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

Reducing sludge quantity

GIZ FABRIC – ETP Operator Course

Contents

Purpose and basic approaches

Purpose for reducing sludge quantity

- To reduce cost for handling and disposal of costs

Basic ways

- By reducing the organic content
- By reducing the moisture

Purpose and basic approaches

Common methods

- Replacement or reduction of chemicals in ETP
- Anaerobic sludge digestion
- Aerobic sludge digestion
- Incineration
- Thermal drying of sludge
- Sludge maturation through storage

Replacement or reduction of chemicals

Replacement or reduction of chemicals

- **Less sludge generation in all-biological treatment** compared to primary chemical treatment
- Conversion of primary ETP into all-biological treatment already done in Bangladesh
  - Be aware of **costs**
  - All-biological treatment requiring **more space**
  - Parts of primary treatment (e.g. screening, equalisation, sludge dewatering) usable in new ETP

giz

Replacement or reduction of chemicals

Conversion of primary to biological treatment

- Primary clarifier used as secondary unit if:
  - Unit of sufficient volume
  - Hydraulic levels not at limit
- No use for
  - flash mixer
  - flocculator
  - chemical preparation,
  - chemical dosing though possible use for dosing colour removal agent

giz

Replacement or reduction of chemicals

Conversion of primary to biological treatment

- Additional units needed
  - Cooling tower before aeration tank
  - pH correction units before aeration tank
  - Additional electricity power requirements

giz

Replacement or reduction of chemicals

Conversion of primary to biological treatment

- Additional units needed
  - Cooling tower before aeration tank
  - pH correction units before aeration tank
  - Additonal electricity power

giz

Replacement or reduction of chemicals

Conversion of primary to biological treatment

Advantages

- Higher efficiency of 75 - 85%
- Simpler and easier to operate
- Cleaner since no risk of chemical spillage
- 50% less sludge quantity compared to primary ETP
- Cheaper in operation and maintenance
- Less cluttered since no need for chemical storage and mixing area

Replacement or reduction of chemicals

Conversion of primary to biological treatment

Disadvantages

- Need for professional engineering guidance in planning
- Higher power consumption (about 50 - 60 HP) though overall cost lower
- Additional capital cost for implementation of aeration system (e.g. blowers, diffusers, piping)
- Shutdown of existing ETP or interim arrangement required during implementation (2 - 3 months)
- More space required (abut 1.5 – 2 times more)

Replacement or reduction of chemicals

Optimization of chemical use

Basic approaches

- **Select** good **treatment chemicals**
- Determine **correct dosing** using jar test
- In combined ETP use chemical **treatment to maintain steady level of organic**s in aeration tank inlet

giz

Replacement or reduction of chemicals

Optimization of chemical use

Basic approaches – chemical use

- Ferrous sulphate only when reactive dyes present in effluent
- Pre-hydrolyzed inorganic coagulants based on aluminum and iron:
  - aluminum chloro-hydrate
  - poly-aluminum chloride
  - poly-aluminum sulfate chloride and mixes with polymers

giz

Replacement or reduction of chemicals

Optimization of chemical use

Basic approaches – chemical use

- Different coagulants and flocculants resulting in different quantities of sludge
  - Sulphate-based chemicals (alum, ferrous sulphate etc.) with lime produces calcium sulphate and adding to sludge
  - Chloride-based chemicals (poly aluminum chloride or ferric chloride)
    - Only fully soluble calcium chloride generated not adding to sludge
    - However slight increase of TDS in supernatant

Sludge digestion

Sludge digestion

Anaerobic sludge digestors

- Most common unit in ETPs, mainly for handling primary sludge
- Good option to reduce quantity of organics and overall quantity of sludge
- Mostly provided with heater:
  - higher bacteria efficiency
  - not needed in tropical climates (e.g. Bangladesh)
  - biogas partly usable for heating

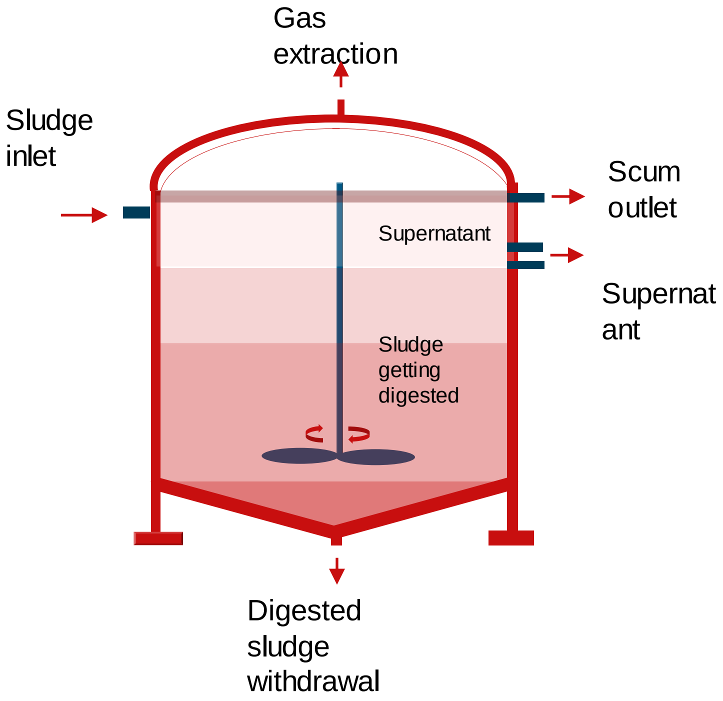
giz

Sludge digestion

Anaerobic sludge digestors

Operational concept

- Organic material degraded into carbon dioxide and methane
- Supernatant returned to equalisation tank
- Produced biogas collected and re-used (e.g. as fuel in boilers and electricity)

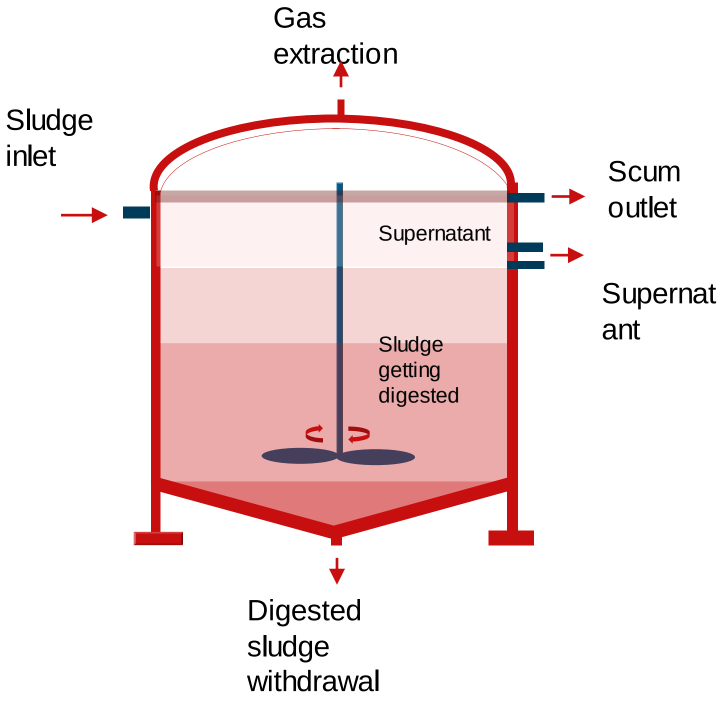


Sludge digestion

Anaerobic sludge digestors

Operational concept

- 50 - 75% reduction in organics/ and sludge volume
  - depending on organics concentration and nature in sludge
- Size of digestor for efficient use
  - Most digestors for textile ETP sludge too small
  - Inadequate biogas quantity for proper use, instead escape or burned off in flare
  - Mixer not must but helpful



Sludge digestion

Anaerobic sludge digestors

Operational steps with unheated batch reactor

(1) Stop mixer for 15 minutes, drain out scum and supernatants using valves

(2) Drain digested sludge by opening bottom valve

– In properly operating digestor ratio of supernatant vs drained sludge in range of 60 - 75 : 25 - 40

(3) Switch on digestor mixer and collect sample

– Tank pH range to be in range 4 – 7.5

– Add calcium bi-carbonate increase pH, setting dose jar tests first

Sludge digestion

Anaerobic sludge digestors

Operational steps with unheated batch reactor

(4) Check gas pressure and operation of emergency release valve by lifting slightly).

(5) Ensure **continuous running of agitator/mixer** in sludge holding tank

- Minimum mixing time of 30 minutes

(6) Pump liquid sludge to digestor while checking level indicator

(7) Stop pumping once level designed stop level

- Quantity equal to drained supernatant and withdrawn sludge

Sludge digestion

Anaerobic sludge digestors

Operational steps with unheated batch reactor

(8) Adjust temperature if heater available

- Not to overheat unit

(9) Add nutrients as needed

- based on nitrogen and phosphates in tank maintain **level of BOD: N: P at 100:2.5:0.5**

(10) Leave digestor to operate

giz

Sludge digestion

Aerobic sludge digestors

- Process used to reduce both organic content and volume of sludge
- Organic matter in sludge oxidized biologically by microorganisms to carbon dioxide and water
  - 50-70% reduction in solids content
- Flow operations:
  - Continuous
  - In batch with sludge added to reaction tank while contents continuously aerated

giz

Sludge digestion

Aerobic sludge digestors

Operational aspects

- Continuous **aeration for long period** (≈ 2 weeks), depending on frequency of sludge wasting in ETP
- **Feeding** aerobic digestor:
  - in **batch units** at least **every week**
  - In continuously operated digestors small portion of sludge wasted every day
- After aeration separation of solids and liquids
  - In batch reactor clarified liquid supernatant decanted and recycled to ETP

Sludge digestion

Aerobic sludge digestors

Operational aspects

- In continuous flow system normal aeration tank used with sometimes with higher density of diffuses followed by settling tank
  - Some units equipped with submersible mixers
- Aerobic sludge digestion **usually for biological sludges** from secondary treatment units
- In endogenous respiration microorganisms utilizing own cell contents for metabolic purposes with remaining sludge mineralized

giz

Sludge digestion

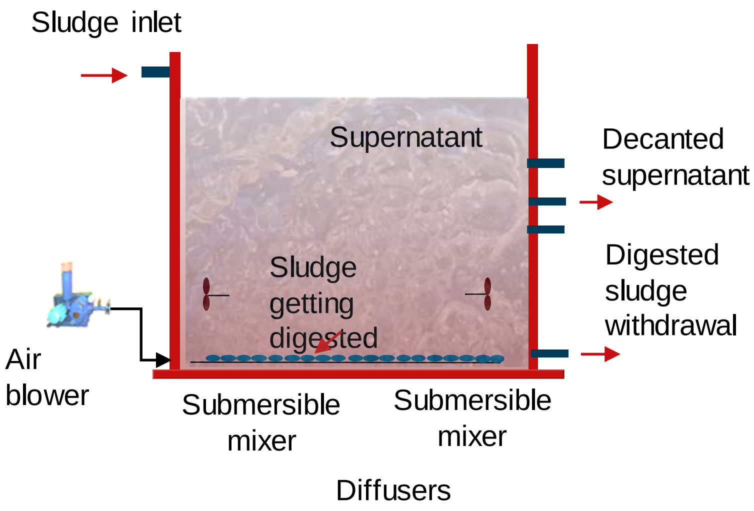
Aerobic sludge digestors

Operational steps

(1) At beginning check blowers for any heating issue, jerks, noise

(2) Switch off blower for 2 hours and observe settling in level tubes

(3) Once sludge settling below bottom of drain channel, open top drain valve



Sludge digestion

Aerobic sludge digestors

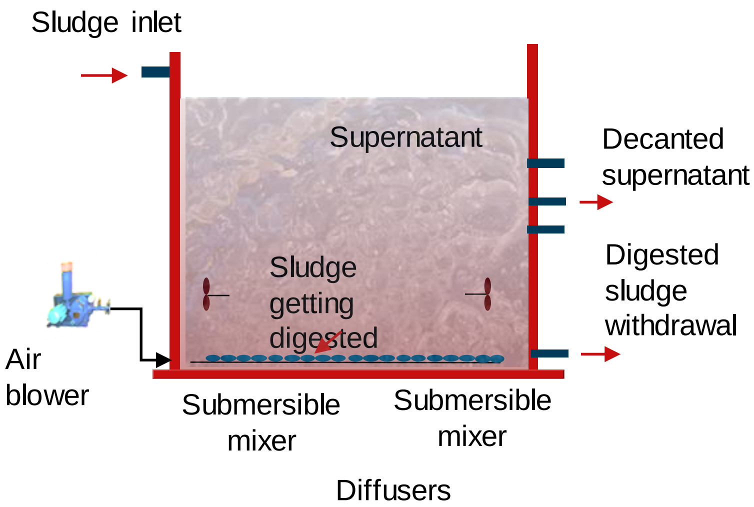
Operational steps

(4) Once draining slowing open lower drain until all supernatant drained

(5) Start air blower and aeration

(6) Open bottom drain valve and withdraw digested sludge

– leave about one-fourth of tank volume to preserve needed biomass for digestor.



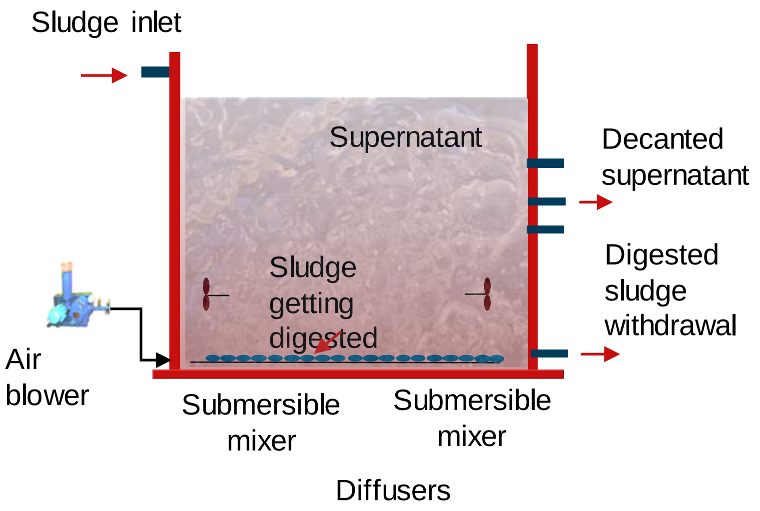
Sludge digestion

Aerobic sludge digestors

Operational steps

(7) Once draining complete pump fresh sludge into digestor.

- If wasting directly done directly from RAS line sludge flow to be apportioned properly between aeration tank and digestor
- If sludge first taken to collection tank and then pumped into digestor, agitator/aeration, if any, to be in continuous operation during pumping



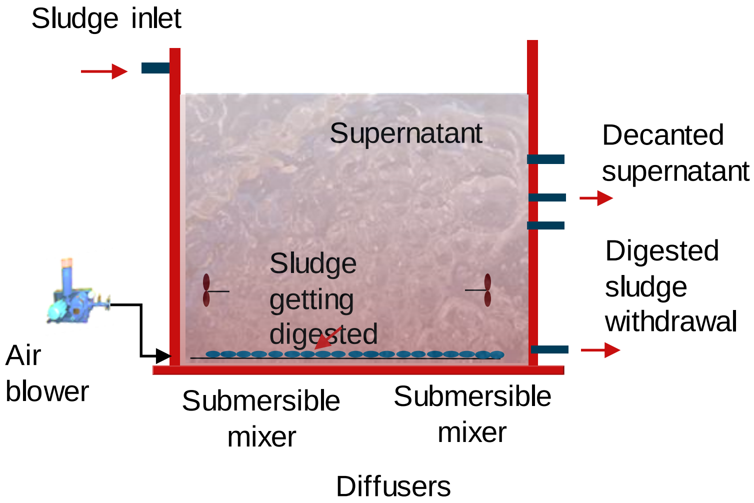
Sludge digestion

Aerobic sludge digestors

Operational steps

(8) Sludge not to be held in collection tank for long time and turn anaerobic in nature.

- Keep blower running all time.
- If need to rotate blower, ensure daily rotation



Sludge digestion

Aerobic sludge digestors

Advantages

- Simplicity of operation and maintenance
- Lower capital costs
- Lower levels of biochemical oxygen demand (BOD) and phosphorus in supernatant
- Fewer effects from upsets (e.g. presence of toxic interferences or changes in loading and pH)
- Less odor and nonexplosive
- Shorter retention periods
- Suitable for small wastewater treatment plants

Sludge digestion

Aerobic sludge digestors

Disadvantages

- Higher operating costs, especially energy costs
- No useful by-products such as methane gas
- Less reduction in volatile solids
- Too costly option for larger wastewater treatment plants

giz

Sludge digestion

Aerobic sludge digestors

- Disadvantages not so relevant for textile effluents since
  - Usable methane rich bio-gas unlikely
  - Volatile solids to be on the lower side
- Due to lower quantity of sludge, **suitable option for most ETPs in Bangladesh**

giz

Sludge maturation

Sludge maturation

- Storage of sludge for long time
  - Normal practice in Dhaka
- Natural drying of sludge using air-drying
- Sludge commonly transferred to open shed protected with roof
- Duration of maturation about 6 - 8 months before final disposal

Sludge maturation

- Adequate ventilation to prevent any anaerobic condition and odour problems
- Normally, sludge moisture reduced to less than 20-30% moisture
  - dried up sludge like powder than sludge cake
- Suitable for small ETPs with very small quantity of sludge

giz

Thermal sludge drying

Thermal sludge drying

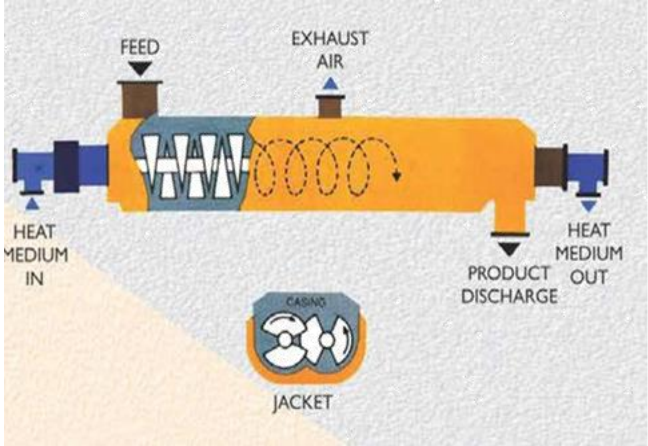
Thermal sludge drying

- Reducing **moisture content to less than 10%**
- Sludge in **powder form**
- **Pathogens destroyed**
- Often done by paddle dryer
  - sludge not forming lumps
  - final product dry powdered sludge
- Fork like discs ensuring even drying and avoiding pasting of sludge

Thermal sludge drying

Components

- **Feeding system** using hopper or screw conveyor for large ETPs
- **Paddle Dryer** with VFD enabled TEFC motor to rotate dual inter-meshing shafts for mixing, heating and drying
- **Steam or thermic fluid heater** as heat source
- **Dried sludge powder handling system**
  - direct collection to bags in small plants
  - belt conveyor for large units



Thermal sludge drying

Components

- Paddle dryer transfers heating from heating medium to sludge
- Efficient drying of sludge through direct contact with revolving hollow paddles (no gas required)
- In most factories in Bangladesh boilers with extra steam possibly used to paddle dryers

Thermal sludge drying

Operational concept

- Trough uniformly heated by passing heating medium through jacket
- Constructed from thick plates and heavy shafts (heavy and sticky sludge)
- Revolving paddles compressing and expanding materials through constant agitation
- Paddle dryers generally of totally enclosed construction
- Entire heat transfer through conduction

Thermal sludge drying

Advantages

- **Lower final disposal cost**
- Reduction in volume of sludge
- **No manual handling during sludge storage** required
- **No landfilling** required
- No spillages of sludge in ETP area
- **No smell or nuisance odor** of sludge
- No need for sun drying of sludge required
- **No storage shed or space** required

Thermal sludge drying

Disadvantages

- Sludge already quite dry in case of maturation
- **Additional operation and maintenance costs** for one more unit in ETP
- Need for external heat
- High capital investment costs
- Quantity of sludge in many ETPs too small to warrant installation of paddle dryer

Sludge incineration

Sludge incineration

- Usually regarded as disposal option
- Allowing for **largest volume reduction** to less than 4 - 10% of original volume
- **Destruction of organic substances and microorganisms**
- Sophisticated **filter systems needed** to reduce pollutant emissions!
- **Sludge co-processing** in cement factories option, if in-situ incineration not warranted

giz

Sludge incineration

Advantages

- Lowest quantity of residual sludge for disposal
- Environmentally clean option
- Low land requirements

Sludge incineration

Disadvantages

- High cost of installation
- Very high operating cost
- High level of technical skills needed

To remember

- Adopt methods to reduce quantity of sludge for less problematic disposal
- Consider optimization of chemical use in all primary ETPs
- Consider sludge digestion for sludge from all-biological ETPs and not primary ETPs
  - Sludge digestors for large ETPs
  - Aerobic digestion suitable option in Bangladesh
- Thermal sludge dryer suitable for medium to large ETPs
- For small ETPs sludge maturation with periodical mixing and spreading of sludge suitable

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