# TRAINING PROGRAMME FOR ETP OPERATORS IN TEXTILE INDUSTRY

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

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

# Tertiary treatment – Part 1

GIZ FABRIC – ETP Operator Course

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- Basic concept and overview
- Tertiary treatment systems –Disinfection
- Tertiary treatment systems - Filtration

# Basic concept and overview of tertiary treatment

# Basic concept and overview of tertiary treatment

- **Final treatment stage**, mostly to comply with norms
- Focus on
  - Reduction of **color**
  - Reduction of **suspended solids**
  - Destruction of **pathogens**
  - Removal of **organics**
  - Improvement of treated effluent appearance
    - sometimes for aesthetic purpose and as precautionary or complimentary measure

# Basic concept and overview of tertiary treatment

- Required as **pre-treatment for effluent recovery** using membrane systems by removing turbidity, hardness etc.
- **Single stage** or using **combination** of tertiary systems.
- Often installed as polishing treatment after physico-chemical treatment, in most primary ETPs and referred to as tertiary treatment

# Basic concept and overview of tertiary treatment

**Common tertiary treatment systems**

- **Disinfection** mainly to kill micro-organisms in treated effluent and some for organic removal.
- **Filters**, using filter media to filter out suspended particles in effluent
- **Adsorption filters** most commonly activated carbon filters to remove organics
- **Oxidation systems** to oxidize residual organics in treated effluent
- **Chemical precipitation systems** for removal of phosphates/metals.

# Basic concept and overview of tertiary treatment

**Other tertiary treatment systems**

- **Softening** using lime/soda softening or zeolite softeners
- **Membrane based filtrations** (using ultra filters or nano-filters)

# Tertiary treatment systems - Disinfection

# Tertiary treatment systems - Disinfection

## (1) Disinfection

- To **kill micro-organisms**, specifically **pathogens** in treated effluent
- Chlorination **most common** disinfection system
  - mixing effluent with chlorine gas in contact chambers or dosage of hypo-chlorites
  - Chlorine killing micro-organisms by breaking their cell walls
  - In case of sodium or calcium hypo-chlorites, chlorine content to be calculated and dosage fixed accordingly
- Generation of **disinfection-by-products** (DBPs)

# Tertiary treatment systems - Disinfection

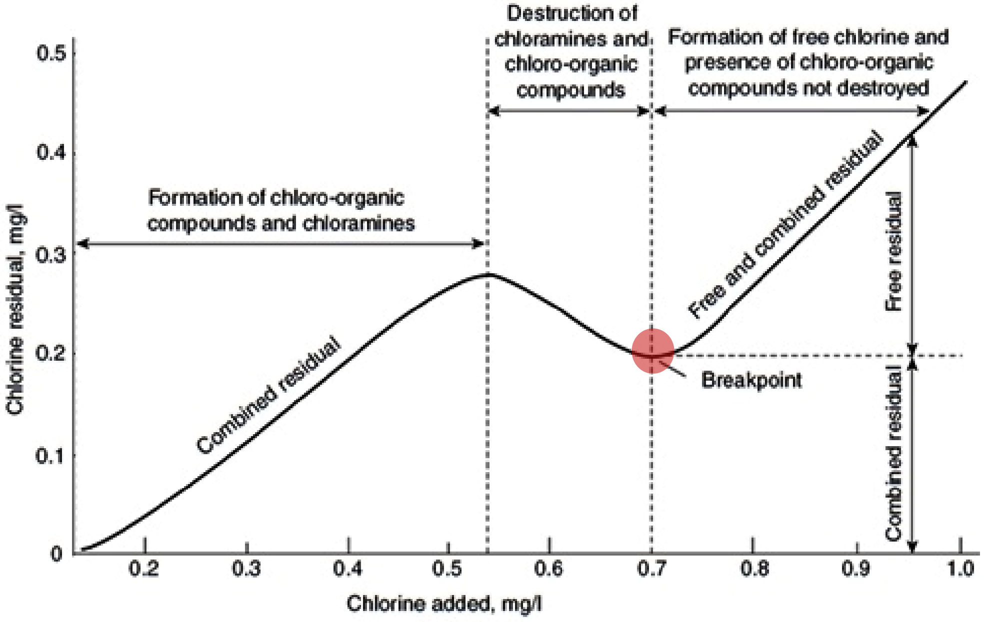
## (1) Disinfection

- Disinfection-by-products (DBPs)
  - haloacetic acid, trihalomethane, and chloral hydrate
  - controlled by activated carbon filtration or membrane filters.

# Tertiary treatment systems - Disinfection

## (1) Disinfection using chlorination

- Chlorination usually based on **break-point chlorination**
  - Keep adding chlorine (or hypo) to measured quantity of effluent
  - Check residual chlorine using DPD laboratory tablets
  - Residual chlorine first increasing, then decreasing and increasing again with more chlorine dosing
  - Point of increase = break point or correct dosage of chlorination.




Example of break-point chlorination chart

# Tertiary treatment systems - Disinfection

## (1) Disinfection using chlorination

- Storage and dosing chlorine gas **difficult and safety risk**
  - Use of sodium hypochlorite or calcium hypochlorite in small- and medium ETPs but less preferred due to sludge issues
  - Sodium hypochlorite generally containing 10% - 12% chlorine
    - Need to calculate dosage accordingly
- **Increased efficiency** of chlorination with **higher dosage**, **lower pH**, **higher temperature** and **longer contact time** (usually 30 min)
  - If not effective, take corrective actions such as by increasing dosage, increasing contact time (reduce flow) or reducing pH

# Tertiary treatment systems - Disinfection

## (1) Disinfection using Ultraviolet (UV) system

- Pathogens killed by **exposing effluent to UV radiation** damaging DNA of bacteria/virus
  - effluent passing through chamber illuminated by UV rays from UV lamp
  - low pressure and medium pressure lamps common.
    - Medium handling higher flows, but consuming more power
- As per wavelength classification into UV-A, UV-B, UV-C
  - UVA less powerful, but consuming less power
  - UV-B with medium efficiency and medium power consumption
  - UV-C highest power consumption and efficiency

# Tertiary treatment systems - Disinfection

## (1) Disinfection using Ultraviolet (UV) system

**Advantages**

- Effective in inactivating most bacteria, viruses and cysts
- No residual effect and not harmful to humans or aquatic life
- Physical process without chemical disinfectant
  - No need to buy, store and handle dangerous chemicals.
- Shorter contact time to other disinfection systems (approximately 20 to 30 seconds)
- Less space requirement

# Tertiary treatment systems - Disinfection

## (1) Disinfection using Ultraviolet (UV) system

**Disadvantages**

- Low dosage not effectively inactivating some viruses
  - Organisms sometimes surviving
- Frequent cleaning necessary to prevent fouling of tubes
- Suspended solids and turbidity reducing efficiency
  - Not suitable for TSS levels above 30 mg/l
- Costlier in installation

# Tertiary treatment systems - Filtration

# Tertiary treatment systems - Filtration

## (2) Filtration

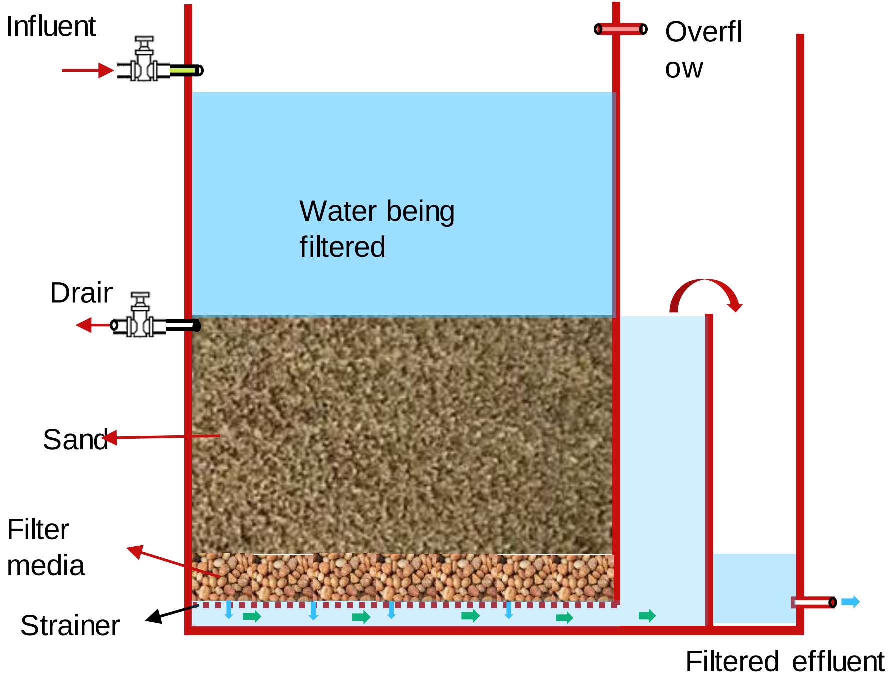
- Used for **removal of suspended solids** in treated effluent
  - Also partly reducing BOD/COD by removing some organics (like MLSS particle) in the suspended solids
- Done by gravity for pressure filters
  - Slow sand filters using gravity (similar to sludge drying beds)
  - Pressure sand filters using vessel filled with filter media with effluent being pumped and filter under pressure
  - Fine filtrations (such as pre-treatment of membrane) with cartridge filters

# Tertiary treatment systems - Filtration

## (2) Filtration - Gravity sand filters

### Slow sand filters

- similar to sludge drying beds with coarse media at bottom, fine sand at top
- water admitted from top, with pressure by water column speeding filtration
- Solids retained in top sand layer
- Periodically, filter dried and solids scooped out for disposal
- Top sand cleaned and topped up with fresh sand



# Tertiary treatment systems - Filtration

## (2) Filtration - Gravity sand filters

**Slow sand filters**

- **Advantages**
  - very **low operating costs**
  - **simple process control**
  - good **efficiency**

# Tertiary treatment systems - Filtration

## (2) Filtration - Gravity sand filters

### Slow sand filters

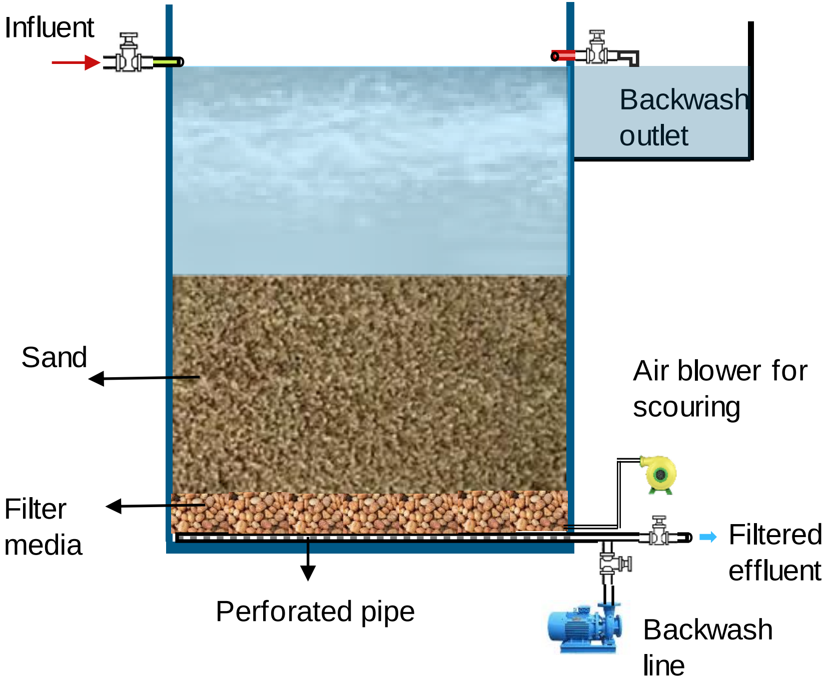
- **Disadvantage**
  - high **land requirement**
  - suitable **for small ETP**
  - potential **clogging**
  - **not suitable** for effluent with **high level of suspended solids**

# Tertiary treatment systems - Filtration

## (2) Filtration - Gravity sand filters

**Rapid sand filters**

- **similar to slow sand filter**, however with provision in filtrate line to **admit water at pressure** to carry out periodical backwash
- network of net covered perforated pipes for draining.
  - drain filtrate during normal operation and admit backwash water during backwashing

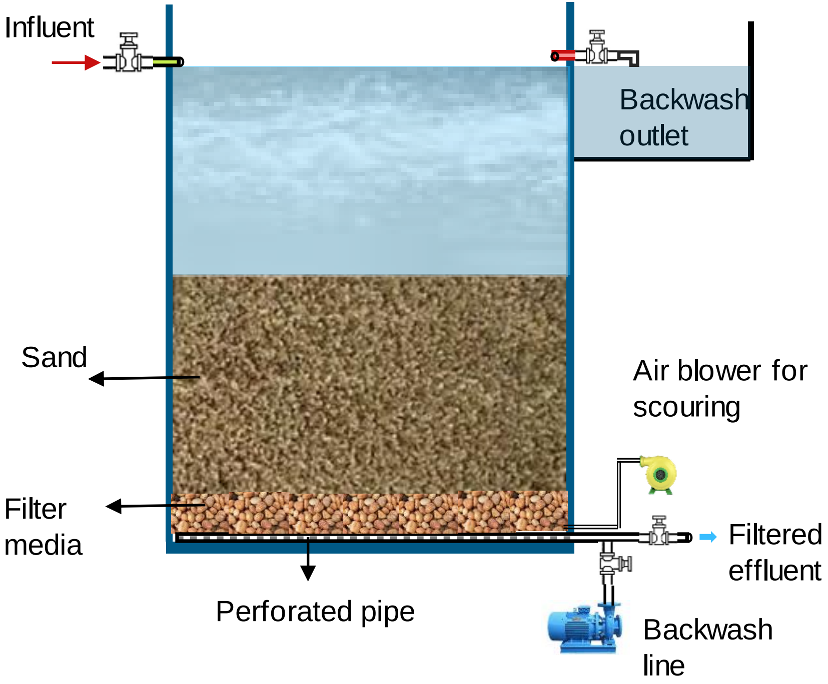


# Tertiary treatment systems - Filtration

## (2) Filtration - Gravity sand filters

**Rapid sand filters**

- backwashing with pump or water tank at sufficient height for required head
  - Often with air scouring as additional washing aid
  - backwash water collected in overflow trough and processed along with sludge



# Tertiary treatment systems - Filtration

## (2) Filtration - Gravity sand filters

**Rapid sand filters**

- **Advantages**
  - higher **capacity**
  - **no manual cleaning** required
  - suitable for medium scale ETPs
  - **easy process control**
  - good efficiency

# Tertiary treatment systems - Filtration

## (2) Filtration - Gravity sand filters

**Rapid sand filters**

- **Disadvantages**
  - **Land requirement** (less than slow sand filter, higher than pressure filters)
  - **not** suitable for effluent with **high suspended solids**
  - relatively **more maintenance intensive**

# Tertiary treatment systems - Filtration

## (2) Filtration – Pressure filters

- Common types in wastewater treatment:
  - **Pressure sand** filters
  - **Multi-grade** filters
  - **Dual media** filters
- Similar in construction and operational pattern but varying in composition of filter media
  - made of FRP, MS (often rubber lined) and stainless steel
  - New types of media coming to market every year.

Mild Steel (MS)

# Tertiary treatment systems - Filtration

## (2) Filtration – Pressure filters

- Measurement of **operational efficiency**
  - **filtration rate** = quantity of water passing through per unit area
  - **head loss** = difference between inlet and outlet pressure
  - **frequency of backwashing** needed.

Fibre reinforced Plastic (FRP)

# Tertiary treatment systems - Filtration

## (2) Filtration – Pressure filters

- Common **filtration media**
  - most common **silica sand** and **anthracite coal**
  - quartz sand, garnet, magnetite
- **Size and shape** of filter media **affecting efficiency**
  - **Smooth and rounded better** than sharp and angular media
  - Most suspended solids at surface (top 5 - 10 cms), gradually solids percolating down to prevent rapid pressure drop

Stainless Steel

# Tertiary treatment systems - Filtration

## (2) Filtration – Pressure filters

**Operation cycle**

- Service
  - Inlet water pumped through media via distribution tube.
  - Drained water collected as filtered water.
- Backwash
  - Flow reversed and forced through bottom and up through media
  - Backwash lifts media and causes scouring
  - Collected dust and debris is flushed to the drain
- Slow Rinse

Stainless Steel

# Tertiary treatment systems - Filtration

## (2) Filtration – Pressure filters

### Operation cycle

- Slow Rinse
  - Clean water allowed to flow down through media bed and distribution tube to drain
  - Entire backwash and rise programmable with auto-valves and controls
    - based on fixed quantity of flow
    - at scheduled times or based on differential pressure

Stainless Steel

# Tertiary treatment systems - Filtration

## (2) Filtration – Pressure filters

**Backwashing of pressure filters**

(1) Take filter off line by switching off feed line and closing feed valve

(2) Provide compressed air and open air line, passing air through filter material

- filter bed expanding and forcing accumulated particles to get loose.

(3) Open backwash line valve and backwash drain valve

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# Tertiary treatment systems - Filtration

**(2) Filtration – Pressure filters**

**Backwashing of pressure filters**

(4) Pass clean backwash water upwards through filter bed and allow it to drain

(5) Observe drained water for its clarity.

(6) Continue backwashing for set time (e.g.10 mins) or until backwash water starts coming clear

(7) Close drain valve and backwash valves

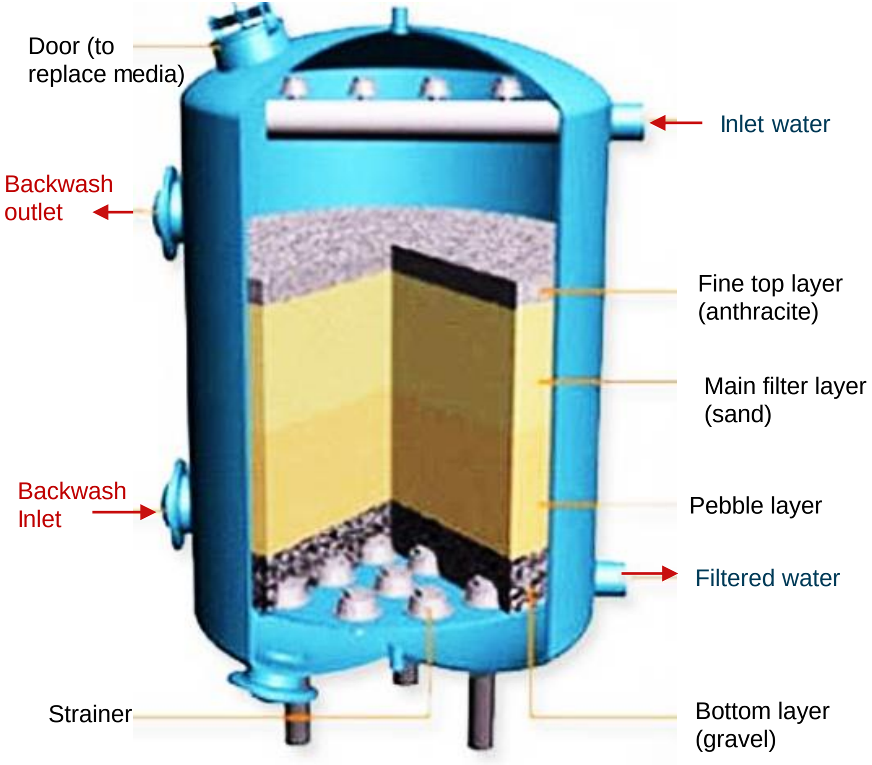
(8) Switch off air/backwash lines and open feed/filtrate lines

Stainless Steel

# Tertiary treatment systems - Filtration

## (2) Filtration – Pressure sand filters

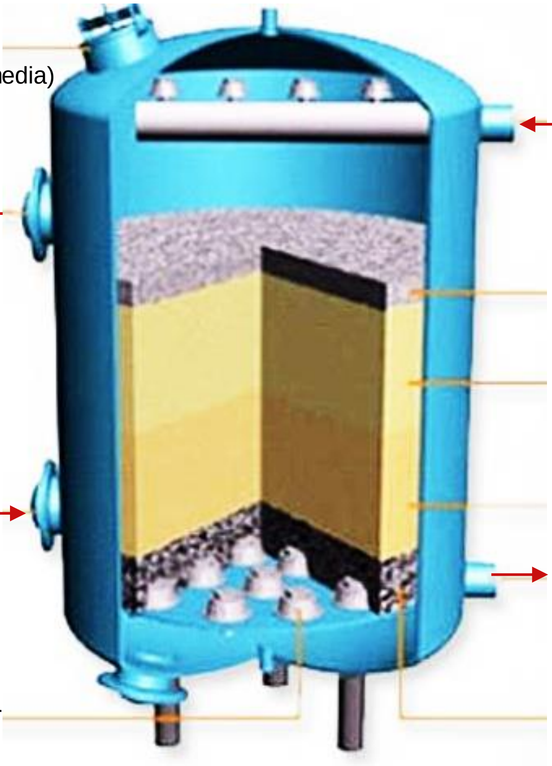
- usually cylindrical vessel filled with filter media.
  - vertical or horizontal orientation
  - set of frontal pipe work and valves
  - graded silica quartz sand
- sand layer supported by under-bed of pebble/gravel.



# Tertiary treatment systems - Filtration

## (2) Filtration – Pressure sand filters

- Water admitted via top distributor
  - uniform distribution throughout cross section of filter
- Under-drain collecting filtered water



# Tertiary treatment systems - Filtration

## (2) Filtration – Pressure sand filters

- Backwashing with clean water or sometimes with filtered water from unit
  - Done whenever pressure drop across filter more than 1 bar.
- Backwash operation
  - Open backwash valves as provided
  - Sometimes preceded by air scouring for agitating sand with scrubbing action and loosens retained solids

# Tertiary treatment systems - Filtration

## (2) Filtration – Multigrade filters

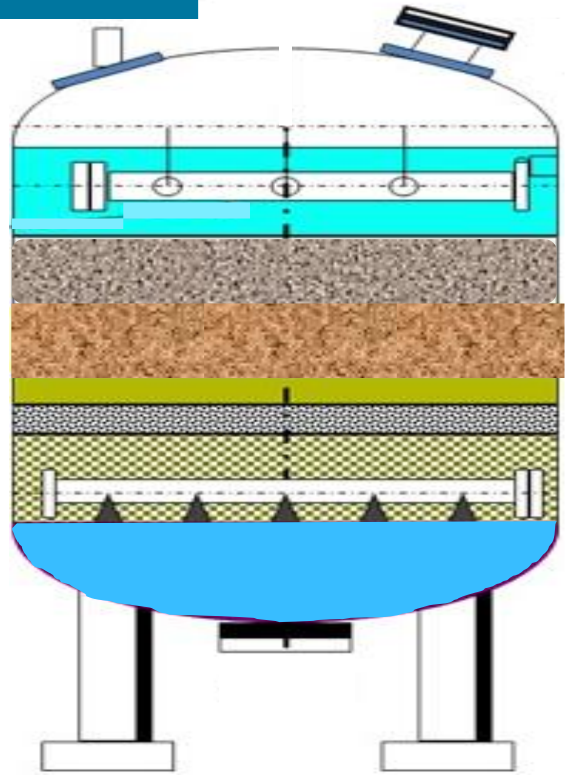
- similar to pressure sand filter in construction with cylindrical vessel and identical piping/valves
- same way of operation and backwashing
- coarse and fine media mixed together in fixed proportion
  - filter bed with adequate pore dimensions for retaining both large and small suspended particles

# Tertiary treatment systems - Filtration

**(2) Filtration – Multigrade filters**

- performing at substantially **higher specific flow rate** than pressure sand filter
  - Smaller number and size required
- **filtration efficiency not as fine** as in pressure sand filter but **turbidity reduction better**

# Tertiary treatment systems - Filtration



## (2) Filtration – Dual media filters

- similar to pressure sand filter in construction with cylindrical vessel and identical piping/valves
- same way of operation and backwashing
- sand-anthracite filter or multi-media used for removal of turbidity and suspended solids
  - as low as 10 - 20 microns

# Tertiary treatment systems - Filtration

## (2) Filtration – Dual media filters

**Advantages**

- very efficient particle removal
- high filtration rate
- operating at substantially higher specific flow rate than pressure and multigrade filters
  - number of filters and size for ETP still smaller
- The main disadvantage is that the backwashing frequency needed for DMF is higher than PSF and MGF and hence the water consumption is higher.

# Tertiary treatment systems - Filtration

## (2) Filtration – Dual media filters

**Disadvantages**

- Higher backwashing frequency than pressure and multigrade filters
  - Higher water consumption

# Tertiary treatment systems - Filtration

## (2) Filtration

**Maintenance requirements**

- If made in mild steel, **periodical painting with epoxy coating** needed
- Once a week:
  - Check of all valves, flanges and gaskets for its tightness.
  - Check for any leaks => to be arrested promptly
  - Check of pressure gauges, auto valves for their correct operation.

# Tertiary treatment systems - Filtration

## (2) Filtration

**Maintenance requirements**

- Irrespective of media, **media degradation over period of time**
  - more predominant with natural media
  - salt in effluent, pH variations etc. chemically degrading media
  - abrasion by flowing water physically degrading media
- **Need to replenish or replace** after period of time
  - Media removed through bottom door
  - Refilled through trap door at top

# Tertiary treatment systems - Filtration

**(2) Filtration – Pre-coat filters**

- filters or flexible screens on which coat of filter medium given
- temporary or fixed to mechanical screen
- Filter media
  - inert materials of fine fibrous or granular structure e.g. diatomaceous earth (diatomite).
  - Other media: Perlite, powered organic rock, activated carbon, asbestos and cellulose

# Tertiary treatment systems - Filtration

## (2) Filtration – Pre-coat filters

In case of temporary pre-coating:

- Primary filter medium layer deposited on basic screen before start-up
  - Correct amount of filter medium mixed with clean liquid
  - Pumped into filter body and deposited uniformly over filter elements

# Tertiary treatment systems - Filtration

## (2) Filtration – Pre-coat filters

**Vacuum assisted drum pre-coat filters**

- similar in appearance to conventional drum filter but different construction
- coated with bed of diatomaceous earth or similar material
  - Other materials: Perlite consisting of glassy crushed and heat-expanded rock from volcanic origin
  - Alternatively, cellulose consisting of fibrous light weight and ash less paper like medium

# Tertiary treatment systems - Filtration

## (2) Filtration – Pre-coat filters

**Vacuum assisted drum pre-coat filters**

- Process
  - With vacuum applied, liquid drawn through pre-coat material
  - Solids deposited on pre-coat surface
  - Solids removed by special doctor blades along with thin portion of pre-coat as drum revolves

# Tertiary treatment systems - Filtration

**(2) Filtration – Cartridge filters**

- used for **very fine filtration** e.g. pre-treatment of membranes
- cartridge filters considered as **consumables**
  - possible to clean blocked cartridges by soaking in cleaning solution
  - to be replaced once logging at irreversible stage
- usually very **small in construction**
- generally **used in-line of pumping lines**

# Tertiary treatment systems - Filtration

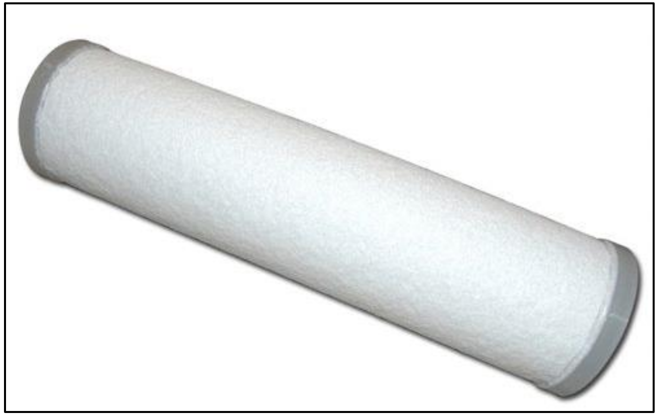
**(2) Filtration – Cartridge filters**

- usually pore sizes in range of **0.2 - 20 microns**
  - smaller pore size = shorter replacement period
- Common types of cartridge filters:
  - surface filters
  - depth filters

# Tertiary treatment systems - Filtration

## (2) Filtration – Cartridge filters

- Surface cartridge filter
  - Pleated cartridge filter, cellulose filter
  - smooth surface for preventing solids getting inside
  - effective for solids larger than pore sizes
  - To be cleaned or replaced when surface caked on outside with solids
  - Comparatively cheap and short shelf life
  - Less mechanical strength of filter medium (except stainless steel filter)



# Tertiary treatment systems - Filtration

## (2) Filtration – Cartridge filters

- Depth cartridge filters
  - String wound filter, ceramic filter, sintered filters
  - Trapping all suspended solids within layers of media
  - Suitable particles smaller than pore size
  - To be cleaned or replaced since solids getting into filter layer and gradually blocking pores
  - depth filter relatively expensive but longer shelf life
  - High mechanical strength of filter medium



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# Conclusion

- Filters common in tertiary or polishing treatment
- **High efficiency** of suspended solids and turbidity removal and **easiness of control** advantages of filtration vis-à-vis other tertiary treatment options
- Filters **susceptible to clogging** by suspended solids and not suitable if high TSS levels
- Recent developments in design of filters using light weight media with high uniformity coefficients
- **Pressure filters** ideal for tertiary treatment units in Bangladesh because of **low space requirements**



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