BIOKUBE

Sludge Handling Solutions

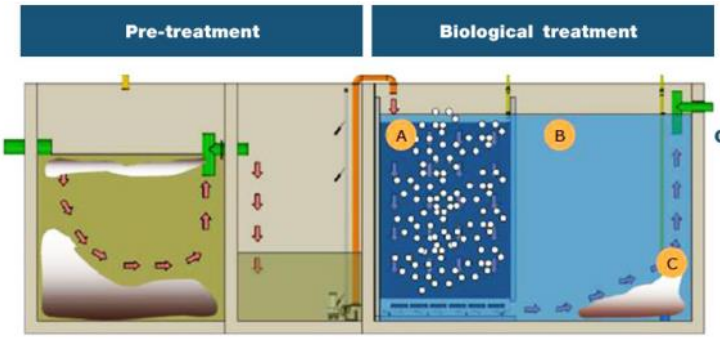
Sludge can be converted from a problem to an asset

How much sludge

Sludge to be removed

All BioKube wastewater treatment systems are based in a two step treatment process.

1. Septic Tank
   This retains primary incoming sludge and Biological sludge from the treatment process. All sludge to be removed will be in the septic tank. For very large systems there might also be like band filters.
2. Treatment unit.
   There will be no sludge in the treatment unit. All bio sludge is continuously recirculated to the septic tank.



How much sludge?

The amount of sludge produced in a wastewater system varies much depending on incoming water, technology used and temperature. See IWA publication "Sludge Handling Solutions". Typical values are 18 kg sludge / y / PE

The treatment process in a BioKube of recirculation of treated water with oxygen to the septic tank will give reduction in the total amount of sludge to biological degradation. In the numbers in this publication it is assumed that sludge production from a BioKube system is 10 kg sludge / y / PE (3 kg bio sludge and 7 kg primary sludge.). Given as sludge per 1 m^3 standard household wastewater in a full year, the amount is 60 kg. sludge as dry matter. A wastewater system for 500 m^3 per day will therefore give 30.000 kg sludge as dry matter in 1 year. We recommend you design the system conservatively (i.e. assume higher amount of sludge)

When to remove sludge?

The sludge truck removes sludge and take it to be processed at another location. If this is the choice then you will remove sludge

- yearly on 5 - 100 PE systems
- Quarterly on 100 - 300 PE systems

Process sludge on site

If you process sludge on site, this will be performed at regular intervals depending on size and technology chosen.

The sludge concentration of the outcoming sludge will be ca 18 % dry matter.

For large systems, also consider mechanically removal of incoming raw sludge with pre-treatment like band filters.

Reuse of sludge

The management of sludge produced by wastewater treatment plants is a continuously ongoing activity for any wastewater plant, regardless technology used or system size.
Sludge produced by a wastewater treatment plant amounts to only a few percent by volume of the processed wastewater, but it's handling accounts for a large part of the total operating costs.
As a consequence of the many circular economy initiatives there is an increased focus on reusing sludge

In addition the need to achieve a sustainable sludge management strategy has become of great concern, due to restrictions, and in some cases legal banning, of conventional and more traditional recycling options, like direct utilization in agriculture and other land uses. The development of innovative systems to maximize recovery of useful materials and/or energy in a sustainable way has therefore become necessary.

Agricultural fertilizer

Sewage sludge from municipal sewage treatment plants contains a host of valuable plant nutrients. Rich in nitrogen, phosphorous, potassium and trace elements such as copper and zinc, such compost is used as an organic fertilizer by farmers. Apart from providing plant nutrition, the organic substances contained in compost stabilize and/or improve soil humus content. Local legal restrictions may limit the use of sludge as fertilizer.

Biogas

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen.

Biogas can be produced from a urban wastewater plant. Biogas producing systems will typically be large systems and **they fall outside BioKube scope of supply**.

The waste from the anaerobic digestion process of biogas production can as compost be used as agricultural fertilizer.

Charcoal

The easiest and cheapest solution to reuse the wastewater sludge is creating charcoal which can be used as a source for heating or daily cooking. This is especially a solution for Third World Countries. BioKube has delivered such systems. See video here.

The sludge is dewatered and dried in the drying beds, the dry sludge is collected and burnt in a charcoal retort, compressed and the charcoal is ready to be used.

The charcoal could be burned and used for cooking, it has an high calorific value and it is a good alternative to electricity, gas or wood as a source of heating.

Sludge truck

Description:

A sludge truck will be the preferred solution for small to medium size systems.
With the sludge truck, the sludge is transported to another location where it is processed.
The treatment process here will typically be a large wastewater treatment system, a local dewatering system or a root zone system.
For up to 10 m3 / day systems, the desludging will take place once a year. For larger periodically depending on size. You will typically not need to remove all sludge and water in the septic tank. You can often with success remove only the bottom sludge and the floating sludge.

Daily Capacity of STP	10 m³ / day	50 m³ / day	250 m³ / day	500 m³ / day
Yearly expected amount of Sludge	600 kg / year	3.000 kg/year	15.000 kg / year	30.000 kg / year
Frequency of desludging	Yearly	Quarterly	Monthly	Weekly NOT PRACTICAL

Key Considerations

Advantages	*Disadvantages*
Economic Solution. Often the preferred solution if no possibility to treat sludge on site	There needs to be a local facility to receive the collected sludge. This will typically be either a large wastewater treatment plant, a root zone or a drying bed
Dried sludge can be composed and used as agricultural fertiliser or charcoal.	
Easy to operate, no skilled personnel required.	

Dewatering Bag

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Description:

Dewatering bag are an effective dewatering technology. The fine solids in the sludge will be retained inside the bag, while allowing water to permeate through the engineered textile. The polypropylene fabric of the filter bags for sludge keeps the sludges free from atmospheric precipitation but allows liquid and moisture to pass through the bag.
The liquid is sent back to the treatment system..
The sludge bag filters with a yield of 90% pollutants with dimensions of 150 µ and with efficiency of 70% particles of 100 µ.
A dehydrated sludge bag stored outdoors loses moisture until it reaches a dry fraction of over 60 % after some weeks.

Daily Capacity of STP	10 m³ / day	50 m³ / day	250 m³ / day	500 m³ / day
Yearly expected amount of dry Sludge	600 kg / year	3.000 kg/year	15.000 kg / year	30.000 kg / year
How often will you remove sludge from the wastewater system? *)	Quarterly	Monthly	weekly	Daily NOT PRACTICAL

* The bag systems come in several sizes, from single bag systems up to 8 bags

Key Considerations

Advantages	Disadvantages
Dewatering and containment in one operation.	Mechanical components needed in process.
Simple and fairly low cost operation.	Requires handling of flocculants.
Solids can be disposed of in a landfill or reused as fertilizer or as charcoal.	Dewatering bag cannot be reused
It can be a good solution for a small isolated wastewater systems	The initial sludge concentration will be 18 %
It can be mounted on a trailer and be used for several small systems.	
Very small footprint.	

BioKube Scope of delivery

Polymer preparation and dosing station

Sludge Transfer pump

40 m flexible sludge piping

Dewatering bag

Control Unit for Pump etc.

Geotube Dewatering Bag

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Description:

GeoTube dewatering containers are an effective dewatering technology fabricated from a specially engineered textile, which will holds of the fine solids inside the bag, while allowing water to permeate through the engineered textile. Over 99% of solids are captured.

Daily Capacity of STP	10 m³/day	50 m³/day	100 m³/day	500 m³/day	1.000 m³ / day
Yearly expected amount of dry Sludge	600 kg/year	3.000 kg / year	6.000 kg /year	30.000 kg / year	60.000 kg / year
Frequency od desludging *)	Not practical	Yearly	Twice yerly	Quarterly	monthly
‘) The GeoTube dewatering bags come in many sizes. For smaller wastewater systems, consider also Filter bags for simpler use.					

Key Considerations

Advantages	Disadvantages
Dewatering and containment in one operation.	Mechanical components included.
One GeoTube bag can be used for several filling cycles until full.	Requires handling of flocculants.
If GeoTube is mounted in a 20 foot open container, easy to truck away	Requires additional footprint.
Solids can be disposed of in a landfill or reused as fertilizer or as charcoal.	

BioKube Scope of delivery

Polymer preparation and dosing station

Sludge Tranfer pump

40 m flexible sludge piping

GeoBags

Sludge Screw Press

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Description:

Sludge dewatering treatment with Sludge Screw Press effectively generates dewatered cake with high dry solids content. The water will be sent back to the buffer tank or the septic tank.

A sludge Screw press dewatering machine is a good solution for wastewater systems ranging in size from 150 to 1.500 m^3 / day.

SYSTEM PERFORMANCE		AQ - 131	AQ - 201	AQ - 301
Max. flow (dry matter of sludge 0,2kg/l)	m3/hour	3	4,5	15
Mean value flow (dry matter of sludge 1kg/l)	m3/hour	1	1,5	5
Min. flow (dry matter of sludge 5 kg/l)	m3/hour	0,2	0,3	1
Dry matter achived	%	18	18	18
Dry matter production	kg/hour	6-10	9-15	30-50
Consumption of clean water	l/hour	24	32	40
Consumption of flocculant	l/hour	20-45	30-70	100-225
Power consumption	kW	0,2	0,6	0,8
Recommended for m^3 / day wastewater system		150 - 500	400 - 1.000	900 - 1500

Key Considerations

Advantages	Disavantage
Efficient solution for sludge removal for minimum of 150 m^3 / day systems up to 1.500 m^3 / day systems.	Qualified personnel are required for management
Sludge comes from the machine in dry cakes with 18 % dry matter	The windings can create maintenance problems
Simple installation and operation	
Low noise and vibration levels	
Filtrated water is delivered back to the wastewater system	
Dried sludge can be sent to storage or reused for fertilizer	

Screw Press on trailer

BIOKUBE

Description:

Sludge dewatering treatment with Sludge Screw Press effectively generates dewatered cake with high dry solids content.

The dewatering machine mounted on a trailer can treat sludge from a number of medium size wastewater systems. This will significantly increase the effective use and thereby reduce cost associated with sludge disposal.

SYSTEM PERFORMANCE		AQ - 131	AQ - 201	AQ - 301
Max. flow (dry matter of sludge 0,2kg/l)	m3/hour	3	4,5	15
Mean value flow (dry matter of sludge 1kg/l)	m3/hour	1	1,5	5
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Power consumption	kW	0,2	0,6	0,8
Recommended for m^3 / day wastewater system		150 - 500	400 - 1.000	900 - 1500

Key Considerations

Advantages	Disavantage
Good solution sor several medium size wastewater systems close to each other	Qualified personnel are required for management
Low energy use	The windings can create maintenance problems
Simple operation, no installation required	
Filtered water will run back to the treatment unit	

Root Zone sludge treatment

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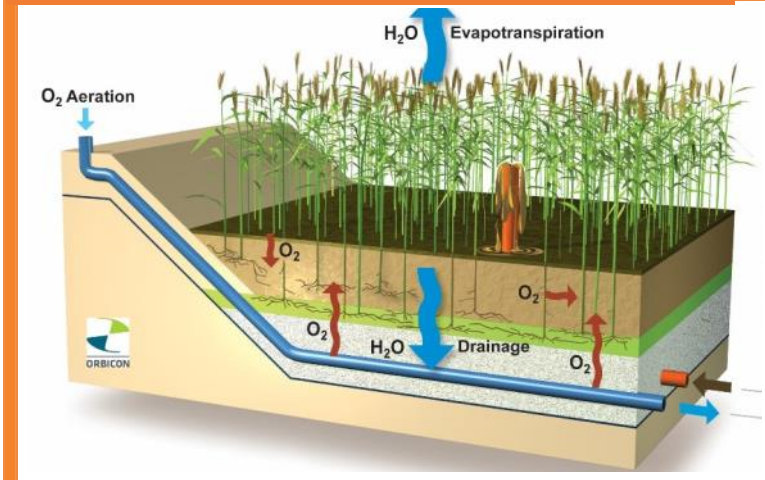


Description:

When mineralizing organic matter in the sludge, 60-70 per cent of the dry matter is transferred into CO2, oxygen, free nitrogen and partly dewatered soil particles.

The sludge is dewatered, depending on the local climate, to a dry matter content of 35% to 60% within two to three weeks.

In the long term the sludge will be reduced to 2-4% of the originally applied volume. This reduces management cost such as handling, transport, final deposition etc.

The drainage water is sent back to the treatment system or you might need a local on site small wastewater system.

Daily Capacity of STP	50 m³/day	250 m³/day	500 m³/day	1.000 m³/day
Number of sludge beds required	2	2 - 3	3 - 4	6 - 8
Total size Reed beds Europe / Africa & Middle East	Europe 50 m^2 Bed Africa 45 m^2 Bed	Europe 250 m^2 Bed Africa 210 m^2 Bed	Europe 500 m^2 Bed Africa 400 m^2 Bed	Europe 1.000 m^2 Bed Africa 800 m^2 Bed
Weekly expected amount of sludge and water to be lead to drying bed	10 m^3	30 m^3	100 m^3	200 m^3

Reed beds have also for larger systems been used in Denmark for many years. See documentation here

Key Considerations

Advantages	Disadvantages
Economic Solution.	Relatively large space requirements
Dried sludge can be composed and used as agricultural fertilizer or charcoal.	Can temporarily cause odor , but typically not a problem
Easy to operate, no skilled personnel required.	Only applied during dry season or roof might be needed
Much reduced sludge volume.	Manual Labor or machinery for dried sludge removal
Can achieve pathogen removal if approved disinfectant is added	Per 6 PE / 1 m^3 you will need 1 m^2 reed bed in Europe
Can be built with local materials	Per 11 PE / 1½ m^3 will need 1 m^2 Reed Bed in hot climate.

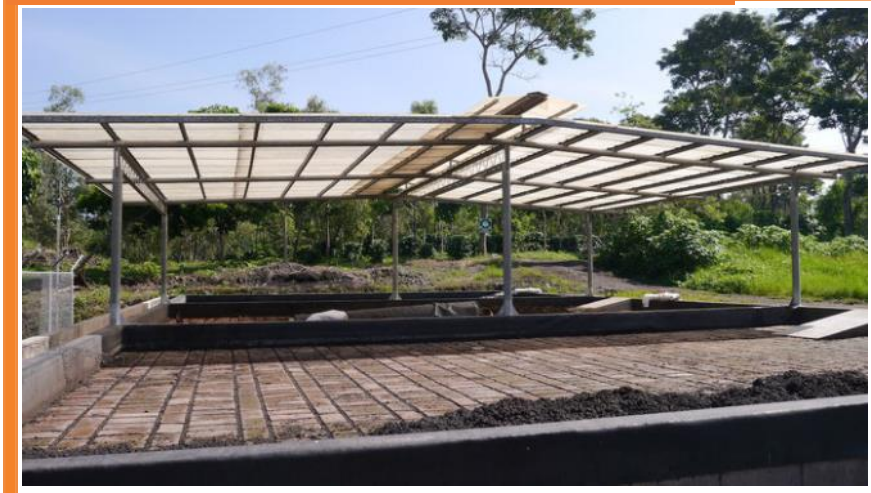
BioKube Scope of delivery

Simple Design Drawings

Sludge Transfer pump

40 m flexible sludge piping

Sludge Drying Beds



Description:

A sludge drying bed is a common method utilized to dewater sludge via filtration and evaporation. Perforated pipes situated at the bottom of the bed are used to drain sewage water or filtrate. A reduction of about 70% in moisture content is expected after drying.

Each normal size sludge bed will be 3x6 m² (18 m²), a small size sludge bed will be 2x4 m² (8 m²).

Daily Capacity of STP	50 m³/day	250 m³/day	500 m³/day	1.000 m³/day
Number of sludge beds required	2	2 - 3	3 - 4	6 - 8
Size of drying bed in warm country	50 m^2	250 m^2	500 m^2	1.000 m^2
Weekly expected amount of sludge and water to be lead to drying bed	10 m^3	30 m^3	100 m^3	200 m^3

Key Considerations

Advantages	Disadvantages
Economic Solution.	Relatively large space requirements
Dried sludge can be composed and used as agricultural fertilizer or charcoal.	Can temporarily cause odor issues, but will be limited
Easy to operate, no skilled personnel required.	Only applied during dry season or roof needed
Much reduced sludge volume.	Manual Labor or machinery needed for dried sludge removal
Can achieve pathogen removal if approved disinfectant is added	
Can be built with local materials	

BioKube Scope of delivery

Simple Design Drawings

Sludge Transfer pump

40 m flexible sludge pipe

Reuse of sludge

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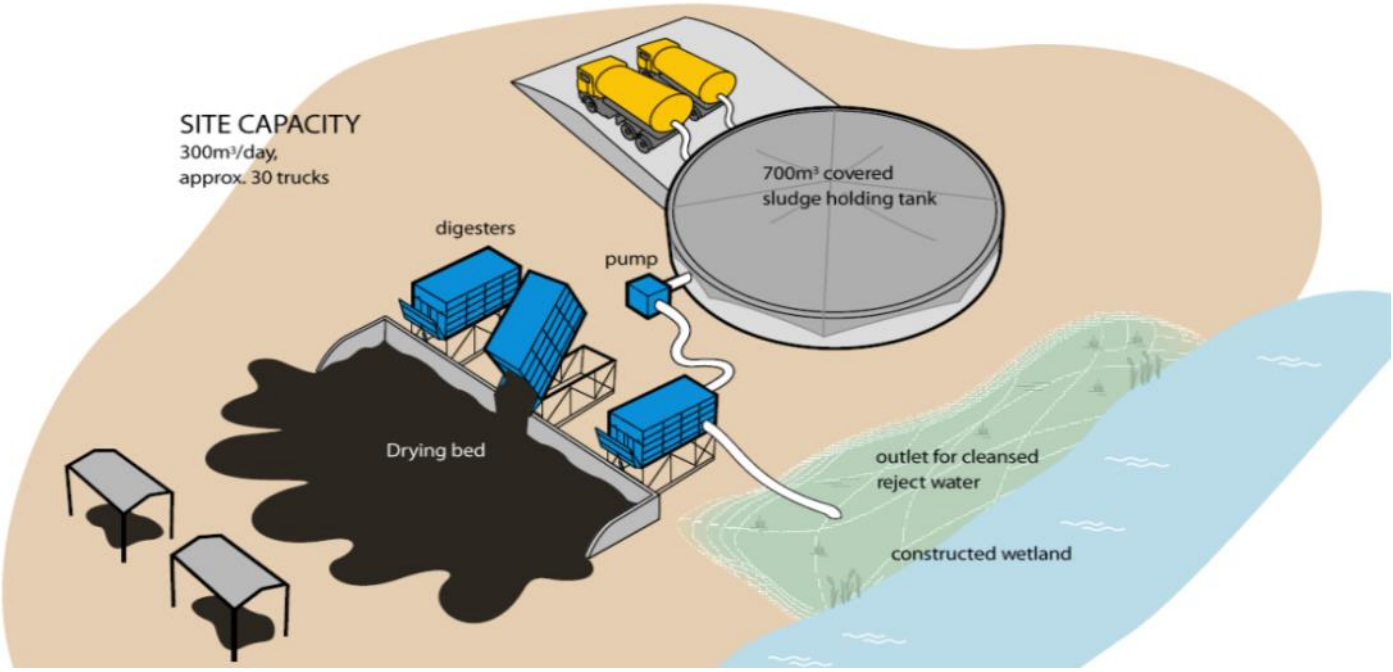
The two most widely used ways to reuse sludge is for either fertilizer or Energy

Below is an illustration of a system installed in Accra, Ghana. See video of the system here



Sludge reused as Charcoal or Fertilizer

This project shows low cost 100 % circular economy of wastewater in a developing country.

- Raw sewage is collected from holding tanks
- Sludge is dewatered and dried
- The dried sludge is used to make charcoal of fertilizer

Reference Name	Accra Lavender Hill
Product Type	Municipal Wastewater
Country	Ghana
Application	Sludge Reuses
Client	Accra Municipality
Capacity [Trucks/day]	40
Year of Installation	2017

UN development Goals

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BioKube's mission statement

BioKube wastewater treatment systems shall always treat wastewater better than required by the authorities with the lowest possible energy consumption.

BioKube will actively take part in Circular Economy to help fulfill The United Nations Sustainable Development Goals by offering wastewater treatment systems where:

- *Treated water can safely be reused*
- ***Sludge can be converted to energy or fertilizer***

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