Master Training Program on Water (Water Supply, In-house Processing, End-of-Pipe) in Textile and Garment factories

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

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Day 6: Presentation 1

Textile effluent Treatment

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Contents

- pollutants in textile effluent
- Ill effects of pollutants
- Typical effluent treatment steps
- Management of sludge
- Treated wastewater quality

Pollutants in textile effluent

- **Organic pollutants:** residues of organic material used both as raw material and process ingredients.
- **Salt:** Most chemicals used in textile processing contributes to salts.
- **Suspended particles:** mostly fine fibers and residues of chemicals.
- **Heavy metals & hazardous substances:** Normally present in dyeing & printing chemicals and discharged in these effluents.
- **Colour & temperature:** caused by the remnants of the dyes & printing agents. The operation is done at high temperature.

Organic pollutants in textile effluent

Contributors	Organic load	Degradability
Starch sizes, vegetable oils, fats and waxes, biodegradable surfactants, organic acids and reducing agents	Medium	Moderate
Dyes, fluorescent brighteners, fibres and polymeric, polyacrylate sizes, synthetic polymer finishes and silicons.	High	Difficult
Sizes, starch ethers and esters, mineral oil (spin finish), surfactants, anionic /non-ionic softeners	Medium	Ready
Formaldehyde, N-methylol reactants, chlorinated solvents & carriers, cationic retarding and softening agents, biocides, sequestering agents	Low	Difficult

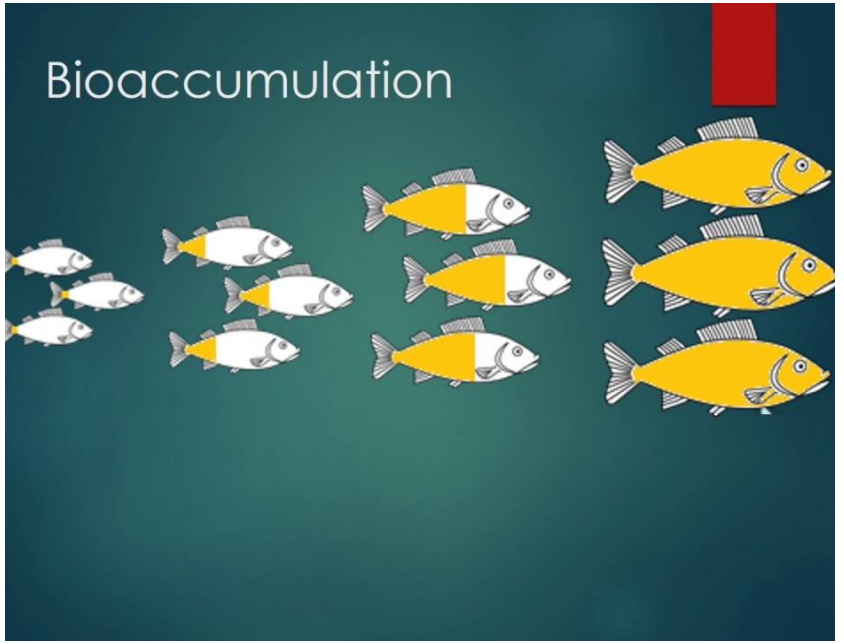
Inorganic pollutants in textile effluent

- Only small portion of chemicals used in manufacturing fully consumed; balance released in effluent.
- Chemicals including alkalis, mineral acids, neutral salts (chlorides, sulphates, phosphates and silicates) and oxidizing agents like peroxides, chlorine and chlorine dioxide.
- Other inorganic compounds in effluent including heavy metals in chemicals used in manufacturing.
  - Copper, Chromium, Nickel, Zinc, Cadmium, Mercury, Antimony
- Residuals mostly emerging in form of salts, either as direct salts or salts formed due to inter-reaction of alkali and acids

Ill effects of pollutants in textile effluent

Pollutant	Effects
Organic pollutants	consuming oxygen in receiving water body, dangerous to aquatic life; generating foul odour on stagnation
Salts	serious pollutant, persistent and difficult to treat, affecting • vegetation growth if high in irrigation water. • Health, when high concentration in drinking water. • aquatic biology
Suspended particles	deposited in discharge bodies and silts channels, creating blockages
Heavy metals & hazardous substances	Highly toxic, chance of undergoing bio-magnification in fish, causing diseases including cancer
Colour & temperature	reducing aesthetic quality of recipient water, affecting natural bio-system Temperature reducing dissolved oxygen in water and affecting aquatic life

Bioaccumulation of heavy metals & hazardous compounds



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What are the pollutants in textile effluents?

TYPICAL WASTEWATER TREATMENT STEPS

Common units in Effluent Treatment

Unit operation	Functions	Common unit
Screening	• Removal of large particles (suspended or floating)	Manual/mechanical screens
Grit Removal	• Removal of sand like materials from the effluent.	Grit chamber
Equalization	• Homogenizing the characteristics of the effluent • Flow balancing.	Equalization tank Aerators, mixers
Coagulation/ flocculation	• Facilitating settling of colloidal solids & allowing the small solids to join together to form sludge.	Flash mixer & flocculator
Primary settling	• Removal of part organic/inorganic settleable solids	Primary clarifier/tube settler
Biological treatment	• Removal of organics using microbial action	Aeration tank
Secondary settling	• Settling of bio-sludge, enabling biomass inventory	clarifier
Tertiary treatment	• Removes suspended solids/increase dissolved oxygen	Multigrade filter & aeration
Sludge dewatering	• Reducing moisture of liquid sludge to dried sludge	Sludge filter press/centrifuge
Sludge maturation	• Reducing moisture of dewatered sludge further	Sludge storage.

Treatment of textile effluent

Preliminary treatment: mainly screening, grit removal & equalization

Primary treatment: Coagulation, flocculation & solids separation

Secondary treatment: removes organics using micro-organisms

Tertiary treatment: polishing treatment and/or recovery & re-use

Common types of treatment set-ups

Primary ETPs

- Common set-up in effluent treatment plants, often combined polishing using tertiary treatment

Combined ETPs

- Popular set-up, combining primary treatment followed by biological treatment

Full biological treatment ETPs

- New trend for medium/large ETPs. The main justification is lower quantity of sludge generation.

ETPs with membrane systems

- Set-up found in many new effluent treatment plants, consisting of membrane bio-reactors for biological treatment;
- some with recovery & recycle systems and even zero liquid discharge.

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Common types of treatment set-ups

Physico-chemical treatment

- Common set-up in effluent treatment plants, often combined polishing using tertiary treatment

Physico-chemical and biological treatment

- Popular set-up, combining primary treatment followed by biological treatment

Full biological treatment

- New trend for medium/large ETPs. The main justification is lower quantity of sludge generation.

Treatment set-up with membrane systems

- Set-up found in many new effluent treatment plants, consisting of membrane bio-reactors for biological treatment; some also incorporating recovery & recycle systems and even zero liquid discharge

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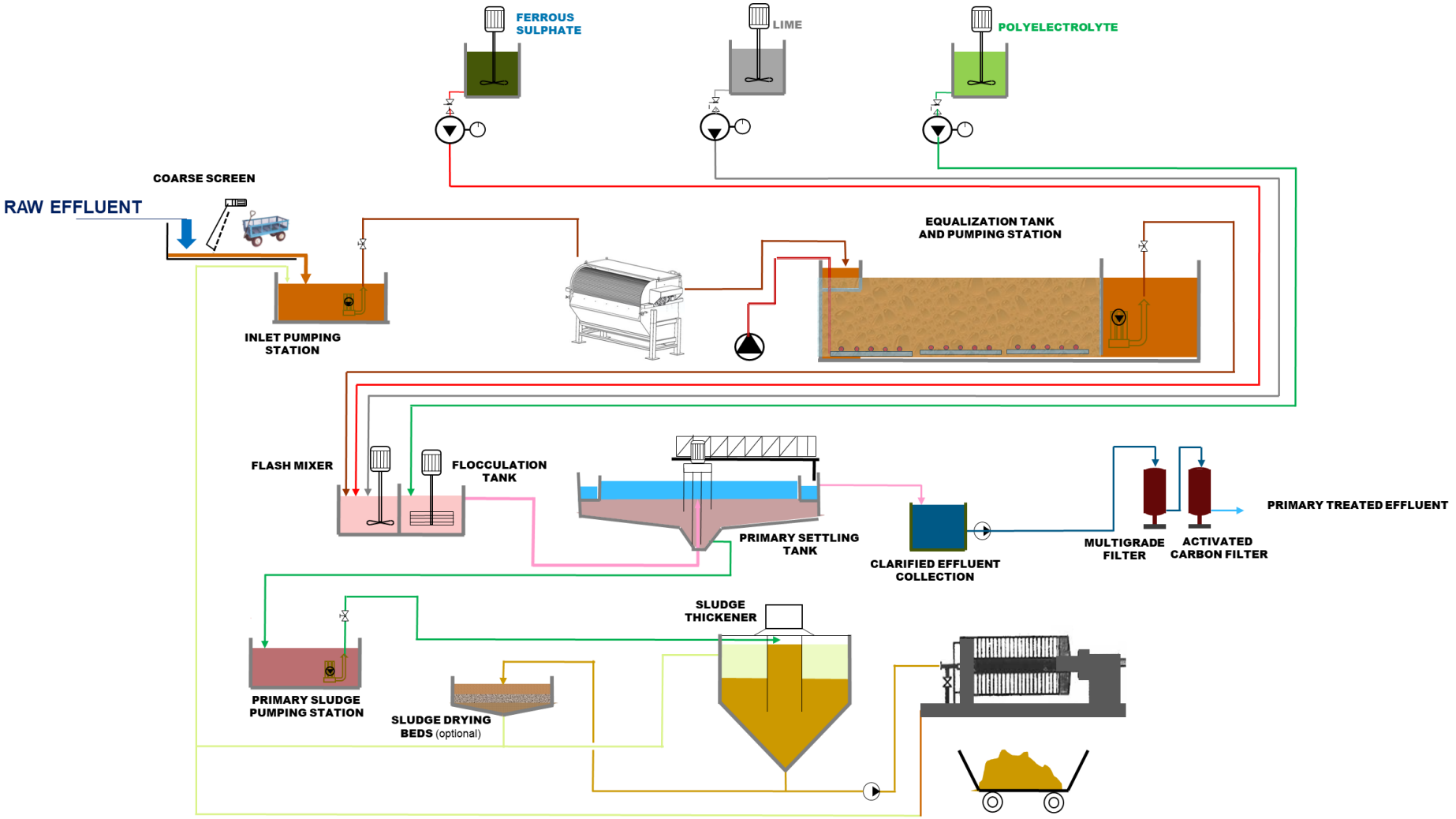
Physico-chemical treatment

Typical elements of stand-alone physico-chemical treatment plant

- Screening system
- Equalization unit
- pH control unit
- Chemical storage tanks
- Chemical mixing unit,
- Coagulation and flocculation unit
- Settling unit and
- Treatment sludge dewatering unit

II. Typical wastewater treatment steps



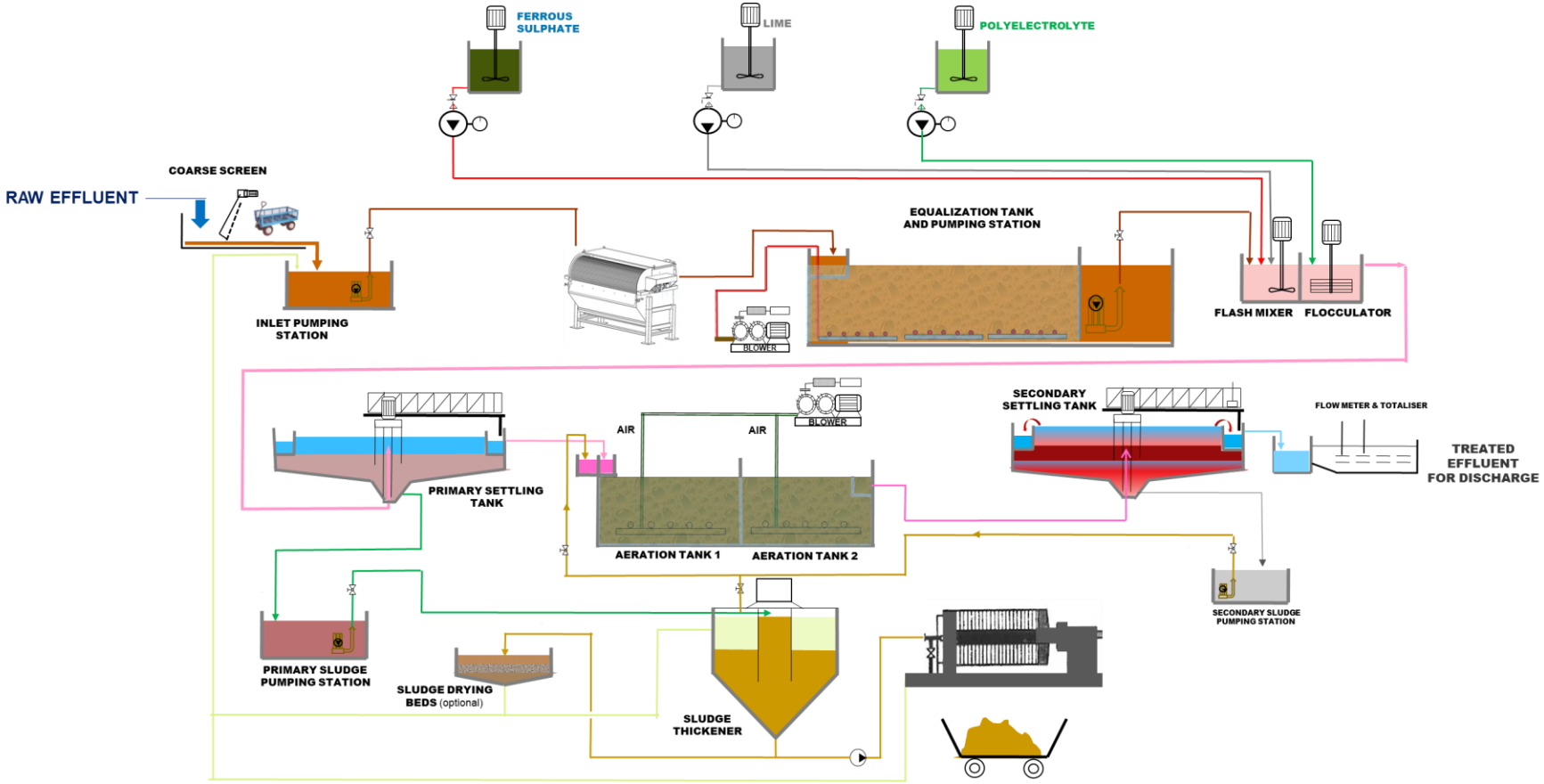
Combined treatment plant

Typical elements of combined physico-chemical and biological treatment plant

- Screening
- Equalization unit
- pH control unit
- Chemical preparation tanks
- Mixing units including coagulation and flocculation units
- Primary settling unit
- Aeration unit
- Secondary settling unit
- Sludge thickener and sludge dewatering unit
- Sludge maturation/disposal arrangement

II. Typical wastewater treatment steps

Physico-chemical and biological treatment combination



All-Biological Treatment Plant

- Increasingly preferred option for treatment of textile wastewater in Bangladesh
- Preferred because of less sludge generation compared to systems with physico-chemical or combined physico-chemical and biological treatment
- Higher land requirement and power requirement main drawbacks
- Need for neutralization and cooling of equalized effluent before aeration
- Neutralization often done using sulphuric acid at inlet of aeration tank; recommended to equip with auto pH correction
- Cooling using cooling towers, either commonly with conventional towers or with heat exchanger type cooling systems

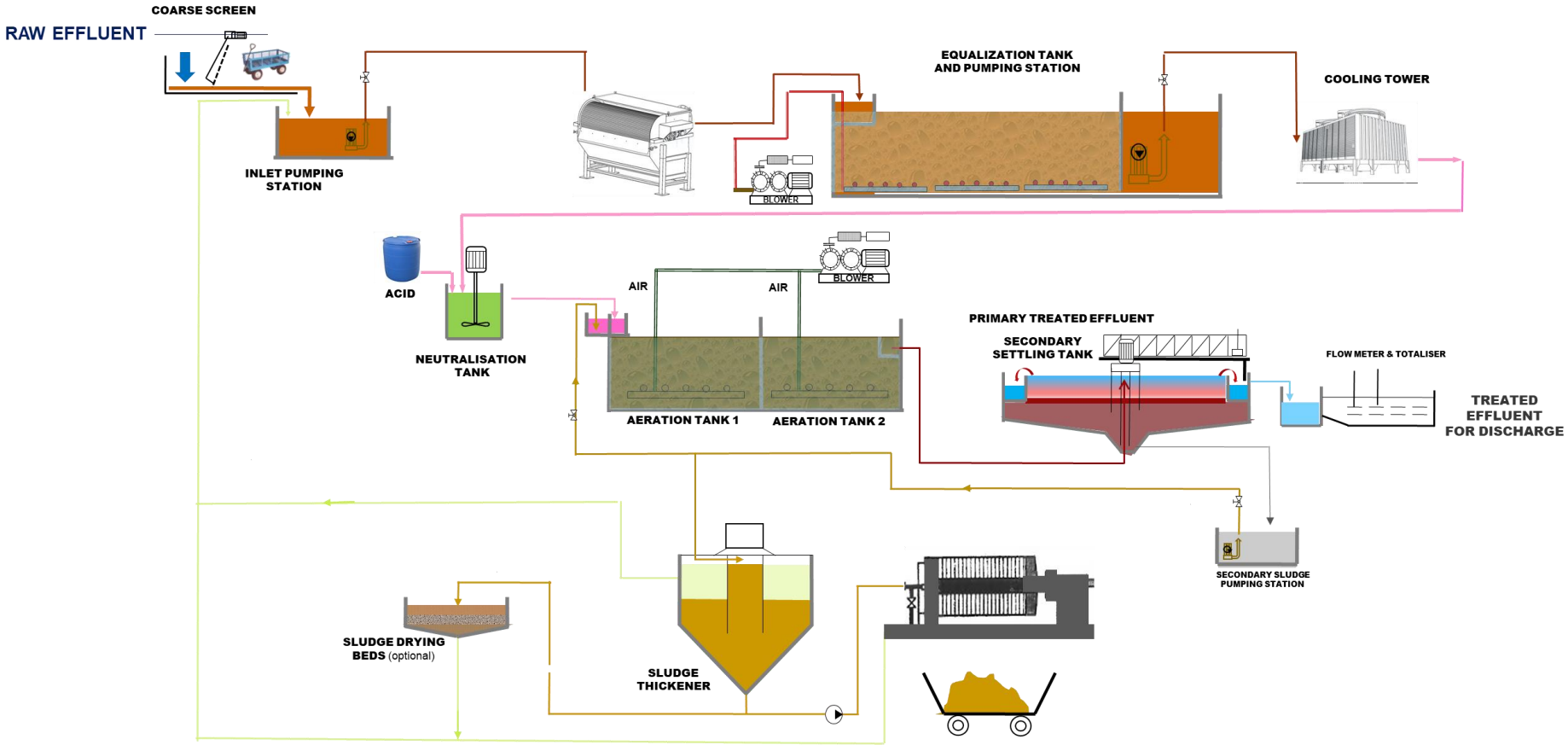
All-Biological Treatment Plant

Typical elements of fully biological treatment plant

- Screening
- Equalization unit
- pH control unit
- Cooling tower
- Aeration unit
- Secondary settling unit
- Sludge thickener.
- Sludge dewatering unit
- Sludge maturation/disposal with conventional towers or with heat exchanger type cooling systems

II. Typical wastewater treatment steps

Full/all biological treatment units



Biological Treatment Concept

Mainly for organics removal with high biological or chemical oxygen demand (BOD/COD), using anaerobic or aerobic approaches

Anaerobic:

- Organic matter being converted to carbon dioxide and methane
- not common for textile effluent (except de-sizing effluent)
- common systems: Anaerobic lagoon, digestors or upflow anaerobic sludge blanket (UASB) systems

Aerobic:

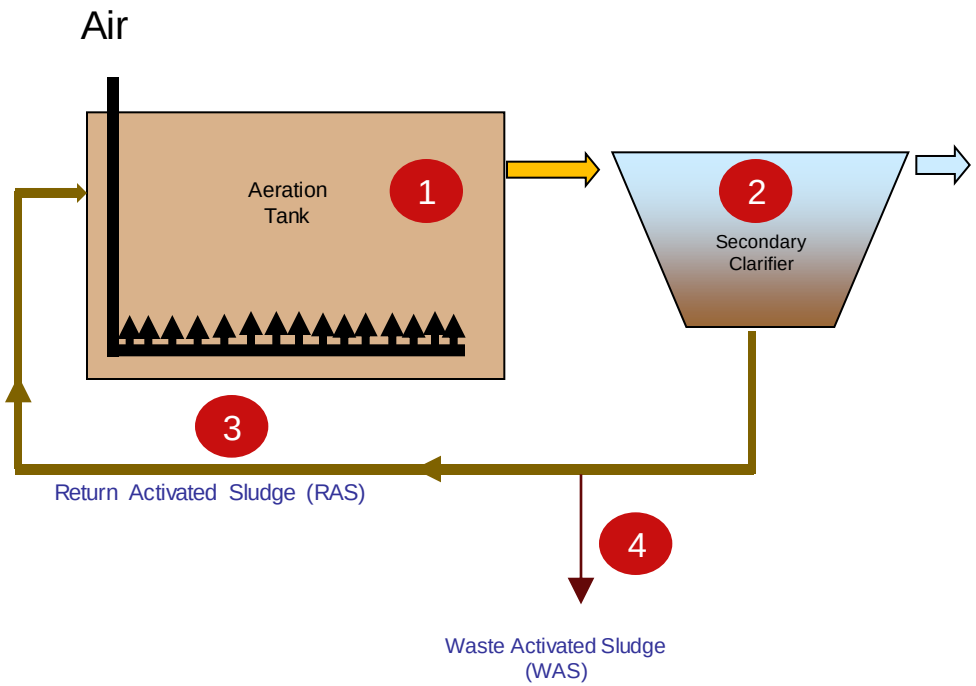
- Outcome water and carbon dioxide
- Early systems with trickling filters (not common now); new version using rotating biological contactor (RBC)
- Common systems: Activated sludge process with rectangular and deep aeration tanks or oxidation ditch
- Variations: Membrane bio-reactor (MBR), sequential bio-reactor (SBR) and moving bed bio-reactor (MBBR).

Biological Treatment Concept

Activate sludge process

involving development of bio-sludge, consisting of microbial clusters, kept in suspension and distributed in aeration tank

- Incoming effluent mixed with activated sludge and aerated for treatment in aeration tank
- Aeration by mechanical action or diffusing air through aeration tank.
- Bio-sludge settling in secondary clarifier and overflow being discharged as treated effluent.
- Separated bio-sludge returned to aeration tank to maintain required quantity of bio-sludge
  - Some excess bio-sludge wasted to keep bio-sludge fresh and healthy



TYPICAL AERATION SYSTEMS

Surface Aeration systems

- Surface aeration system can be floating aerators or fixed aerators. Oxidation ditches has got surface aerators in the form of cage rotors.
- Here aeration occurs due to entrainment of air in water while splashing.
- Aspirators forcing air through water is another surface aeration system.

Floating aerator

Cage Rotors

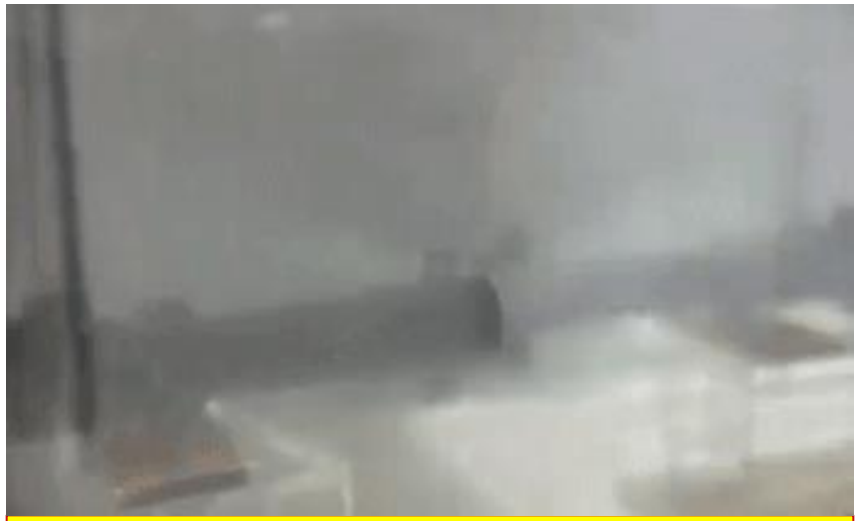
Aspirators

Fixed aerator

Surface Aeration systems

- The most common submersible aerators is diffused aeration. In this system, air is sparged from tank bottom and oxygen gets dissolved in water while air passes through the water column.
- Diffused aeration can be fine bubble or medium/coarse bubble systems.
- Ejectors pump water with air & water in the bottom and turbine aerators distribute air in the bottom mixing water.

Fine bubble diffused aerators



Ejector aerators

Turbine aerators

Medium bubble diffused aerators

REQUIREMENTS OF ETPs

Requirements of ETP

Space

- ETP needs considerable amount of space. Higher the capacity higher area needed. Few tanks be constructed underground, most need open area.
- Primary ETP with polishing needs lowest space, not so efficient, need more chemicals, produces more sludge.
- All biological treatment need maximum space: Less sludge, better efficiency.

Power

- ETP need power mostly for aeration in equalization and aeration tank. Pumps, filter press etc. too consumes power.
- Primary ETP- lower power, 0.4 -0.6 kWh per cubic meter of effluent treated.
- Combined ETP - about 0.8-1.2 kWh per cubic meter of effluent
- All biological ETP -1-1.4 kWh kWh per cubic meter of effluent

Requirements of ETP

Manpower

- ETP needs manpower in the form of ETP in-charge, chemist, operators and casual labor for cleaning, chemical loading etc..
- In small ETPs, the ETP in-charge doubles up as Chemist and general shift operator too.
- A typical 1 MLD primary & combined ETP may need 6-8 staff and 4-5 part time labor. 1 MLD all-biological ETP need 4-6 staff and 1-2 labor.

Monitoring

- The success of ETP depends on proper monitoring to large extent.
- Monitoring involve
  - checking & controlling operational parameters like chemical dosages, cleanings.
  - Biological parameters like dissolved oxygen, MLSS, nutrients, SVI, RAS/WAS etc.
  - performance parameters, i.e, quality of effluent at different treatment points.

Management of ETP sludge

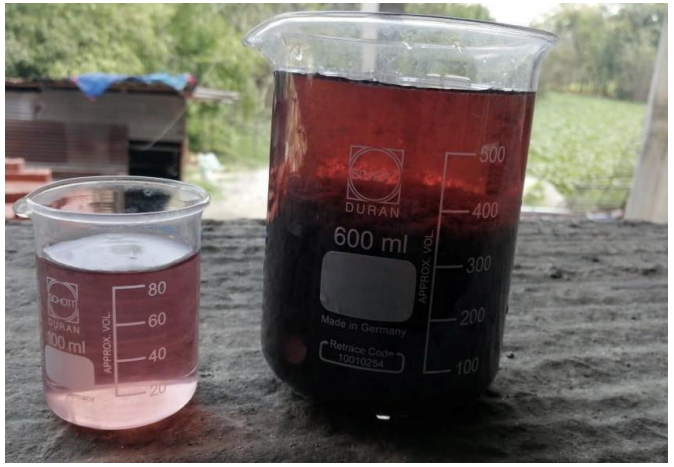
- ETP generates three types of sludge: primary, secondary and tertiary treatment sludge.
- Primary sludge, two categories: generated with chemicals & without chemicals.
- Secondary sludge is excess activated biomass, purposely wasted.
- It is from (a) inorganic portion of inlet suspended solids + (b) residuals of COD removed in the biological treatment
- Tertiary sludge: tertiary chemical precipitation from softening, colour removal etc.
- In most of ETPs sludges are combined together for treatment and disposal.

Sludge management requirements

- Discharge of liquid sludge is universally prohibited by law.
- Even after drying, solid/semi solid sludge need special disposal requirements.
- Most countries regard sludge from textile effluent treatment as ‘hazardous’ or ‘restricted’ categories.
- This is mostly due to the presence of heavy metals and in some cases toxic organics.
- Many countries specified limits for heavy metals beyond which the sludge is categorized as ‘hazardous’.
- Some countries allow conversion of sludge with heavy metals within limit into products (compost, bricks etc.) - most do not.

MANAGEMENT OF TREATED EFFLUENT

Quality of treated effluent



- Clearly, the treated effluent quality will depend on the type of treatment.
- Generally, the Bangladesh ETPs do conform to the norms of DoE.
- The effluents commonly have some reddish colour, has BOD around 30-50 mg/l, Total dissolved solids (TDS) about 2000 mg/l.
- In factories which adopted strict water conservation, the TDS value are higher, say upto 4000- 5000 mg/l.
- Mostly, the suspended solids are very low, but occasional sludge bulking may increase it at times.
- The treated effluent may also contain some small quantity of heavy metals.

Disposal of treated effluent

- Most of the textile factories in Dhaka discharges treated effluent into rivers, more into River Turag.
- As such, the treated effluent does not offer much re-use potential.
- Even with some tertiary treatment such as oxidation or filtration, recovery & reuse in textile operations are not viable.
- This is because textile processing need high quality water and any degraded water may affect quality control.
- Treated effluent after polishing treatment may be used in floor washing, toilet flushing, gardening etc., but requirement is less.

Conclusion

- It is very evident that textile effluents are high in almost all kinds of pollution parameters.
- The effluent is rich in pollutants such as colour, odour, organics, heavy metals, inorganic salts, toxic compounds…..etc.
- Earlier the focus of effluent treatment was mostly limited to removal of colour and treat the organics.
- Issue of heavy metals, hazardous compounds and salt is getting more attention of late.
- Primary, all-biological and combined ETPs are being installed, which generally conforms to the standard of DoE.
- Disposal is mostly to River Turag.
- Need extensive additional treatment to consider any recovery & reuse.

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