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

Disposal of dewatered sludge

GIZ FABRIC – ETP Operator Course

Contents

- Types and impact of sludge
- Managing hazardous sludge
- Sludge disposal options

Types and impact of sludge

Types and impact of sludge

Sludge contains hazardous components as:

- Heavy metals
- Carcinogenic organics in some cases

Dissolving in groundwater and leaching into other water bodies

Creating **bio-magnification** in fishes

Causing serious human diseases (e.g cancer?

Types and impact of sludge

Sludge from ETPs to be disposed in **environmentally safe manner**

(1) Primary treatment sludge containing

- **chemicals** used for coagulation/flocculation
- **suspended solids** in raw effluent
- **precipitated metals** and other

(2) Bio-sludge from biological ETP

- usually **mineralized bio-sludge**, mostly **organic** matter
- not to contain any harmful compounds, but carrying **heavy metals and chemicals** used for color removal, if any.

Types and impact of sludge

(3) Tertiary treatment sludge

- Possible sludge generation, with mixture of organic and inorganic compounds

(4) Combined ETP sludge

- mixture of primary and bio-sludge, with approximate quantity contribution of 70:30

Types and impact of sludge

- **Sludge from municipal sewage treatment plant**
  - Mostly primary sludge
  - Usually called **sewage sludge** if no chemicals used
- **Other industrial ETP** sludge from
  - primary treatment
  - biological treatment
  - containing many harmful compounds

Types and impact of sludge

General requirements for sludge disposal

- In most countries, **primary sludge** from **textile** ETPs **requiring special disposal**
- **Separate processing** of **less hazardous sludge** (e.g. wasted bio-sludge) allowed in some countries
  - Example for composting
- **Combined mixed sludge** requiring **special disposal.**
  - In most ETP differ types of sludge mixed before dewatering

Types and impact of sludge

General requirements for sludge disposal

Region/country	Hazard level classification of sludge
Most South Asian countries	Sludge considered hazardous irrespective of concentration of contamination
Some developed countries	Tolerance limits for heavy metals & other hazardous compounds specified
Bangladesh	**Two grades of classification** depending on concentration of heavy metals

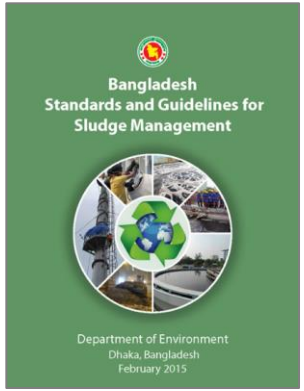
Types and impact of sludge

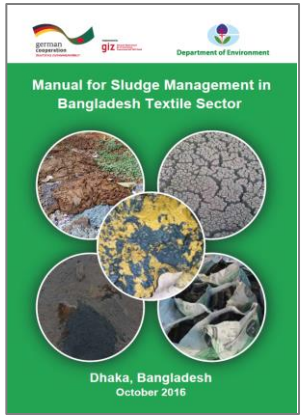
Guidelines on sludge management

- **Guidelines by Department of Environment** (DoE): Ministry of Environment and Forests
  - 'Bangladesh Standards and Guidelines for Sludge Management' in 2015
  - 'Manual for Sludge Management in Bangladesh Textile Sector' in 2016.

Overview of content

- General requirements for sludge management
- Classification of sludge
- Sludge management options





Types and impact of sludge

Classification of sludge

Category	Sludge Source	Characteristics
A	**Municipal** sludge	• Sludge from sewage treatment plant treating domestic or urban wastewater or comparable; considered safer than B
B	Sludge from **industry** including sludge from CETP	• Sludge not categorized as A or C; mixed sludge containing more than one category of sludge (e.g. for a mixture of Categories A and B)
C	Sludge from **industry including sludge from CETP** belonging to the category of hazardous waste.	• Sludge or wastewater generated from any hazardous labelled industry or containing any chemical recognized as hazardous. • Sludge exhibiting one or more hazardous characteristics (e.g. high flammability, explosive property, oxidizing property, toxicity, infectious etc)

Source: Bangladesh Standards and Guidelines for Sludge Management

Types and impact of sludge

Classification of textile sludge

According to Bangladesh Standards and Guidelines

- Sludge from textile industries containing heavy metals and hazardous chemicals
  - Either category B or C
  - **Aim at achieving at least category B**, since disposal less complicated

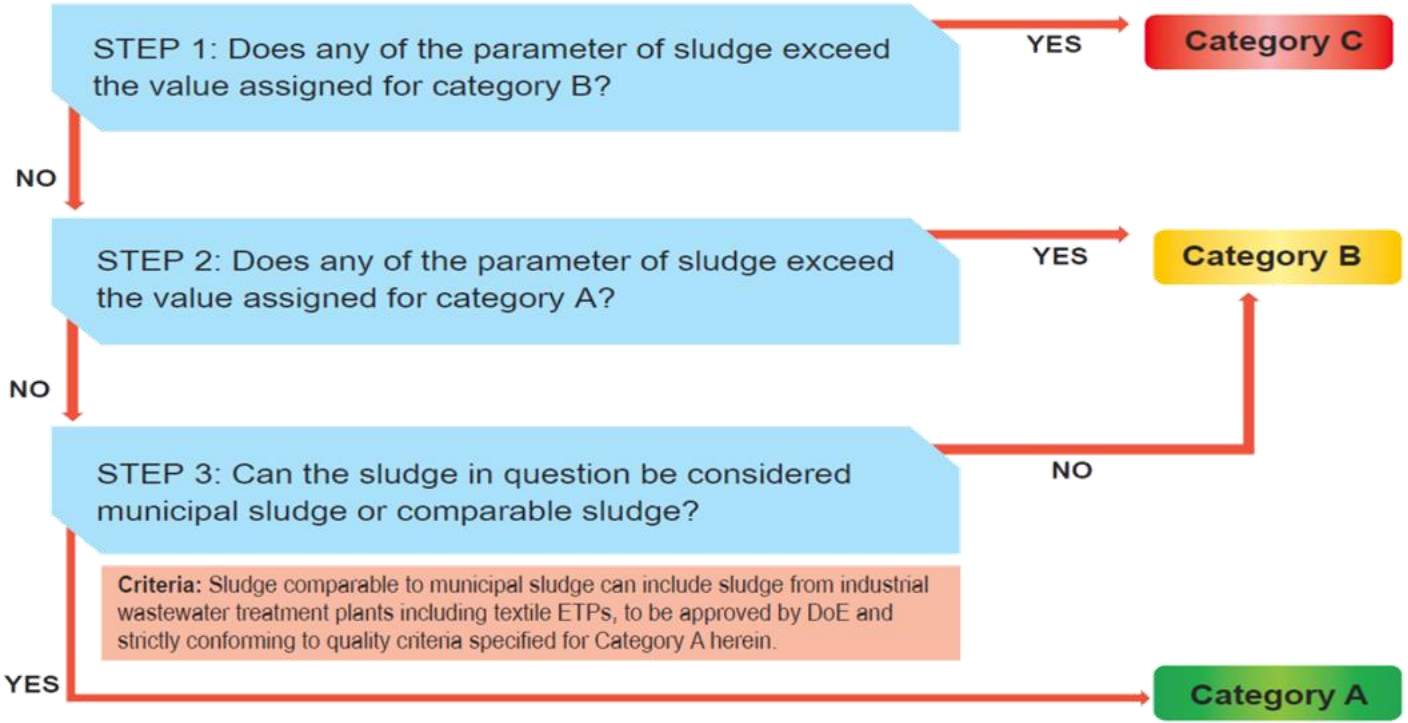
Types and impact of sludge

Classification of sludge – Limit values

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

Types and impact of sludge

Determining the sludge category



Managing hazardous sludge

Managing hazardous sludge

Manage hazard level of sludge

- **Reduce concentration of heavy metals** to comply with at least with category B o preferably category A
- Possible approaches:
  - **Change process and/or substitute existing chemicals with low/less hazardous ones**
    - heavy metals mostly origining from chemicals used in dyeing process.
  - Refer to **substitution steps in ZDHC** guidelines
  - Refer to **ZDHC manufacturer restricted substances lists (MRSL)** and **positive lists**

Managing hazardous sludge

Manage hazard level of sludge

- Options to consider by factory
  - **Chemical and dye substitution**
  - **Process modification**
  - Use of new technology or machinery to replace or reduce chemical use
- Benefits of in-house modifications
  - generally these are **one-time modifications**
  - **Long-time positive effects**
  - **Lower pollution load** and **reduced treatment costs**

Managing hazardous sludge

Manage hazard level of sludge

Examples of specific options

- Use of bi-functional reactive and polyfunctional-reactive dyes as alternatives to the conventional chemicals
- Use of multifunctional chemicals, particularly for low to medium requirements
- Use of mineral salts in place of a metal salt
  - e.g. magnesium salts instead of zinc salts

Managing hazardous sludge

Manage hazard level of sludge

Examples of specific options (contnd.)

- Use of peroxides instead of chlorine bleach to prevent presence of halogenic compounds in effluent
- Use of metal-free alternatives instead of regular chemicals
- Use of knitting/weaving oils without heavy metals to prevent any residual carry over.

Managing hazardous sludge

Manage hazard level of sludge

Challenges in implementing modifications

- Presently used chemicals established and proven over period of time, considering many factors
  - cost, local availability, quality of product etc.
- Readily available and proven process recipes for established chemicals
  - alternate chemicals without ready-made or fully proven dosage practices

Managing hazardous sludge

Manage hazard level of sludge

Challenges in implementing modifications

- Alternative chemicals **perceived as**
  - Being costlier than conventional chemicals
    - Unless other monetary saving (like saving in sludge disposal cost) low readiness to use
  - Having possible issues with availability, stocks with local suppliers etc.

Managing hazardous sludge

Manage hazard level of sludge

Challenges in implementing modifications

- Alternative chemicals
  - need for many trials resulting in damaged batches and wastage of money for use of new recipes
  - possibly less stable to store and more difficult to handle vis-à-vis established chemicals
  - Alleged quality control issues such as lower color fastness.

Sludge disposal options

Sludge disposal options

- Available sludge **disposal options related to sludge categories**
- Common disposal methods
  - Disposal in **secured landfills**
    - most popular for hazardous sludge
    - multiple layers of liners to prevent leachates from sludge
  - Sludge **incineration**
    - effective for sludge with high organic content
    - small quantity of residual material (ash) need to be disposed off in secured landfills

Sludge disposal options

Possible for industry to obtain class A category for disposal in future

- **bio-composting** where organic and nutrient content converted into **organic fertilizers**
- **energy generation**, by mass burning or anaerobic digestion, when mixed with other organic wastes
- **construction purpose**, by using sludge for bricks or as direct construction aggregates (e.g. base material for road)
- **co-processing in cement industry** as a raw material if heavy metals are low (category A or at least B)

Sludge disposal options

Sludge use as manure

- Ways to use non-hazardous sludge as manure:
  - Direct agricultural application
  - **Composting** and then **use as manure**
- Currently **not** permitted **for textile ETP waste** (if Category B or C)
- Only permitted for non-hazardous waste from Category A

Sludge disposal options

Sludge use as manure

Direct application in agriculture

- If high concentration of nutrients such as phosphorus and nitrogen
- If high organic content
  - textile sludge not known to possess much nutrient value

Sludge disposal options

Sludge use as manure

Composting

- micro-organisms used to stabilize organics and nutrients to make it readily available
- need for some organic rich waste to be added to sludge as admixture
- Different processes for composting:
  - with admixtures
  - with vermicomposting
  - windrow composting – aerobic composting technique

Sludge disposal options

Sludge use as manure

Composting

- Sludge and suitable admixture laid in layers keeping moisture high
- In large composting units external aeration from air blowers
- In small composting units aeration through gaps at bottom and periodical turning

Sludge disposal options

Sludge use as manure

Composting - Process

(1) Temperature in heap rising (>700C) for many days, then reducing

- Destroying pathogens in sludge

(2) After turning heap using mixer (or shovel in small units) temperature rising again

(3) When temperature not anymore rising composting

(4) Common control by visual observation and monitoring of temperature.

- Additional laboratory tests involving fulvic acid & humic acid

Sludge disposal options

Sludge use as manure

Composting - Process

- Admixtures adding extra organics to heap, providing adequate porosity to mass for better aeration
- Common admixtures:
  - green wastes
  - leaves
  - twigs
  - paper waste etc.

Sludge disposal options

Land application of sludge

- Controlled dumping of sludge on ground for possible improving the soil quality
- Not permitted for all industrial ETP sludges
- Possible consideration by DOE in future
  - heavy metals in sludge to be below tolerance limits for Category A
- Pre-conditions for Category A:
  - sludge well stabilized without any possible leaching from sludge
  - if leaching, not to contain any harmful materials

Sludge disposal options

Land application of sludge

Possible uses

- filling material for flood prevention
- material/ substrate for re-cultivation of mining sites
- covering landfill sites
- co-disposal of sludge with municipal solids waste.

Sludge disposal options

Land application of sludge

- **not extending to agricultural use**
  - considered as uncontrolled land filling and requiring large land areas
- **Sludge composition** to be considered for minimizing impact of leaching
- If necessary, **conditioning with some stabilizing agents**
  - If directly applied to soil with low permeability (like in Dhaka) worsening of soil quality!

Sludge disposal options

Thermal incineration

Burning organics and volatile compounds effective when high level of organics

- Significant sludge volume reduction (to less than 10%)
- Potential energy production depending on calorific value
- Usually involving pre-heating, incineration, exhaust gas treatment etc.

Sludge disposal options

Thermal incineration

- conventional process generally consuming more energy
  - If moisture content and low calorific value
- More cost effective through co-incineration, heat recovery and cogeneration
- Drawbacks
  - process very expensive in operation
  - potential for air pollution.

Sludge disposal options

Brick manufacturing

- Sludge stabilization and solidification with Calcium oxide to prevent leaching
- Brick burning:
  - with clay for use in construction activities
  - destruction of organics
  - Temperature and firing period varying for good results
    - e.g. compressive strength, density, low water absorption, good efflorescence

Sludge disposal options

Co-processing

- Use of waste materials in industrial processes (e.g. cement, lime, or steel production), power stations or other large combustion plants
- **Cement manufacturing**
  - Material-intensive process
  - Process:
    - Calcination of calcium carbonate
    - Sintering with silica, alumina, and iron oxide to form clinker
    - Clinker ground or milled with gypsum and other constituents for making cement

Sludge disposal options

Co-processing

- Replacement of additives with mineral rich sludge
  - Less additives and fuel needed
  - Disposal of mineral sludge
- Ratio of sludge used depending on nature of sludge and minimal environmental impact
- Consideration of emission quality at acceptable standards.

Sludge disposal options

Co-processing

In Bangladesh implemented by Geocycle Bangladesh:

- Operating cost per ton depending on quantity of sludge
- Cost per ton lower than those by secured landfill sites
- No need of incremental area with respect to sludge quantity

Sludge disposal options

Secured landfilling

- 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

Sludge disposal options

Secured landfilling

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
  - Regular water sampling and checking
- Landfills mostly made out of clay or clayey soil, with series of liners at bottom

Sludge disposal options

Secured landfilling

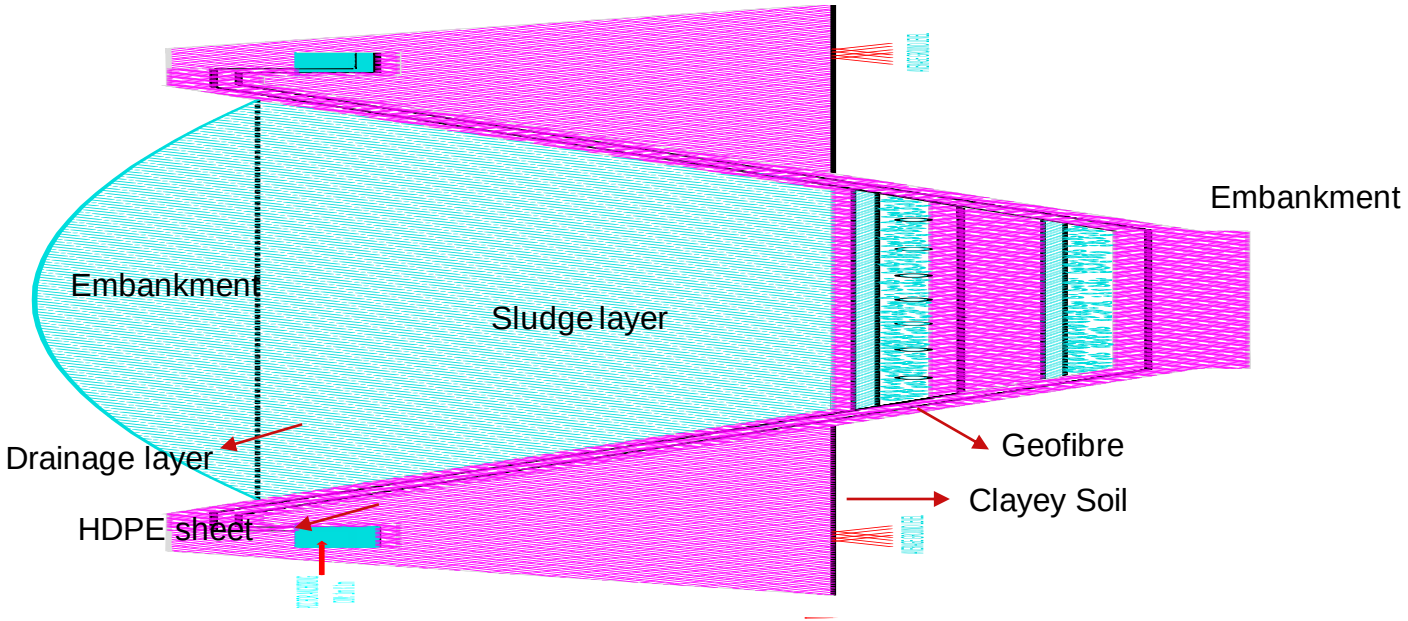
Construction requirements

- Bottom:
  - Consolidated earth
  - 0.4-0.8 m thick clay layer
- Top:
  - 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

Sludge disposal options

Secured landfilling

Construction requirements



Sludge disposal options

Secured landfilling

- 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

Conclusion

- Proper **disposal or re-use** of all end products of treatment process integral goal of ETP management
  - Sludge disposal part of pollution control measures and often costliest
- Available **options depending on sludge categorization**:
  - Secured landfilling or co-processing most common
    - In Bangladesh co-processing feasible
  - Explore other options such as composting or brick making!
- Aim at **reduction of sludge hazard level** through in-house measures to enhance disposal options and reduce cost

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