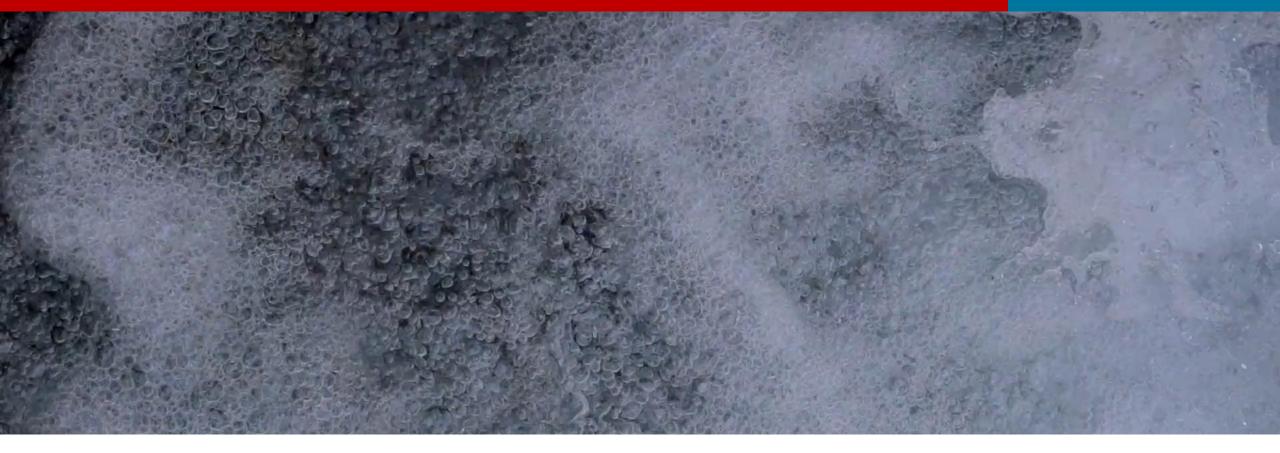
TRAINING OF TRAINERS PROGRAMME ON CAPACITY DEVELOPMENT OF ETP OPERATORS

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







Day 4: Presentation 2

Sludge volume reduction & disposal



Contents

Sludge generation

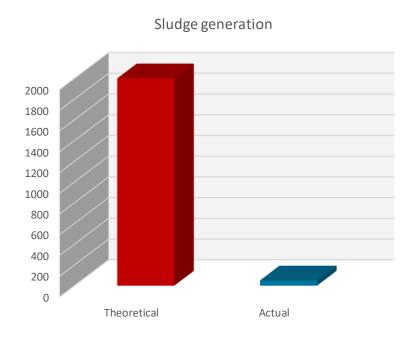
Thermal sludge drying

Sludge disposal options

Sludge incineration & landfill

Sludge Generation in Bangladesh

Quantity of sludge generation



- Quantity varies : ETP scheme, Effluent type, ETP process
- Primary ETPs generate sludge @ 1.2-1.5 kg/m3 of effluent treated
- Secondary ETP generate sludge @ 0.3-0.5 kg/m3, Combined ETP generates sludge @ 1.3-1.5 kg/m3
- Actual quantity is much less in Bangladesh.
- Daily production of sludge from BD ETP

Theoretical: 2000-4000 tons/day Actual reported: 50-100 tons/day

Purpose and basic approaches



Purpose for reducing sludge quantity

- Reducing size of ETP units
- To reduce cost for handling and disposal
- By reducing the organic content through digestion
- By reducing the moisture by maturation & thermal treatment

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 problem
- Normally, sludge moisture reduced to less than 20-30% moisture
 - \checkmark dried up sludge is like powder than sludge cake
- Suitable for small ETPs with very small quantity of sludge



What are the options for thermal reduction of sludge quantity?

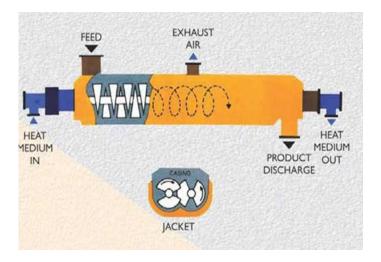


Thermal drying of sludge



Image: Water & Wastee Digest

- 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



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



Components

- Paddle dryer transfers heat 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



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



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



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 Categories – Bangladesh



Category A: Municipal sludge from domestic or urban waste waters only.

Category B: Sludge from industry, including sludge from CETP*.

Category C: Sludge from industry belonging to a hazardous waste category including sludge from CETP.

> Exhibits one or more hazardous characteristics such as high flammability, explosive property, oxidizing property, poisonous, infectious etc.

Sludge Categories – Bangladesh



Treatment and disposal	Sludge category		
options Option	Α	В	С
Anaerobic Digestion (Co-Fermentation)	X ¹	X ¹	**
Aerobic Digestion (Composting)	X ¹		
Agricultural Use	X		
Controlled Landfill*	X	X	X
Thermal incineration	X ¹	X ¹	X ¹
Land application (filling material, e.g. for flood prevention)	X	X ²	**
Recycling in brick, cement or asphalt manuf.	X	X ³	**

Increasing hazardousness for human health and the environment.

¹Residues will remain that have to be disposed of, fulfilling the requirements applicable to the category, on an alternative route e.g. by landfill.

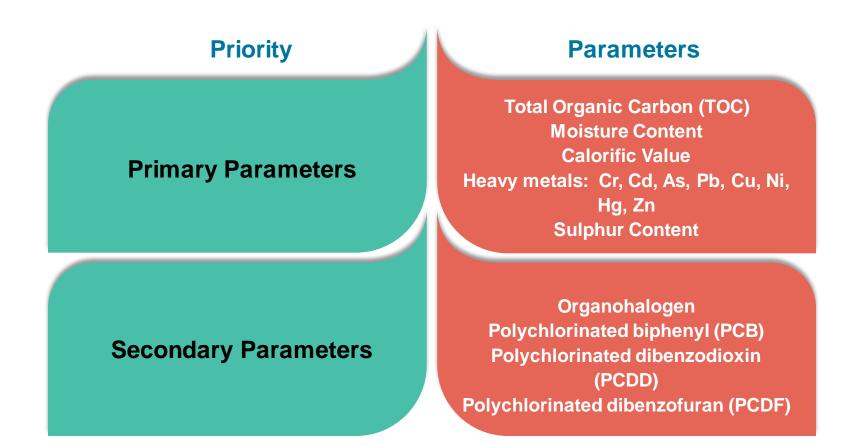
²Inert material (low organic matter required)

³Availability and capacity limited by local conditions. Accepted sludge volume limited due to a loss of compressibility of the product * Requirements for the landfill class (Chapter 3.3.4) vary depending on category of the sludge.

**As described in Chapter 2, the producer may provide evidence that sludge categorized as category C sludge according to Annex 1A or 1B does not possess any hazardous characteristics; in this case it may be categorized as category B sludge and the management options of <u>anaerobic digestion (co-fermentation)</u>, land application (filling material e.g. for flood prevention), recycling in brick, cement or asphalt making are permissible.

Sludge Characterization

Parameters needed to be tested before deciding on any sludge disposal application



Sludge Characterization

Threshold differentiates by categories A, B and C. Range of parameter values can be considered to determine the sludge category.

To simplify classification approach, acceptable limits for major sludge quality parameters defined in the Guideline for Sludge Management in Bangladesh Textile Sector.

Parameter	Unit	Category A	Category B	Category C
As	mg/kg	≤ 40	41-75	> 75
Cd		≤ 10	11-85	> 85
Cr		<600	<600	> 600
Cu		≤ 800	801-4,300	> 4,300
Pb		<840	<840	> 840
Ni		≤ 200	201-420	> 420
Zn		≤ 2500	2,501-7,500	> 7,500
Hg		≤ 8	9- 57	> 57

Sludge Disposal Options



Some of the options such as agricultural use or direct land application are not applicable for sludge from most textile ETPs.

In the Bangladesh Standards and Guidelines for Sludge Management, applicable disposal options for various categories of sludge are discussed.

Manual for Sludge Management in Bangladesh Textile Sector focuses on the textile sludge disposal.

Sludge Disposal Options



Generalized guide for selecting suitable sludge disposal option

Disposal Options	Sludge Category		gory	Bangladesh Scenario	
Disposal Options	Α	В	С		
Anaerobic digestion (co-fermentation)	X*	X*	X¥	Pilot Trial	
Aerobic digestion	X*			Need to be tested before	
(composting)	^			application	
Agricultural use	x			Need to be tested before	
				application	
Controlled landfill ${}^{\Psi}$	x	x	Х	Not yet started but easily	
				implementable	
Thermal incineration	Χ*	Х*	Χ*	Pilot Trial	
Land application	Х	X#	X¥	Commonly practiced	
Recycling in brick,				Formal and informal brick trial,	
cement or asphalt	Х	X§	X¥	pilot trial to make Compressed	
making				Stabilized Earth Blocks (CSEB).	



What are the Sludge disposal options not available to the textile industry at present?



Disposal options not permitted at present : composting, brick manufacture, land conditioning/manure.

Direct land application



© Nogales International. *No flags* raised by landfill sludge study., 2015

Land application (uncontrolled land filling) refers to a wide variety of uses such as filling material for flood prevention, material/ substrate for re-cultivation of mining sites, or covering landfill sites.

This is mostly suitable for category A sludge.

Category B and C can be considered for this application if the requirements are fulfilled

 Any specific land application of sludge requires prior permission from the Soil Resource Development Institute (SRDI) and the Department of Environment (DOE).

Recycling in Brick Manufacturing



- There are around 8,000 operating brick kilns in Bangladesh.
- The use of sludge in the construction industry is environment friendly and reduces the usage of topsoil.
- Sludge with decent heating value also reduces the energy consumption compared to the regular brick making process.
- Lower moisture content and lower organic content are required for this application.
- Due to presence of heavy metals in textile sludge, leachate study is necessary for optimum mixing.

Disposal as manure



- There are two ways to use a non-hazardous sludge as manure: Direct agricultural application & composting.
- Needless to say, these are currently not permitted for textile ETP waste (Category B or C).
- At the moment, these are is only permitted for nonhazardous waste from Category A.
- Direct application in agriculture: If the nutrients such as phosphorus and nitrogen is high & organic content is high it can be used directly as manure.
- However, textile sludge is not known to possess much nutrient value.

Composting of sludge



- Composting: Composting and then use the sludge as manure is a popular option.
- In this process, micro-organisms are used to stabilize the organics and nutrients to make it readily available form.
- It may be needed that **some organic rich waste** may be added to the sludge as admixture.
- There are different processes for composting: composting with admixtures and vermicomposting.
- Windrow composting is the common aerobic composting technique.
- The sludge and a suitable admixture is laid in layers keeping the moisture high.

Composting of sludge



- Common admixtures are green wastes, leaves, twigs, paper waste etc.
- Large compositing units are provided with external aeration from air blowers.
- In small composting units aeration is ensured by providing gaps in the bottom and periodical turning over.
- Compositing will raise the temperature of the heap to, say >70°C. This will help in destruction of pathogens in the sludge.
- When temperature of the heap do not rise after turning, composting is deemed complete.

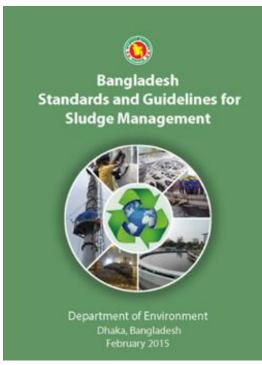


What are the sludge disposal options available to the textile industry at present?



Disposal options allowed at present for all sludge and those within category B: secured landfilling and co-processing.

Sludge disposal requirements in Bangladesh



- Sludge from textile ETP considered hazardous requiring special disposal.
- **Sludge guidelines** adopted by DoE of Bangladesh:
 - Three groups of sludge categories (A, B, C)
 - Category A only for municipal sludge; remaining sludge either B or C based on concentration of heavy metals.
 - Sludge from textile ETPs mostly category B but also some in category C.

Sludge disposal requirements in Bangladesh



Sludge incinerator

Disposal requirements for category C sludge

- Secured landfill with multiple layers of liners, leachate collection & treatment, capping on filling; costly, land requirement, non renewable.
- Incineration feasible, but costly, need for disposal of ash, logistics arrangements.
- Co-processing of category B & C for making construction materials,
- In Bangladesh only one co-processing company (Geocycle).

Disposal option: secured landfill





- Last option for sludge disposal
- Special attention to preventing leachate to groundwater
- Factors to be considered:
- Minimize water entering the sludge heap
- Leachate collection and treatment
- Basin to be protected from outer environment on all sides





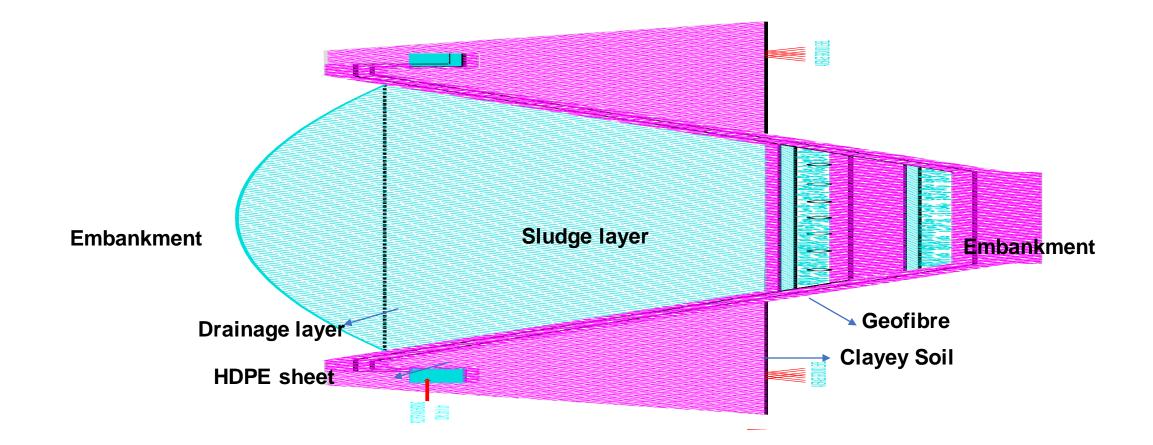
- Special requirements for site
- Leak detection and control system for detecting, collecting and removing any leakage between liners
- Sampling pipes (viz. piezometers) to prevent contamination of groundwater
 - $\checkmark\,$ Regular water sampling and checking
- Landfills mostly made out of clay or clayey soil, with series of liners at bottom





- Construction requirements
- Bottom:
 - \checkmark Consolidated earth
 - ✓ 0.4-0.8 m thick clay layer
- **T**op
 - ✓ Geomembrane (LDPE or HDPE) of 1-1.5 mm
 - ✓ Second layer of clay
 - Drainage layer with network of perforated pipe with fabric layer
 - ✓ Layer of sand

Secured Landfill construction







- Sludge depth commonly 5 8 m
- Top of sludge heap made in shape of cap
- After filling:
 - Another series of liners (clay, HDPE/LDPE membrane), rain water drainage and then clay and grass

Other options: Co-incineration, economic viability.

Thermal Incineration and Co-incineration



Sludge incinerator

- The purpose of incineration is to destroy the organic material from any type of sludge (Category A, B or C).
- Conventional incineration process generally consumes more energy than it produces.
- Not a good disposal option for sludge with high moisture content and low calorific value (Category A).
- Drying sludge and **mixing it with other waste** is a viable option for generating energy.
- High incineration temperature prevents generation of toxic chemicals such as dioxin and furan.

Economic viability of co-incineration



Sludge incinerator

- Co-incineration of textile sludge in the cement industry is popular over the world where wastes are destroyed at a higher temperature and longer residence time.
- It makes the incineration more cost-effective and reduce the chances of forming toxic gases.
- Geocycle, in collaboration with LafargeHolcim Bangladesh limited, has initiated sludge co-incineration in Bangladesh in 2012.
- Basic sludge requirements for co-incineration are the same as thermal incineration.

Thermal Incineration and Co-incineration



- The use of textile waste water treatment sludge by co-incineration in cement plants costs between 30 and 80 EUR / t
- The sludge for co-incineration should have a water content of max 65 % (min. 35 % dry substance)
- The cost depends on the transport costs and the eventually necessary pretreatment like drying, grinding, mixing with other AFR or fuels.

Recommendations



To reduce the hazardous chemicals load of the treatment sludge by substitution of hazardous chemicals in the finishing processes, the sludge category could be brought down to B or even A. This would allow less sophisticated discharge options, like brick manufacturing.

Recommendations



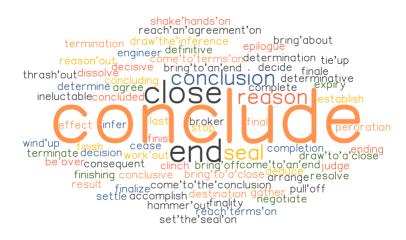
- The use of hazardous chemicals can be avoided or at least be reduced by the application of Best Available
 Techniques (BATs).
- The successful use of environmental sound practices and chemicals can reduce the hazard potential and lead finally to a recategorization of the textile wastewater treatment sludges.

To Conclude



- There are methods to reduce quantity of sludge for less problematic disposal
- Thermal sludge dryer suitable for medium to large ETPs
- For small ETPs sludge maturation with periodical mixing and spreading of sludge suitable.

To Conclude



- The common disposal, i.e., secured landfill has the issue of land area in Bangladesh.
- Co-incineration appears to be the viable option at present for the industry.
- If the hazardousness is reduced to category A level, industry can approach DoE for relaxed disposal norms

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