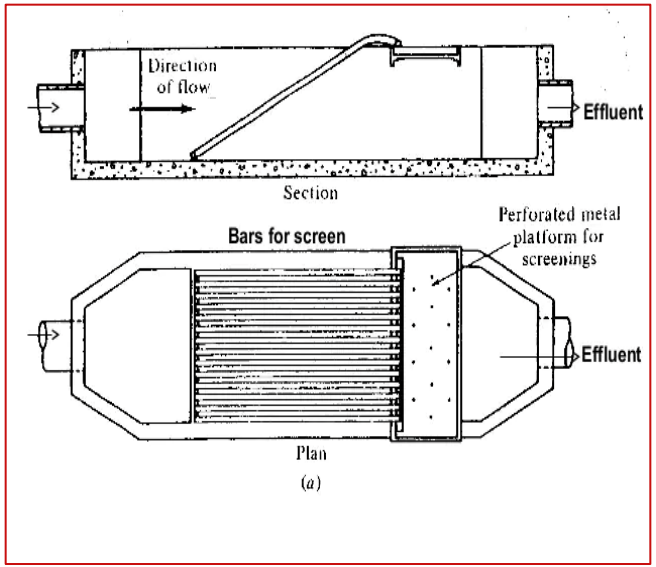
Screening

Manually cleaned screening

- First screening by manually cleaned bar screen
  - Commonly 20 - 50 mm spacing
  - Stainless steel or also non-corrosive poly propylene
- Cleaning with a fork like gadget attached to spindle by operator stand outside screen chamber
- Little or no equipment maintenance required
- Good choice for smaller ETPs with few screenings.

Rake and spindle for cleaning screen

Screening



Cross section and layout of bar screen

Manually cleaned screening

- Use of screening platform with perforations for screening removal after draining water
- Low cost solution
  - No electricity consumed
  - Low maintenance requirements
  - Higher labour costs than mechanically cleaned screens

Screening

Mechanically cleaned screening

- Often after manually cleaned screen and protected by coarse bar-screen
- Automatic cleaning system
- Suitable when raw water contains high volume of coarse matter.

Screening

Mechanically cleaned screening

Three popular types

1. Like **manually cleaned screen with mechanical comb** for cleaning
2. **Brush screen** with screen portion in trough and series of rotating blade with brushes for cleaning
3. **Drum screen** with effluent flowing through perforated drum and screenings removed by brush-blades

Screening

Mechanically cleaned screening

- Tighter bar spacing on mechanical screens
  - Drum screens: 3 - 5 mm,
  - Automatic rake screens usually 5 - 10 mm spacing.
  - Brush screen: Usually 1 - 3 mm, but also less than 0.5 mm
- Often with water jet to prevent clogging but still periodical cleaning required

Screening

Mechanically cleaned screening

- Advantage:
  - Except for occasional check-up and maintenance of moving parts, no personnel required
  - High degree of efficiency
- Disadvantage (compare to manual screens)
  - Higher initial investment cost
  - Higher Maintenance
  - Electricity consumption

Screening

Automatic mechanically cleaned screening

- Automatic cleaning systems works on intermittent basis using either/or
  - cyclic system of controllable frequencies (1 min to 1 h) and lengths of time (1 to 15 min)
  - differential head loss indicator
  - combination of both systems.

Screening

Automatic mechanically cleaned screening

Special features

- **Control mechanism** linked to start-up of upstream pumps **with built-in timer** (screen operation for 1 to 30 minutes)
- Automatic bar screen equipped with **torque limiter** to prevent equipment damage
- Device for **automatic stop of rake** when outside of the screen area

Screening

Mechanically cleaned screening

Good operational practices

- Ensure **smooth rotation of blades** without any jerks and noise.
- **Avoid gaps** between screen wall and rotating brushes preventing water without screening
- Regularly **inspect rake teeth** since susceptible to breakage and bending
- Regularly **inspect drive mechanisms** to prevent fouling from grit and rags.
- **Dispose removed grit** on regular basis

Grit removal

Grit removal

Purpose

= **removal of sand like mineral** material found in raw effluent

- To prevent **abrasive damage and failure of mechanical equipment** (e.g. pumps, valves)
- To prevent **damage to sensitive filters** and membranes
- To avoid **reducing flow and tank volumes** due to deposition of grit
- To avoid **disruption of biological processes**
- To reduce **efficiency loss and energy waste** in aeration tanks
- To reduce **maintenance efforts** from manually removing grit settling settle in channels, aeration tank floors and sludge digestors

Grit removal

Concept

Removing grit in separate **grit chamber** because too small for screening

- Settling by gravity sedimentation
  - Faster than organic solids (higher specific gravity >2.0)
  - Settling velocity approximately 0.03 m/s.
- Controlling velocity for settling grit and keeping organics in suspension
  - hydraulically (as in constant velocity chambers),
  - air-induced helical rolling motion (as in aerated chambers),
  - mechanically induced vortex chamber
- Removing settled grit from bottom of grit chamber

Grit removal

Approaches

- Type of grit chambers
  - horizontal
  - aerated
  - vortex
- Screw type grit classifiers or sieve bends for dewatering (sometimes)
- Important to maintain **horizontal flow velocities below 0.3 m/s**.
  - Scouring of deposited material at higher velocities

Equalisation

Equalisation

Purpose

- To equalize or homogenise effluent streams after screening and grit removal
- To avoid shock loading/over loading in chemical and biological treatment,
- To make fit for further treatment
- To neutralize effluent by combining acidic and alkaline waste streams
  - Less treatment chemicals later need for neutralization (adjustment of pH value)

Equalisation

Good practices

- Installation and use aeration systems
  - to mix well and ensure good homogenisation
  - to prevent anaerobic conditions occurring leading bad smell
  - to reduce temperature of effluent to some extent.
- Sufficient storage capacity for over 20 h/d

Equalisation

Common aeration systems in use

- Diffused aeration
  - Supplying coarse, medium or fine bubbles
  - Anchored at bottom of equilisation tank
  - Not affected by changing water levels in tank
  - But possible choking of diffusers in case of accumulation of sludge or sediments

Note

- **Fixed aerators** mounted on platforms **not suitable** for equalisation tanks!

Equalisation

Alternative aeration systems in use

- Jet aeration,
- Floating aerators mounted
- Aspirators
- Perforated pipes (in small and low cost ETPs)

Note

- **Fixed aerators** mounted on platforms **not suitable** for equalisation tanks!
  - No adjusting to changes in water levels

Neutralisation – pH Control

Neutralisation – pH control

Purpose

- Important if ETP with biological treatment
  - Microorganisms requiring pH in range of 6 - 8.
- To adjust pH level, since effluent rarely pH neutral
  - Acidic streams from pre-treatment and reactive dyeing

Approaches

- Natural neutralization (in equalization)
- Use of chemicals

Neutralisation – pH control

Use of chemicals

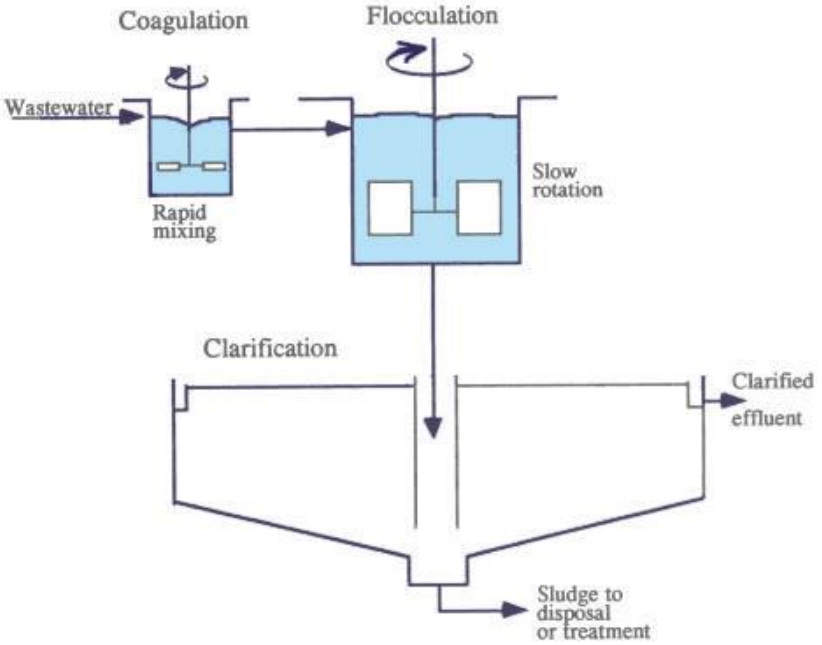
- For acidic wastes (low pH)
  - sodium hydroxide
  - sodium carbonate
  - calcium carbonate or calcium hydroxide
- For alkali wastes (high pH)
  - sulphuric acid
  - hydrochloric acid

Chemical treatment processes

Chemical treatment processes

Overview of common processes

- Chemical coagulation
- Chemical neutralization and stabilization
- Chemical precipitation
- Chemical oxidation and advanced oxidation



Chemical treatment processes

Coagulation, flocculation and solids separation

Basic three steps

1. **Coagulation:** Precipitating colloidal particles with coagulant
2. **Flocculation:** Facilitating colloidal particles to join together and grow in size.
3. **Separation:** Separating flocculated particles from effluent using
   - sedimentation
   - floatation
   - filtration

Chemical treatment processes

Coagulation, flocculation and solids separation

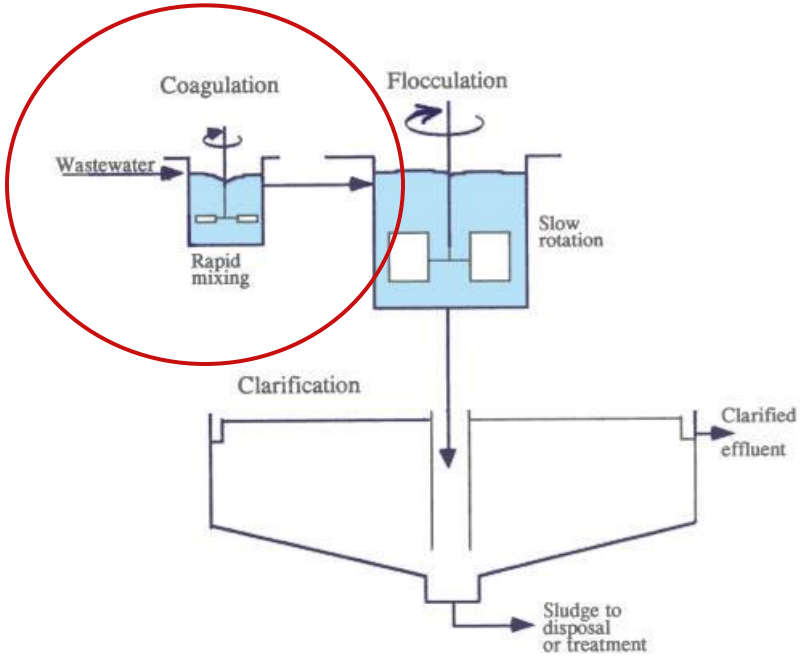
Common separation methods in Bangladesh

- Sedimentation
  - Tube settler
  - Lamella clarifier
  - Hopper bottom settling tanks
  - Gravity circular clarifier
- Rarely dissolved air floatation

Chemical treatment processes

Coagulation

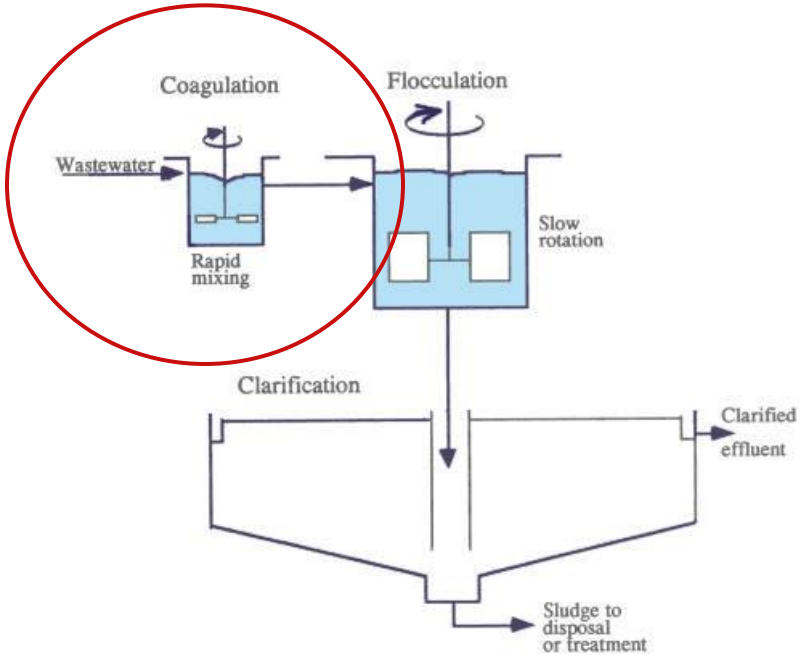
- Coagulants mixed with effluent in flash mixer
  - Coagulant chemicals added to water
  - Water mixed quickly and violently to ensure even distribution of chemicals
- Common coagulants use
  - Metallic salts of aluminum like alum
  - Iron like ferrous sulphate,
  - Polyelectrolytes



Chemical treatment processes

Coagulation

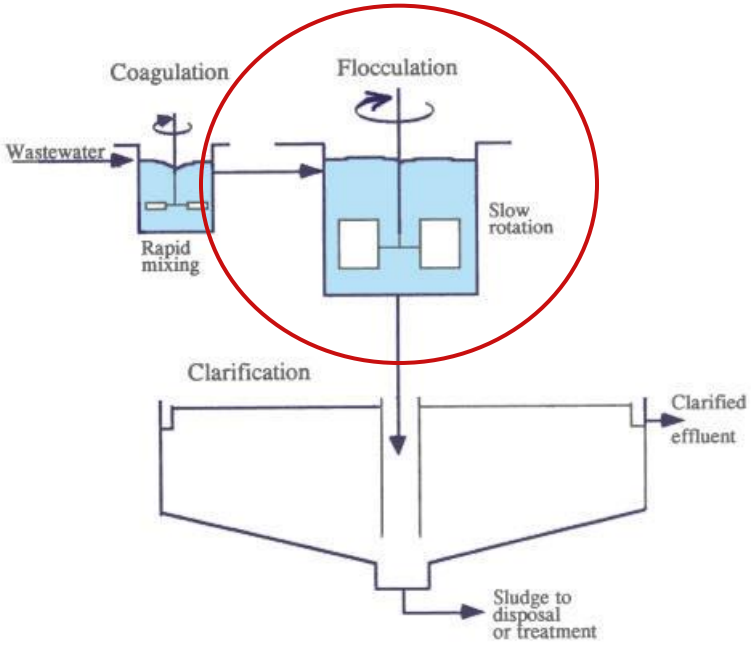
- Colloidal solids
  - very small suspended particles with size in between common visible suspended solids and dissolved solids.
  - After dispersing turbid appearance (milky and muddy water), clearing after week
  - Particles suspension due to electrical charge (zeta potential) between these particles.
  - Start of settling once charge neutralized



Chemical treatment processes

Flash mixing & flocculation in ETP

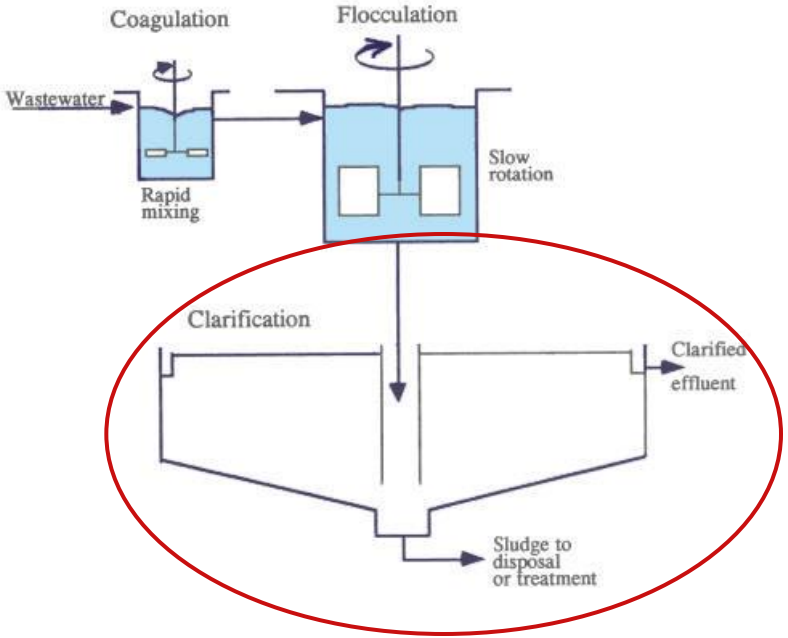
- Flash mixing for between 30 – 60 seconds
  - not less than 30 seconds
  - Not more than 60 seconds because tearing up of flocs
- Gentle mixing for bringing particles together, for about 30 – 45 minutes
  - flocculation basin with number of compartments with decreasing mixing speeds
  - Increase in flocs in compartmentalized chamber



Chemical treatment processes

Chemical precipitation

- Common method for removing heavy metals
  - not suitable for certain dissolved substances, e.g. sodium chloride.
- Conversion of dissolved metals into solid particle with help of precipitation reagent
  - precipitated as hydroxides or metallic sulphides
- Once precipitated, removal like common suspended solids & coagulated colloids.



Chemical treatment processes

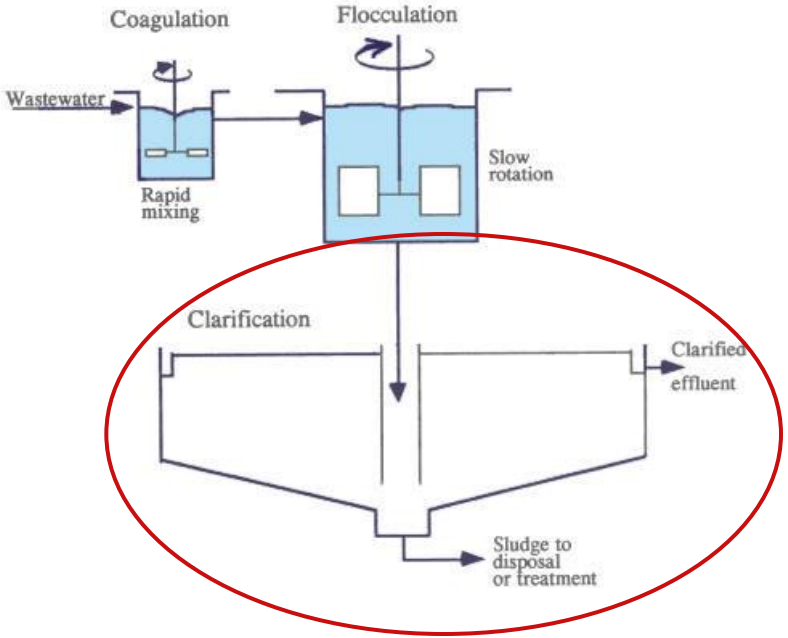
Chemical precipitation

Commonly used reagents

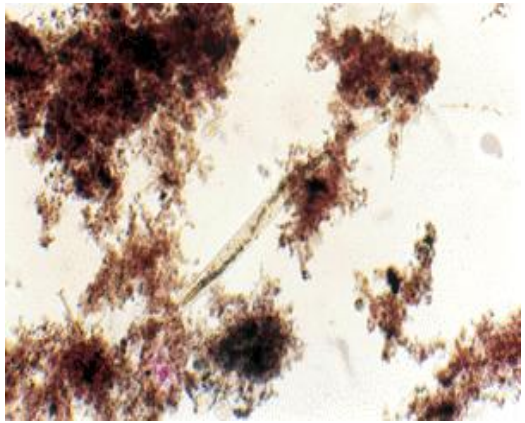
- Calcium
- Sodium hydroxide

Process dependent upon

- kind of metal present
- concentration of the metal and
- kind of reagent used.



Chemical treatment processes

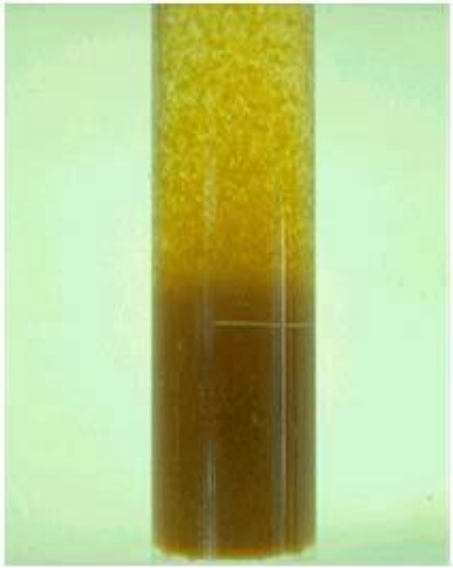


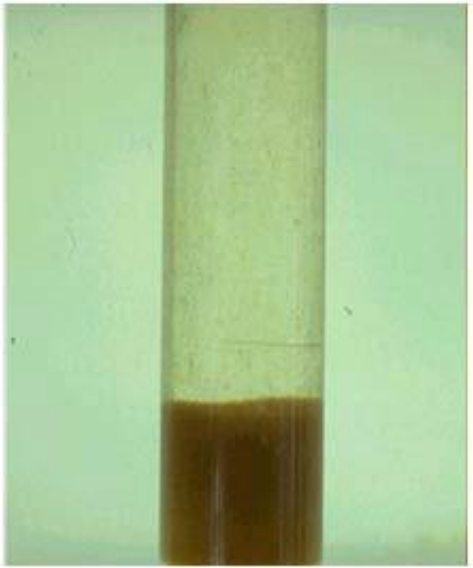
Flocculation

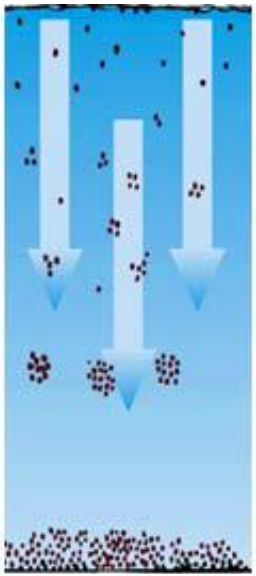
- results in visible suspended solids (floc).
- Floc settling as sludge in the sedimentation/ floatation basin, possibly filtered out
  - Good floc size 0.1 to 3 mm.
  - Smaller floc (less than 0.1 mm) not settling easily.
- Mass settling of flocs as blocks, trapping smaller particles and clearing effluent.

Chemical treatment processes

Flocculation







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