



UNICEF GHANA

Advanced Toilet Technology Manual

First Edition

Department of Civil Engineering

Kwame Nkrumah University of Science and Technology

Kumasi, Ghana

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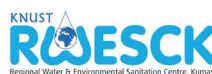
Prepared by

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List of Abbreviations

ABR"	Anaerobic Baffled Reactor
BOD"	Biochemical Oxygen Demand
DPM"	Dump Proof Membrane
E. Coli"	Escherichia coli
EHOs "	Environmental Health Officers
HRT"	Hydraulic Retention Time
KVIP"	Kumasi Ventilated Improved Pit
NGO"	Non-Governmental Organisation
O & M"	Operation and maintenance
PVC"	Polyvinyl Chloride
TSPs"	Technical Service Providers
UDDT"	Urine Diverting Dry/Dehydration Toilet
VIP"	Ventilated Improved Pit
WASH"	Water, Sanitation and Hygiene
WC"	Water Closet
WHO"	World Health Organisation

PART 1: GENERAL INTRODUCTION

Background

Adequate and improved sanitation solutions are crucial for the protection of public and environmental health. Ghana has made significant progress in providing access to improved water to about 80% of the population. However, access to basic sanitation is estimated to be 18% and about 4,000 children die each year from diarrhea. The states of the world's toilet named Ghana among the world's top 10 most countries with the highest percentage of population without decent toilet facilities. Currently, the national sewerage coverage is as low as 4.5% and open defecation is practiced by about 18% of the Ghanaian population. The remaining population mainly depend on on-site sanitation technologies. Sanitation technologies are defined as technologies designed to collect, contain, transform and treat human excreta. In recent years there has been an increasing number of sanitation innovations appropriate for various conditions and a stronger sector focus on the entire sanitation service chain (from the toilet via collection and transport to the final treatment and safe disposal and/or reuse). Building on these developments, this manual provides a comprehensive, structured and user-friendly manual and construction guide on advanced sanitation technologies that can be used in various settings. It serves as a systematic overview of existing and emerging sanitation technologies in Ghana appropriate for use in rural, urban and peri-urban settings. The target group for this manual includes engineers, planners, environmental health officers (EHOs), artisans, technical service providers (TSPs), natural leaders, households, Non-Governmental Organisation (NGOs) and other WASH sector actors involved in the design, construction and maintenance of toilet facilities. Each of the technologies described in this document is considered advanced based on their designs and the level of skilled labour required to construct them. The manual is primarily concerned with technologies directly related to managing faecal sludge or blackwater. It does not specifically address greywater, although it does signal when a specific technology can be used to co-treat greywater with excreta.

Who can use this manual?

This manual aims to provide information on advanced sanitation technologies and support the construction of sanitation technologies in Ghana to improve sanitation coverage. Given the technical level of this resource, users do require a basic skillset and

previous construction experience. The manual contains information on the types of sanitation technologies, such as the advantages and disadvantages of technology, how to construct them, the materials and tools needed, as well as suggested location and maintenance requirements.

Decision making criteria of this manual

Selecting the most appropriate set of sanitation technologies for a specific context is a challenging task and requires considerable experience. The key decision criteria as presented in this manual aim to give users a general guidance in the technology selection process, and in the overall construction of a sanitation system. The decision criteria are featured in each of the technology information sheets.

The structure of the technology information sheet includes

- Principles of operations
- Design considerations
- Social considerations
- Advantages and disadvantages
- Proper use and hygiene practices

Sanitation Technology Options

There are many types of toilets systems. Some need water to operate and others do not. Toilet types can be broadly categorised as follows:

- **Off-site systems:** Off-site sanitation systems generally involve the construction of long lengths of permanent infrastructure. They are more common in the developed world, cities and high-density areas, and often take on the form of sewerage systems which require a reliable water supply and the provision of wastewater treatment systems. Examples of off-site systems include conventional, simplified, condominium and settled sewerage systems.
- **On-site systems:** They are isolated and provide some level of treatment and/ or containment at the toilet location and may avoid the need for further treatment. However, a number of on-site systems need regular emptying. Examples of on-site systems include simple pit latrine, Kumasi Ventilated Improved Pit (KVIP) latrine, Enviro Loo toilet, Ecological Sanitation toilet (Composting and Urine Diverting Dry Toilet), Pour flush toilets, water closet with septic tanks, biofil toilet, biogas digester, aqua privy, etc.

This manual focuses on on-site toilet technologies.

PART 2: ON-SITE TOILET TECHNOLOGY OPTIONS

On-site toilet technologies are broadly categorised as dry systems and wet systems.

Dry On-site Toilet Systems

A dry toilet system is a toilet that operates without flush-water. The dry toilet may be a raised pedestal on which the user can sit, or a squat-pan over which the user squats. In both cases, excreta (both urine and faeces) fall through a drop hole.

In dry toilet systems, excreta are broken down by anaerobic methods (i.e., decomposition or dehydration). In decomposition systems bacteria, worms and other organisms break down urine and faeces. Dehydration methods separate urine and faeces, and then ash, shredded leaves, or sawdust is applied on the faeces to absorb excess moisture and deodorize it. The added material also improves the nitrogen content in the event that the faeces are to be reused as fertilizer. Examples of dry toilet systems include simple the pit latrine, Ventilated Improved Pit (VIP), Kumasi-Ventilated Improved Pit (KVIP) latrine, Enviro Loo toilet, Composting toilet and Urine Diverting Dry Toilet (UDDT).

The dry systems described in this document are those regarded as advanced technologies in terms of their designs and the level of skilled labour required to construct them. These technologies are described as follows:

The Kumasi Ventilated Improved Pit (KVIP)

What is the KVIP?

The Kumasi Ventilated Improved Pit (KVIP) latrine is an improvement over the Ventilated Improved Pit (VIP) latrine. KVIPs are constructed with two pits (used in alternating order), and instead of moving the latrine when the pit is full (in the case of the VIP), users switch to the other pit. Pit alternation allows for effluent to infiltrate into the soil and sludge to decompose in the one pit, while the other pit is in use.

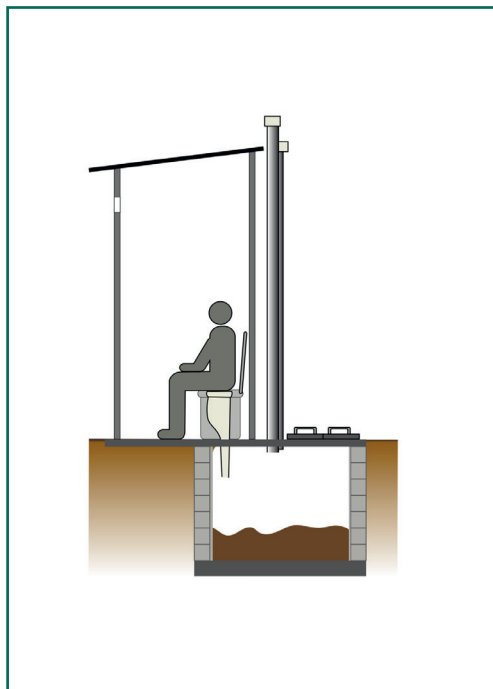


Figure 1 Two-dimensional view of the KVIP

The Ventilated Improved Pit (VIP) Latrine

Ventilated Improved Pit (VIP) latrines are an improvement over traditional latrines in two important respects: they mitigate the noxious odor and reduce the number of flies and other insects that plague users of traditional latrines. The VIP has a vent pipe that allows fresh air to flow through the latrine, reducing odor. The vent also allows light into the latrine, attracting insects into the pipe, where they are trapped by the fly screen at the top of the pipe. The screen also keeps out insects looking to enter the pipe from the outside.

Box 1 Description of the VIP



Figure 2 Front view of a KVIP toilet

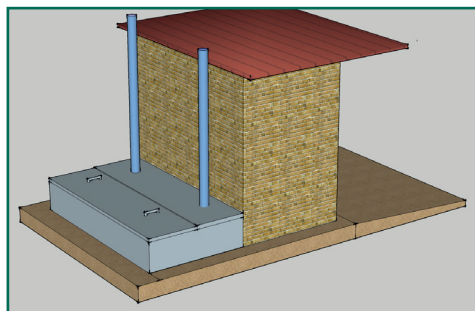


Figure 3 Back view of a KVIP toilet

Principles of operation

The Kumasi ventilated improved pit (KVIP) latrine use two pits in alternating order. Pit alternation allows for effluent to infiltrate into the soil and sludge to decompose in the one pit, while the other pit is in use. The alternating system reduces the amount of pit humus that needs to be emptied and makes the end product more hygienic. When the first pit has filled up it is sealed and the toilet user interface is switched to the second

pit. While the second pit is in use, the materials in the first pit decompose and dry up, and the effluent infiltrates into the soil; thus the pit content decrease in volume and become more hygienic. Usually the alternation cycle is about 1–2 years depending on the pit volume and the number of users. Due to the extended resting time, the material within the pit becomes partially sanitised and humus-like. The faecal sludge that is generated from the pit is manually removed and buried, or may be transported for further treatment by composting.

Design Considerations

- For each system, only one toilet user interface is needed, which is moved from the first pit to the second pit when the first pit is full.
- The KVIP is constructed like the single VIP (refer to the latrine technology manual) but with two collection pits.
- Each pit must be provided with their own ventilation system. Pits should be built next to each other separated with a dividing wall, or with enough distance between them to avoid cross contamination.

Applicability

- Suitable where people use solid/ hard materials for anal cleansing. These can be directly deposited into the toilet pit.
- Suitable for locations where there is scarcity of water or where the water supply is not always dependable.
- Suitable where the ground is easy to dig, where the water table is low, and where there are no issues with water-logging and flooding.
- Suitable where there is not much space available to dig a new pit and move the superstructure when the old pit becomes full, hence its suitability for urban areas.
- The KVIP is equally appropriate where there is enough space and reuse potential for the pit humus that is being generated. Therefore, these systems are most appropriate in rural and peri-urban settings, and in communities comfortable with handling and re-using faecal material.

Social Considerations

Users should have an appreciation of the advantages of the KVIP and should be willing to operate and maintain it. If users do not appreciate the benefits, the system could fail. Double pit systems are usually built as toilets serving single households, ensuring a clear attribution of operation and maintenance responsibilities (O & M). If used as shared or

public facilities the responsibilities for O & M must be clearly determined prior to the implementation.

Advantages and Disadvantages

Advantages

- Longer (indefinite if maintained properly) life than the single VIP latrine.
- Excavation of humus is easier than faecal sludge.
- Significant reduction in pathogens.
- Potential for use of stored faecal material as soil conditioner.
- Flies and odour are significantly reduced (compared to non-ventilated pits).
- Can be built and repaired with locally available materials.

Disadvantages

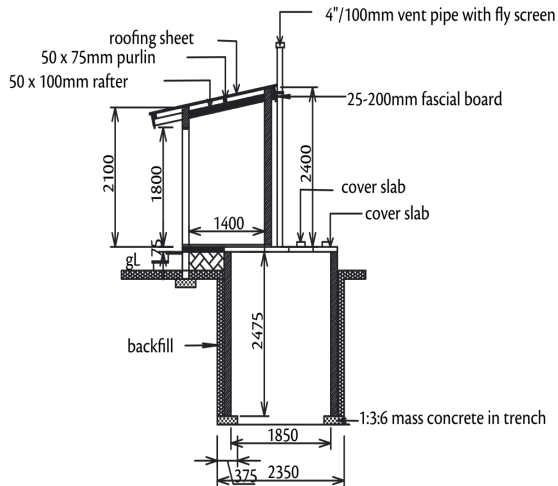
- Manual removal of humus is required.
- Possible contamination of groundwater.
- Higher capital costs than the single VIP, but reduced operating costs if self-emptied.

Toilet location, proper use and hygiene

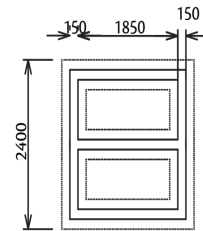
- This toilet can be built closer to the house than the traditional pit latrine.
- The location should be chosen considering wind and sunlight direction.
- The toilet should be located at a minimum distance of 30 meters away from any water source.
- For the air to be able to flow, use of a drop-hole cover is not recommended during the day time.
- The main operational task for KVIPs is to seal pits when they are full and empty full pits prior to re-use. If pits are used simultaneously the system does not function.
- Where there is only one user interface and one ventilation pipe, they must be switched to the new pit when the old one is full.
- Once a week, sweep, wash and clean the toilet floor (preferably using a disinfectant but not a detergent), and clean the toilet surrounding area.
- Once a month, clean the walls, door and ceiling.

- Once every six months check the fly-screen on top of the vent-pipe and check that the pipe is not obstructed.
- Repairs should be carried out immediately when problems are identified.
- The pits must not be used for garbage disposal.

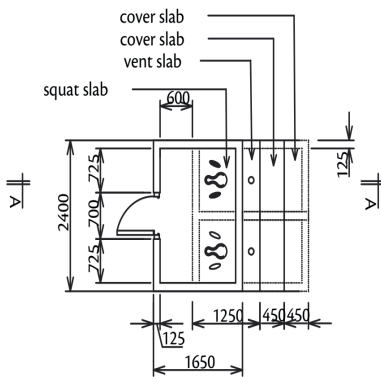
Engineering Drawing of the KVIP



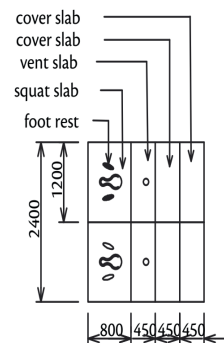
SECTION A - A



FOUNDATION PLAN FOR PIT



PLAN VIEW - VIP



KVIP SLAB

Figure 4 Engineering drawing of the KVIP

The Compost Toilet

What is a compost toilet?

A compost toilet is a dry toilet that uses no water for flushing. All waste is captured within a closed chamber that sits above ground level. Compost toilets are the best option where there is a risk of polluting groundwater or the environment.

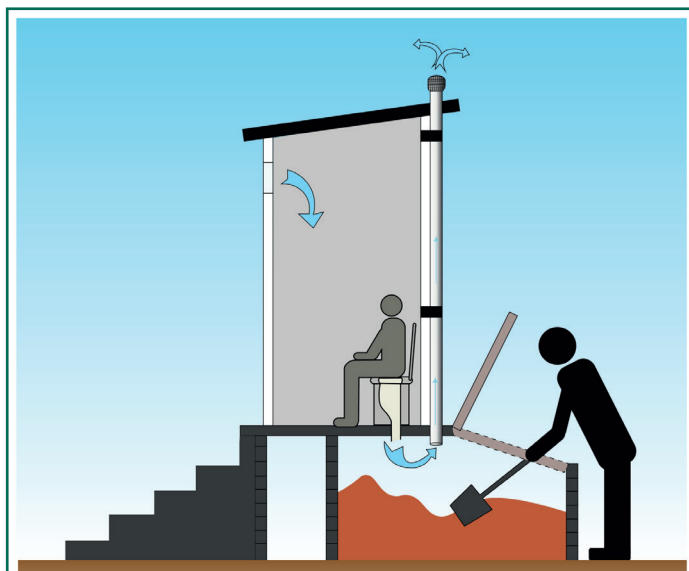


Figure 5 A two-dimensional view of a composting toilet



Figure 6 Front view of a compost toilet



Figure 7 Back view of a compost toilet

Principles of operation

This type of toilet recycles nutrients from human excreta for agricultural purposes. In a composting toilet, the toilet seat sits immediately above a fully-enclosed dry chamber. After each use, a handful of organic material is added. No water is used, except a small

amount for regular cleaning of the toilet seat. The deposited faecal matter is dried by exposure to heat or the sun. A further addition of organic matter (lime, ash, sawdust, vegetables), controls the moisture and chemical balance. The mixture produces reusable compost material for soil conditioning in at least one year. Harmful germs (or pathogens) are killed by the heat of the compost pile and by the length of time the compost is left before removal from the chamber. The finished compost is eventually removed and can be used as a soil conditioner (fertilizer).

In a composting latrine, there are two (2) vaults, only one of which is used at a time. When one is nearly full, it is covered with soil and left for at least two (2) years for the excreta and waste to be decomposed and the pathogenic germs in it to die. While the vault is closed the second is used. A properly maintained compost toilet is very clean and hygienic and does not smell.

Design Considerations

- To reduce odour and flies the latrine should be equipped with a ventilation pipe.
- Drainage should be considered around the toilet so that rainwater does not enter the pit.
- The vault size must be chosen according to anticipated number of users and to allow for a storage time of at least one (1) year.
- Vault dimensions should account for cover material, airflow and non-even distribution of faeces.
- WHO recommends a minimum storage period of 6 months if ash or lime are used as cover material (alkaline treatment), otherwise storage should be for at least 1-2 years.

Applicability

- Suitable if the household is interested in using the decomposed faeces as plant fertilizers.
- Does not require water. Therefore, suitable for locations where there is scarcity of water or where the water supply is not regular.
- Suitable for hard-rocky areas and high water-table areas because the whole structure is above ground-level. No risk of ground-water contamination.
- The alternating use of the two pits allows the toilet to be used continuously without any interruption.
- When the first pit becomes full, the drop-hole is closed and sealed and the second pit is put into use. When the second pit becomes full, the emptying hatch of the first pit is dismantled and the decomposed contents can be removed and

safely used as a plant fertilizer. The emptying hatch is then re-closed and the pit put back into use while the second pit is sealed.

Social Considerations

- Households might need some education/training on the technology as the use of composting toilets might have considerable acceptability and behaviour change implications.
- Training might be needed to support acceptance, ensure proper use and maintenance and to avoid accidental misuse.
- It should reflect local user preferences (sitter vs. squatter, anal cleansing practices, direction, positioning, etc.) and should account for the accessibility and safety of all users, including men, women, children, the elderly and disabled people.

Advantages and Disadvantages

Advantages

- Almost no water is needed, just a small amount for cleaning purposes.
- No smell in the toilet room when properly maintained.
- Limits groundwater or environmental pollution.
- Can be located anywhere, as the chambers sit above ground.
- Requires no digging of pits.
- The compost produced can be used for soil conditioning.
- Permanent structure with no need to rebuild/ move when full.
- Biodegradable cleaning material (such as toilet paper and leaves, etc) can be used.

Disadvantages

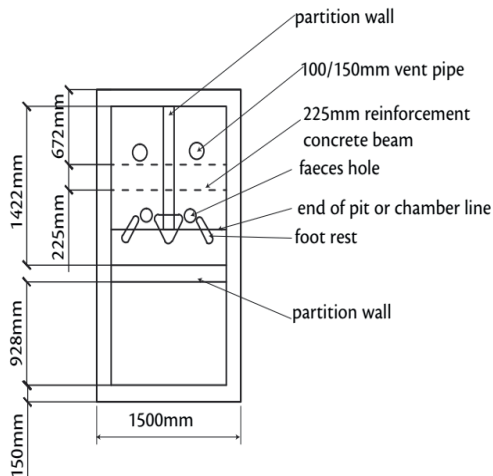
- Organic matter (or ash) must be regularly collected and stored in the toilet for use.
- Users must understand and control the addition of organic matter to ensure proper composting.
- For a two-chamber compost toilet, the construction cost is the same as a septic tank system.
- Users have to overcome discomfort about emptying composted toilet wastes from the chambers, every 1-2 years.

- The toilet room is elevated above the ground, so access may be difficult for the elderly or disabled.

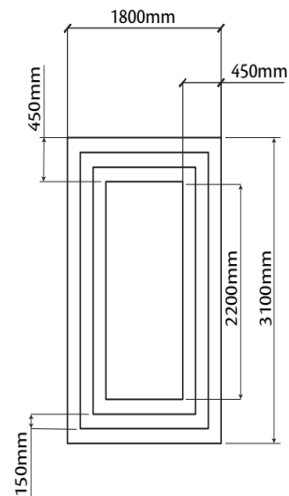
Toilet location, proper use and hygiene

- This toilet can be located in, attached to or close by the house.
- The collected faecal matter is collected in a suitable container and subsequently used as manure.
- A small amount of wood-ash or other suitable material like sand or sawdust should be added through the drop-hole after each use and the lid for the drop-hole replaced.
- Once a week, sweep and clean the toilet floor (preferably using a disinfectant), and clean the toilet surrounding area. Do not use excess water.
- Once a month, clean the walls, door and ceiling.
- Once every six months check the fly-screen on top of the vent-pipe and check that the pipe is not obstructed.
- Repairs should be carried out immediately when a problem is identified.
- The pit must not be used for garbage disposal.
- Faecal matter in compost chambers should be turned periodically.

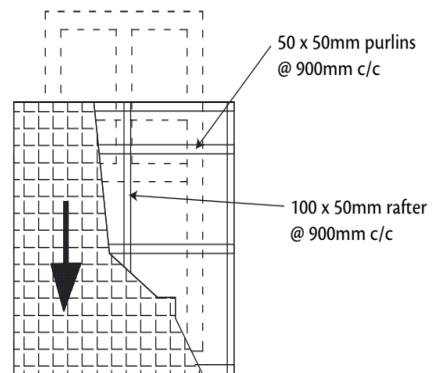
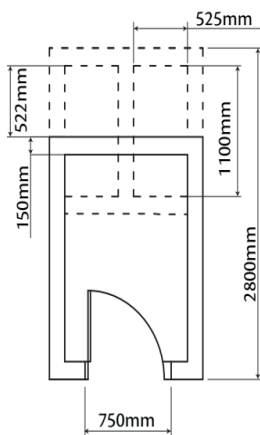
Engineering Drawing of the Compost Toilet



Plan



Foundation Plan



Roof Details

Figure 8 Engineering drawing of the compost toilet

Urine Diversion Dry/Dehydration Toilet (UDDT)

What is a UDDT Toilet?

A urine-diverting dry toilet (UDDT) is a toilet that operates without water and has a divider so that the user, with little effort, can divert the urine away from the faeces. It has separate collection and storage chambers for faeces and for urine.

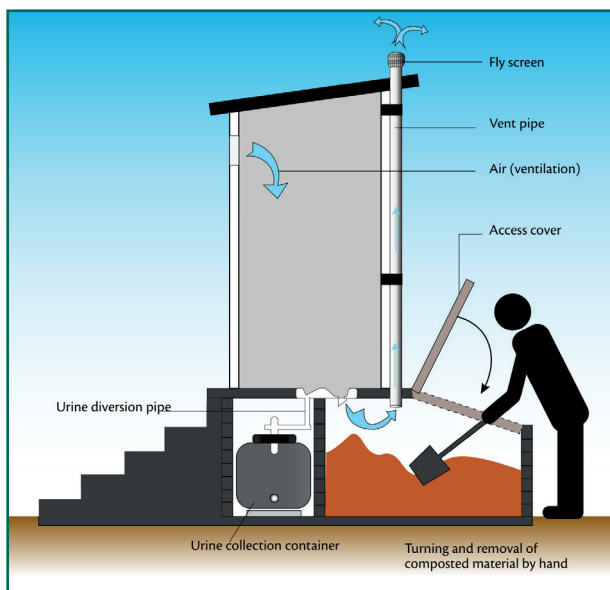


Figure 9 A two dimensional view of UDDT



Figure 10 Front view of UDDT toilet



Figure 11 Back view of UDDT toilet

Principles of operation

The Urine Diverting Dry Toilet (UDDT) operates without water and has a divider so that the user, with little effort can divert the urine away from the faeces so that either is stored

separately. While urine goes into a container (or is drained away), faeces are collected in vaults underneath, where they are stored and dried. To encourage drying, a small amount of ash, lime, dry soil or sawdust is used to cover the faeces after each use. UDDTs may be constructed with two (2) adjacent dehydration vaults or one single vault with interchangeable containers. This technology was originally promoted in connection with safe reuse of excreta. However, the primary focus of UDDT implementation has gradually shifted from that of excreta reuse to the broader objective of creating odourless, dry and versatile toilet. The alternating use of the two pits (or containers) allows the toilet to be used continuously without any interruption. It also allows for prolonged storage and treatment of collected faeces in the unused vault. When the first pit becomes full, the drop-hole is closed and sealed and the second pit is put into use. When the second pit becomes full, the emptying hatch of the first pit is opened and the decomposed contents can be removed and safely used as a plant fertilizer. The emptying hatch is then closed and the pit put back into use while the second pit is sealed. When faeces are not mixed with urine and other liquids, they dry quickly. In the absence of moisture, pathogens are destroyed and smell minimized. The use of alternating vaults allow faeces to dehydrate in one vault while the other fills up.

Design Consideration

- The vault size must be designed or chosen according to the anticipated number of users and to allow for a storage time between 1-2 years.
- WHO recommends a minimum storage period of 6 months if ash or lime are used as cover material (alkaline treatment), otherwise storage should be for at least 1-2 years.
- Vault dimensions should account for cover material, airflow and non-even distribution of faeces.
- Urine piping should not go directly through vaults to avoid potential leaking.
- A vent pipe is required to remove humidity from vaults and control flies and odours.
- Vaults should be made of sealed brickwork or concrete to ensure surface runoff cannot enter.
- Water from the handwashing facility and anal cleansing water (if applicable) must be drained separately.
- Connection pipes should be as short as possible without sharp bends and must be installed with >1% slope.
- An odour seal should be installed at the urine drain.

■ Applicability

- Suitable if the household is interested in using the decomposed faeces as plant fertilizers.
- Does not require water. Therefore, suitable for locations where there is scarcity of water or where the water supply is not regular.
- Suitable for hard-rocky areas and high water-table areas because the whole structure is above ground-level. No risk of ground-water contamination. But in flood-prone areas special care should be taken to ensure that vaults are watertight.
- The alternating use of the two pits allows the toilet to be used continuously without any interruption.
- When the first pit becomes full, the drop-hole is closed and sealed and the second pit is put into use. When the second pit becomes full, the emptying hatch of the first pit is dismantled and the decomposed contents can be removed and safely used as a plant fertilizer. The emptying hatch is then re-closed and the pit put back into use while the second pit is sealed.
- In an emergency situation, UDDTs might not be appropriate in the instance of acute response needed, due to the time needed to educate and train users, and also to construct the structure.

■ Social Considerations

- Households might need some education/training on the technology as the use of composting toilets might have considerable acceptability and behaviour change implications.
- Training might be needed to support acceptance, ensure proper use and maintenance and to avoid accidental misuse.
- It should reflect local user preferences (sitter vs. squatter, anal cleansing practices, direction, positioning etc.) and should account for the accessibility and safety of all users, including men, women, children, the elderly and disabled people.
- If reuse is not intended and soil conditions allow, urine can be drained away in a Soak pit. This avoids regular urine management and might increase acceptance.

■ Advantages and Disadvantages

Advantages

- Avoids contamination of water sources and soil.
- Composting of human waste for use as a natural fertilizer.

- There is no need of emptying the pits.
- It is applicable for water logged, water-scarce, coastal and rocky areas.
- Significant reduction of pathogens by drying.
- Promotes soil fertility and improved crop production.

Disadvantages

- High capital/initial cost
- UDDTs in urban areas require special attention in the collection of urine and composted faecal sludge.
- Is prone to clogging with faeces and misuse.
- Slightly more difficult to clean compared to other technologies.
- Difficult to use by small children.
- More effort will have to be put into creating awareness and the necessary behavioural change.

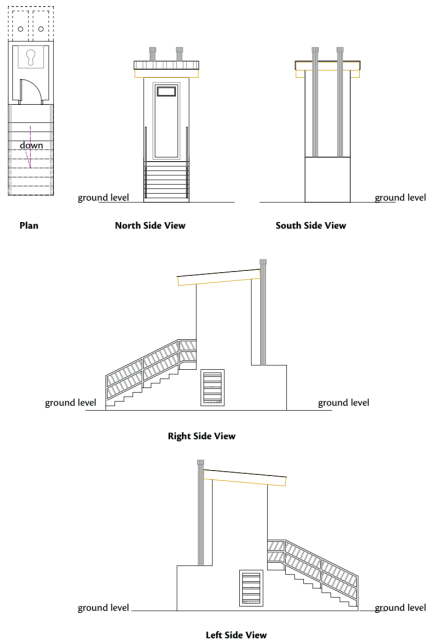
Toilet location, proper use and hygiene

- This toilet can be located attached to or close by the house.
- The separated urine is collected in a suitable container such as a 15-20 litres plastic jerry can and used as liquid manure. The urine collected can be safely used on the farm after storage for forty (40) days. Alternatively, the outlet of the urine pipe can be connected to a soak away pit and the urine dispersed off into the soil.
- A small amount of wood-ash or other suitable material like sand or sawdust should be added through the drop-hole after each use and the lid for the drop-hole replaced.
- Once a week, sweep and clean the toilet floor (preferably using a disinfectant), and clean the toilet surrounding area. Do not use excess water.
- Once a month, clean the walls, door and ceiling.
- Once every six months check the fly-screen on top of the vent-pipe and check that the pipe is not obstructed.
- Repairs should be carried out immediately when the problem is identified.
- The pit must not be used for garbage disposal.

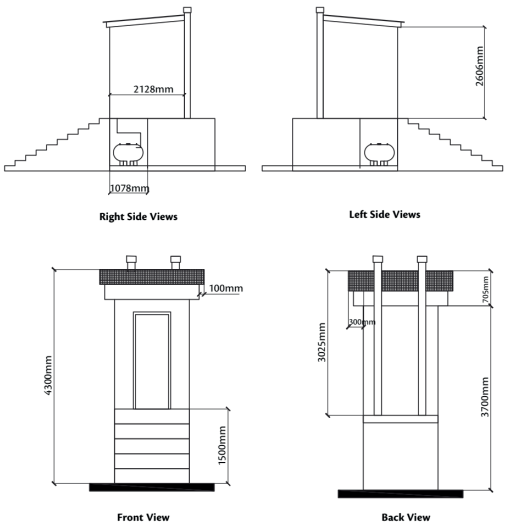
Engineering Drawing of the Urine Diversion Dry/Dehydration Toilet

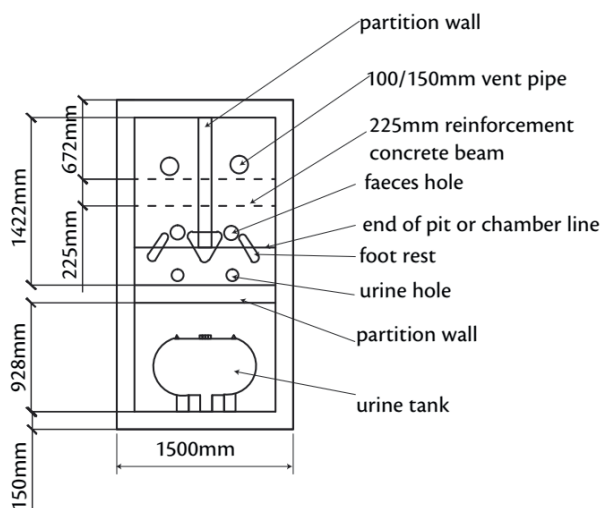
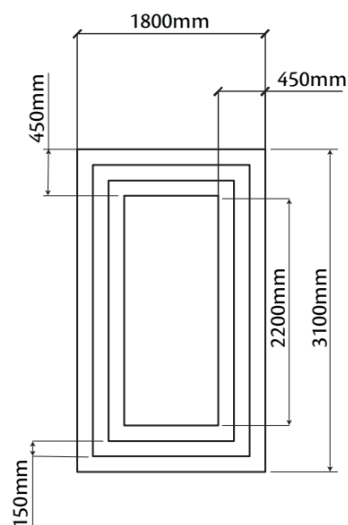
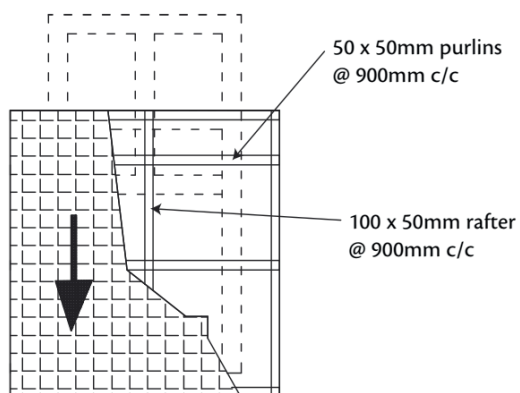
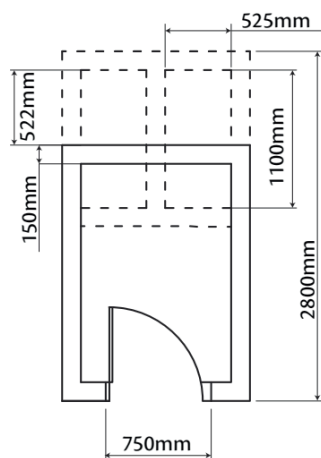
Engineering Drawings

UDDT with railings



UDDT without railings



**PLAN****Foundation Plan****Roof Details****Figure 12** Engineering drawings of the UDDT

Wet On-site Systems

These are systems that rely on water to be functional. Wet on-site toilet technologies utilise water to treat waste. They are recommended for communities that have adequate supplies of water. Examples of wet on-site toilet technologies include pour-flush toilet, aqua-privy, bio-digester toilets, septic tank, etc.

The wet systems described in this document are those regarded as advanced technologies in terms of their designs and the level of skilled labour required to construct them.

The Pour-flush Toilet Connected to Twin-Leach Pits

What is a pour flush toilet?

A pour flush toilet is like a regular flush toilet except that instead of the water coming from a cistern above, it is poured in by the user, using a bucket, cup or bottle. A pour-flush toilet consists of a cover slab and a special pan that provides a water seal. A U-shaped pipe is used to maintain the water seal.

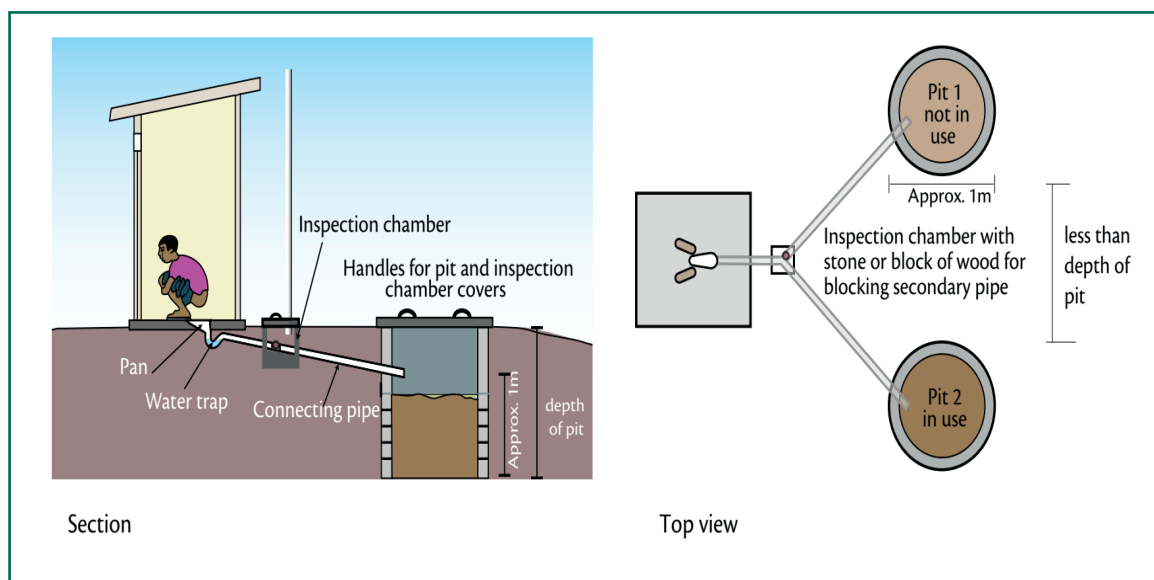


Figure 13 Two-dimensional view of a pour-flush connected to twin leach pit



Figure 14 Front view of a pour-flush toilet



Figure 15 Back view of a pour-flush toilet

Principles of operation

This pour-flush toilet consists of two alternating pits connected to a flush toilet. The toilet pan is 'flushed' by pouring a few litres of water into the pan after use. The amount of water used ranges between 1-3 litres depending mainly on the pan, and the length of the pipe that connects the pit. Pans requiring a small amount of water for flushing have the added advantage of reducing the risk of groundwater pollution. The flushing water does not have to be clean and could include laundry, bathing or other water pre-used from around the house. The pits are constructed with holes to allow for infiltration of water into the soil. The blackwater is collected in one pit and allowed to slowly infiltrate into the surrounding soil. When full, one pit is closed and with time the solids are sufficiently dewatered, enabling manual removal, while the other pit is used. As the pit sludge can be quite liquid, the full pits require a longer retention time (two years or more is recommended) to degrade the material before it can be safely emptied. This technology can be a more cost-effective alternative to the Septic Tank as an on-site water-based technology, where a water flush system is required.

Design considerations

- The pits should be of an adequate size to accommodate an excreta volume generated over two years. The resting period of the full pit allows the contents to transform into a partially sanitised, soil-like material.
- It is recommended that the twin pits are constructed at least 1 m apart to minimise cross-contamination between the maturing pit and the one in use.
- Pits should be constructed over 1 m from any structural foundation as leachate can negatively impact structural supports.
- The full depth of the pit walls should be lined to prevent collapse and the top 30 cm should be fully mortared to prevent direct infiltration.

- To ensure that only one of the two pits is used at any time, the idle pipe of the junction connecting to the out-of-use pit should be closed (e.g. with cement or bricks).

Applicability

- Suitable where the ground is easy to excavate and where there is no high water-table, water-logging, or flooding.
- Appropriate for areas where it is not possible to continuously build new pit latrines or where regular desludging might be an issue.
- Suitable only if there is dependable water supply (requires at least 3 or 4 litres per use).
- Suitable where users are accustomed to using water for anal cleansing.
- Where people use solid/ hard materials, these must not be put into the toilet. Instead they should be put in a covered container kept inside the toilet, and disposed of each day by burning and/ or burying.
- It is recommended not to concentrate pits in a small area as the soil may not have sufficient capacity to absorb the liquid and the ground could become water-logged (oversaturated). Clay, tightly packed or rocky soils are not appropriate for pour flush pits.

Social Consideration

- This is a commonly accepted sanitation option that works best in rural and peri-urban areas, and where people are used to flush toilets.
- It should reflect local user preferences (sitter vs. squatter, anal cleansing practices, direction, positioning etc.) and should account for the accessibility and safety of all users, including men, women, children, the elderly and disabled people
- The potential handing over to beneficiaries, and the roles and responsibilities for O & M need to be agreed upon early on and closely linked to respective hygiene promotion activities to ensure appropriate use and O & M of the facilities.

Advantages and Disadvantages

Advantages

- Water required for satisfactory operation is usually just about 2-3 litres per flush.
- High social acceptability especially in Muslim communities where water is used for anal cleansing.

- With minimum householder care and maintenance, odour and insect nuisance are negligible.
- Both adults and children can use the toilet without fear.
- Pits can be used by multiple households in the case of off-set pits.

Disadvantages

- Trap may be regularly blocked by bulky anal cleansing materials.
- Possible ground water contamination from leach pit especially in areas with high water table.

Toilet location, proper use and hygiene

- This toilet can be built inside, attached to, or close to the house.
- The location of the leach-pits should be chosen considering wind direction. There should be enough space to allow at least 4-5 feet between the two pits.
- Once a week, sweep, wash and clean the toilet floor and squatting pan (preferably using disinfectant), and clean the toilet surrounding area.
- Once a month, clean the walls, door and ceiling.
- Once every six months check the fly-screen on top of the gas-pipe fitted to the leach-pit covers and check that the pipe is not obstructed.
- Repairs should be carried out immediately.
- Periodic inspection of chambers

Engineering Drawing of the Pour-flush Toilet

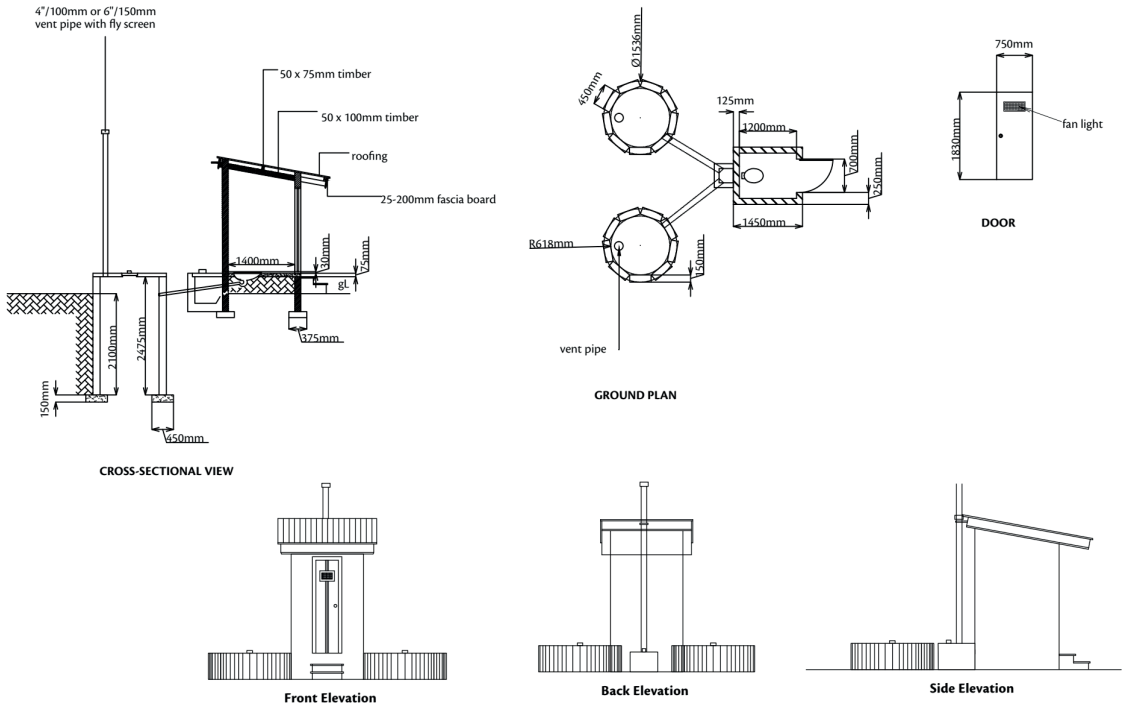


Figure 16 Engineering drawing of the Pour-flush toilet

Water Closet (WC) Connected to Septic Tank

What is a septic tank toilet?

This is a toilet where the waste is flushed into a sealed septic tank located in the yard of the house. The septic tank is an underground watertight settling chamber.

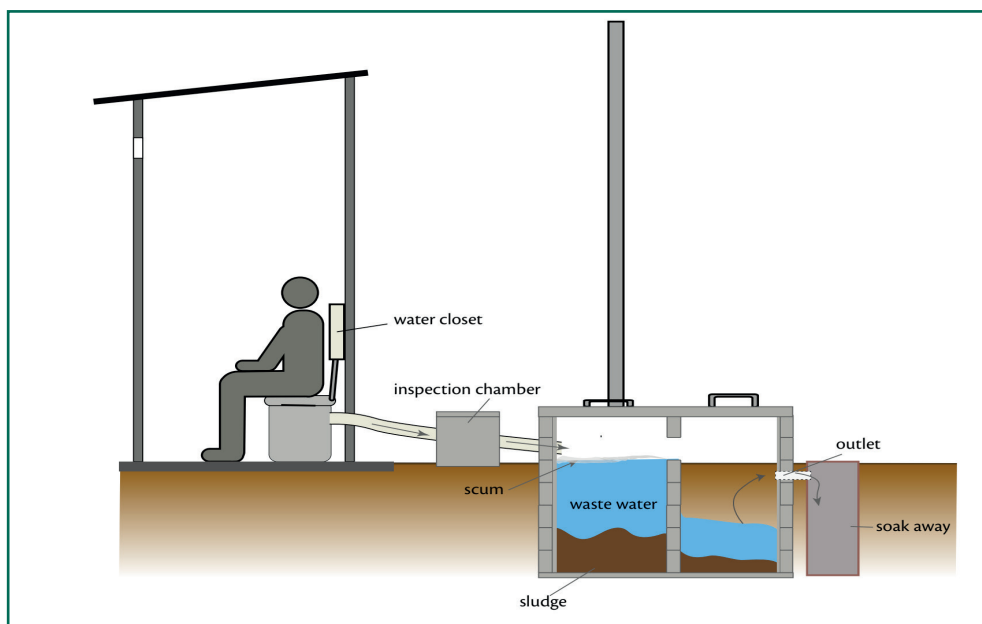


Figure 20 Two-dimensional view of a septic tank

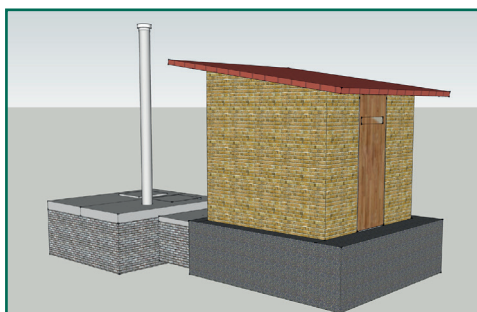


Figure 21 Front view of a septic tank

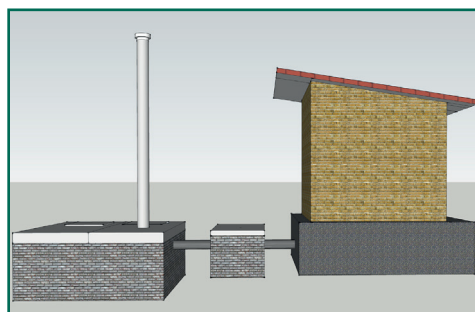


Figure 22 Side view of a septic tank

Principle of operation

A Septic Tank is a watertight chamber made of concrete, fibreglass, PVC or plastic, through which blackwater and greywater flows for primary treatment, before further

treatment or infiltration. Water closet is a type of flush toilet that disposes of human waste (blackwater and greywater) by using water to flush it through a drain pipe into a septic tank that acts as a settling and treatment chamber for both the blackwater and greywater. This technology maintains a separation between humans and excreta. Wastewater enters the first chamber of the tank, allowing solids to settle and scum (mostly oil and grease) to float to the top. The liquid is retained in the septic tank for at least 24 hours, but may be up to 10 days. Over time, solids that settle are degraded anaerobically. The liquids pass out of the tank and into a subsoil drainage system (soak-away). Digested sludge gradually builds up in the tank and requires eventual removal by a vacuum tanker.

Generally, the removal of 50% of solids, 30–40% of the biochemical oxygen demand and a 10-fold reduction of E. Coli can be expected in a well-designed and maintained Septic Tank, although efficiencies vary greatly depending on operation and maintenance, and climatic conditions.

Design Considerations

- A Septic Tank should have at least two chambers. The first chamber needs to be at least 50% of the total length because most of the solids settle out in the first chamber.
- Accessibility to all chambers (through access ports) is necessary for maintenance.
- Septic Tanks should be vented for controlled release of odorous and potentially harmful gases.
- The design of a septic tank should take into consideration the expected number of users, the water used per capita, average annual temperature, desludging frequency and wastewater characteristics.
- The minimum recommended retention time for small tanks is 24 hours, decreasing to 12 hours in very large tanks. The volume must be large enough to avoid turbulent flow.

Applicability

- Suitable only if there is a dependable water supply system since it requires at least 5-8 litres per use.
- Where people use solid/ hard materials, these must not be put into the toilet. Instead they should be put in a covered container kept inside the toilet, and disposed of each day by burning and/ or burying.
- This technology is appropriate at the household level as well as for institutions such as hospitals and schools.

- If Septic Tanks are used in densely populated areas, on-site soil infiltration should not be used, because the ground may become saturated and contaminated, posing a serious health risk. Instead, Septic Tanks should be connected to a conveyance technology, through which the effluent is transported to a subsequent treatment or disposal site.
- Even though Septic Tanks are watertight, it is not recommended to construct them in areas with high groundwater tables or where there is frequent flooding.
- As the Septic Tank must be regularly desludged, a vacuum truck should be able to access the location.

Social Considerations

- The Septic Tank is a very common and well-accepted technology among people who use flush toilets. Because of the delicate ecology in the system, awareness raising on eliminating the use of harsh chemicals for the users is necessary

Advantages and Disadvantages

Advantages

- No real problems with flies and odour if used correctly.
- The excreta of one user are flushed away before the next user arrives.
- Hygienic to use.

Disadvantages

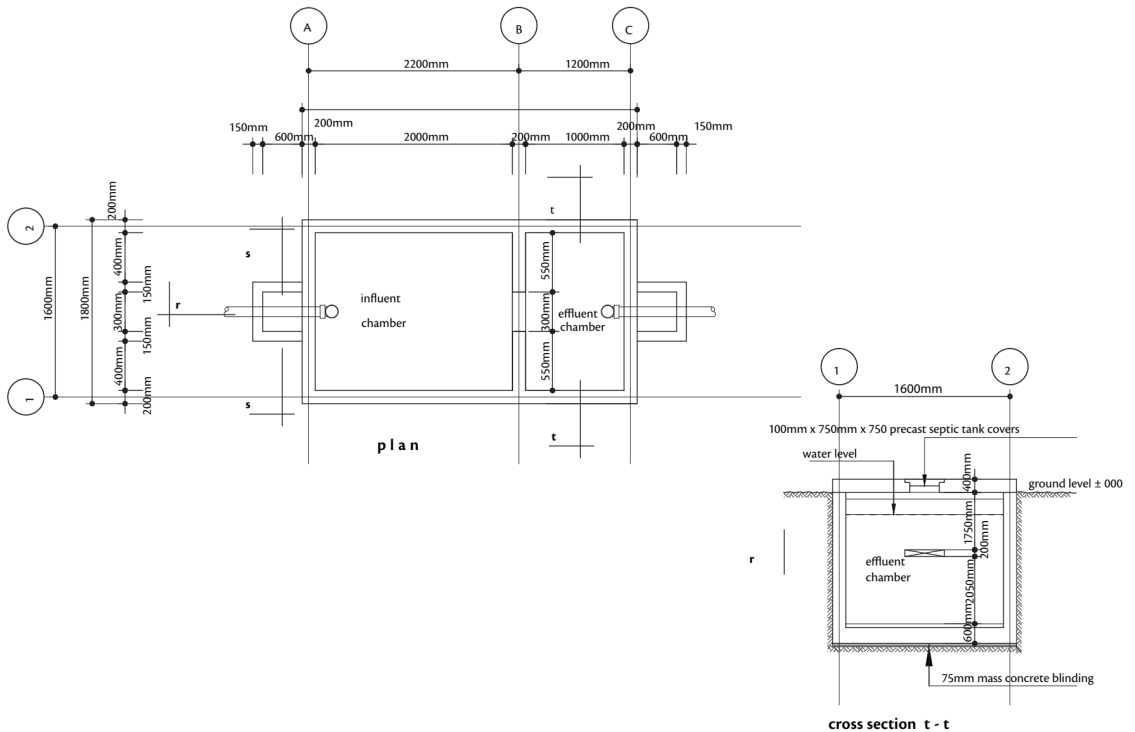
- High capital and operating costs.
- Requires a reliable household water connection.
- Can only be constructed in areas with access for emptying of tanks by vacuum tanker.
- Cannot be built and/or repaired with locally available materials.
- Can pollute groundwater if water table is high or if trenches are not designed and installed correctly.
- Needs occasional costly desludging of faecal sludge using motorized emptying system (e.g vacuum truck)

Toilet location, proper use and hygiene

- This toilet can be built inside, attached to, or close to the house.
- The location of the leach-pit should be chosen considering wind direction.

- Once a week, sweep, wash and clean the toilet floor and squatting pan (preferably using a disinfectant), and clean the toilet surrounding area.
- Once a month, clean the walls, door and ceiling.
- Once every six months check the fly-screen on top of the gas-pipe fitted to the leach-pit cover and check that the pipe is not obstructed.
- Well-functioning systems will require emptying every two to five years.
- Scum and sludge levels need to be monitored to ensure that the tank is functioning well
- Repairs should be carried out immediately.
- Effluent, scum and sludge must be handled with care as they contain high levels of pathogens. During sludge and scum removal, workers should be equipped with personal protective equipment

Engineering Drawing of the Septic Tank



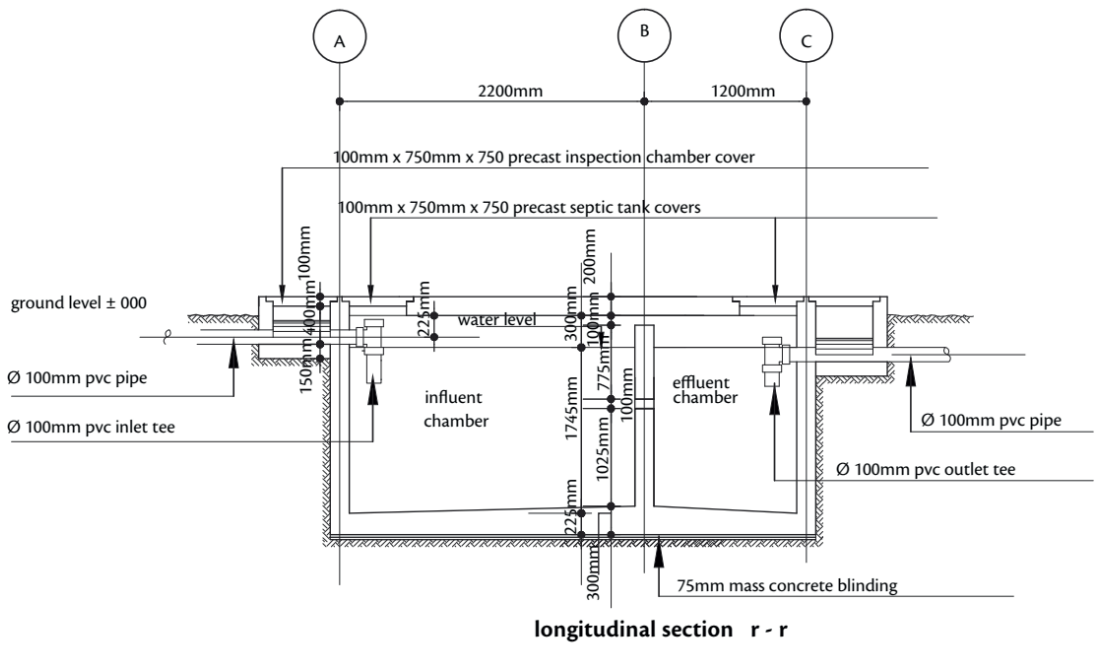


Figure 23 Engineering drawing of the Septic tank

Anaerobic Baffled Reactor (ABR)

What is an ABR?

The Anaerobic Baffle Reactor (ABR) is an improved septic tank that uses baffles to optimize treatment of human waste.

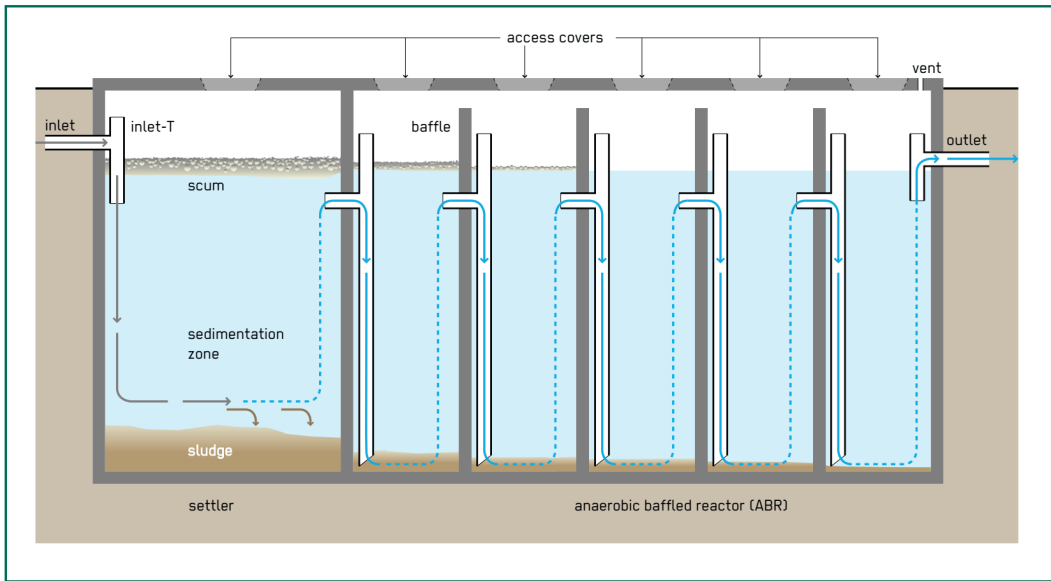


Figure 24 Schematic diagram of an Anaerobic Baffled Reactor

Principles of operation

The Anaerobic Baffled Reactor (ABR) treats many different types of wastewater and can be considered an 'improved' Septic Tank that uses baffles to optimize treatment. Treatment of the wastewater takes place as it is forced to flow upward through a series of chambers, where pollutants are biologically degraded in an active sludge layer at the bottom of each chamber.

ABRs can treat raw, primary, and secondary treated sewage and greywater (with organic load). The principal working process is anaerobic (in the absence of oxygen) and makes use of biological treatment mechanisms. The upflow chambers provide enhanced removal and digestion of organic matter. Biochemical oxygen demand (BOD) may be reduced by up to 90%, which is far superior to its removal in a conventional Septic Tank.

Design Considerations

- ABRs should consist of at least 4 chambers (as per BOD load), more than 6 are not recommended.
- The organic load should be $<6 \text{ kg/m}^3/\text{day}$ BOD, the water depth at the outlet point is preferably about 1.8 m; a maximum of 2.2 m (for large systems) should not be exceeded.
- Hydraulic retention time should not be less than 8 hours, and 16–20 hours is a preferred range.
- Upflow velocity ideally ranges around 0.9 m/h, velocities above 1.2 m/h should be avoided.
- Accessibility to all chambers (through access ports) is necessary for maintenance.
- The tank should be vented to allow for controlled release of odorous and potentially harmful gases.
- Where kitchen wastewater is connected to the system, a grease trap must be positioned before the settler component to avoid excess oil and grease substance entering and hindering treatment processes.

Applicability

- Once in operation, 3–6 months (up to 9 in colder climates) is needed for the biological environment to establish and maximum treatment efficiency to be reached. Therefore, ABRs are not suitable for the acute response phase of an emergency but are more suited for the stabilization and recovery periods.
- The neighbourhood scale is most suitable, but it can also be implemented at the household level or in larger catchment areas and/or public buildings (e.g. schools).
- Even though ABRs are designed to be watertight, it is not recommended to construct them in areas with high groundwater tables or where there is frequent flooding, alternatively prefabricated modules can be placed above ground.
- ABRs can be installed in every type of climate, although the efficiency will be lower in colder climates.

Social Considerations

- Usually, anaerobic treatment systems are a well-accepted technology. Because of the delicate ecology in the system, awareness raising on avoiding the use of harsh chemicals in the system is necessary.

Advantages and Disadvantages

Advantages

- Low operating costs.
- Resistant to organic and hydraulic shock loadings.
- High reduction of BOD.
- Low sludge production; the sludge is stabilized

Disadvantages

- Requires expert design and construction.
- Low reduction of pathogens and nutrients.
- Effluent and sludge require further treatment and/or appropriate discharge.
- Long start-up time.

Bio-digester Toilets

What is a Bio-digester Toilet?

Bio-digester toilets are waste treatment systems designed to digest or treat human excreta under a controlled aerobic environment to produce usable products such as organic compost, and wastewater. The degradation process is caused by micro-organisms. The bio-digester comes as either a normal-flush or micro-flush unit. As a normal flush unit, it typically serves as an alternative to the septic tank by receiving and treating faecal matter directly from water closets or pour-flush seats. As a micro-flush, a uniquely designed “micro-flush” seat uses wastewater from a hand wash basin - first as a water seal and secondly as a flush unit to discharge faecal matter into the digester.

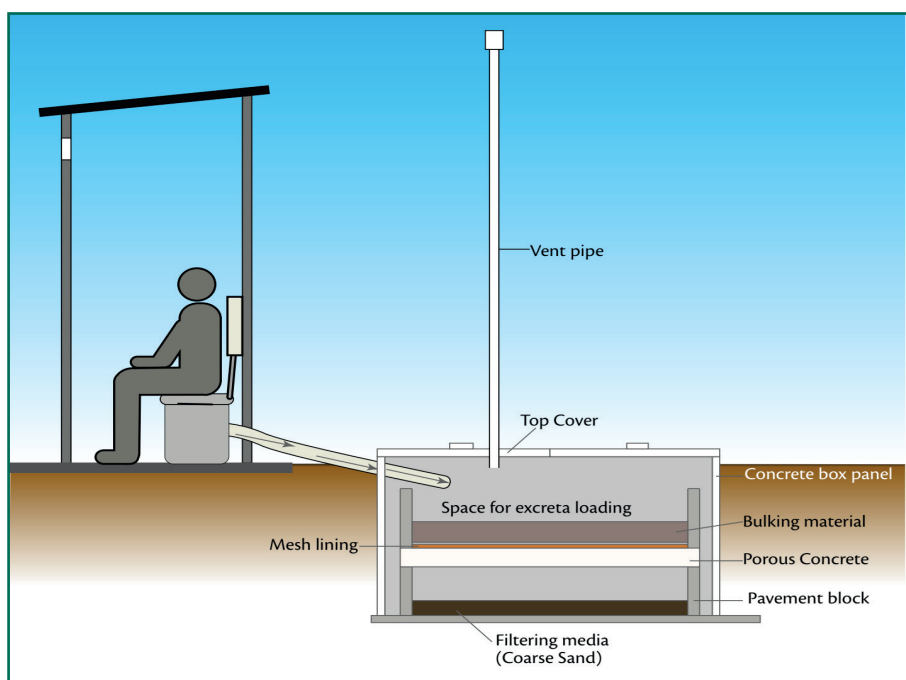


Figure 25 Two-dimensional view of a Bio-digester toilet

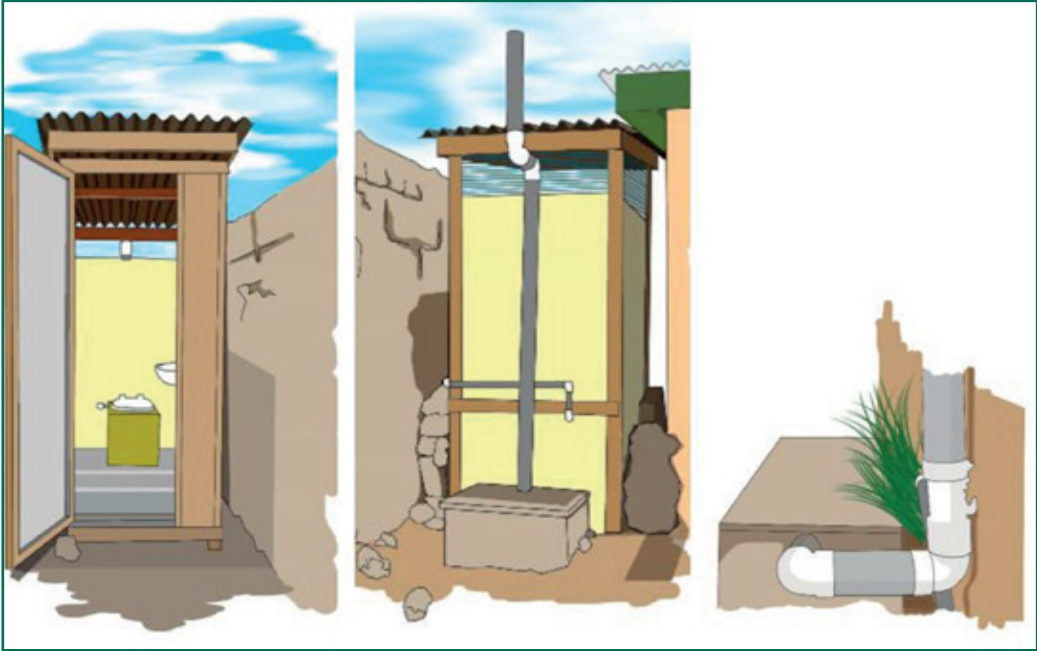


Figure 26 Front, back and side views of a Bio-digester toilet

Principles of operations

The bio-digester toilets are on-site sanitation designed to rapidly separate human excreta for degradation by micro-organisms (worms, cockroaches, enzymes, etc.) under aerobic conditions. Bio-digesters typically serve as alternatives to septic tanks in the treatment of excreta directly from water closets or pour-flush seats. The blackwater (raw excreta + flushwater and anal cleansing material) undergo rapid solid–liquid separation through a porous filter in the digester. The solid material is retained on the porous filter where it is broken down aerobically by microorganisms and macro-invertebrates. The bio-digester technology mimics the decomposition found under forests floors and other natural environments. The organisms are introduced into the digester by adding a bit of humus or detritus during installation while the cockroaches come in by themselves. The effluent (liquid) that remains after the solid–liquid separation process is biologically treated to a limited extent, and discharged directly into the subsurface soil.

Design Considerations

The surface area of the household tank for a bio-digester toilet varies from 0.7 m² to 1 m² depending on the number of users. The depth of the tank is approximately 1 m. The bottom of the tank is exposed to the soil. The tank contains about 5cm of porous filter material, 10 cm of organic bedding material (coconut husks, rice husks, or sawdust) and

the micro-organisms (worms, or enzymes and cockroaches). The lid to this tank needs to fit extremely well, but should not be sealed. This is then connected to the pour-flush or water-closet system.

Applicability

- Suitable if the household is interested in using the decomposed faeces as soil conditioner.
- Requires very little water and is therefore suitable for use in locations where there is scarcity of water or where the water supply is not regular.
- Suitable for all soil types because the whole structure can be built above or below ground level.

Social Considerations

- Households need to be educated on the use of bio-digester toilets. Because of the delicate ecology in the system, creating awareness on avoiding the use of harsh chemicals for cleaning of the toilet is necessary.

Advantages and Disadvantages

Advantages

- Ground water is not affected.
- Water is directed into top soils where microbial activities are most active.
- Nutrients are removed by soil bacteria decomposition.
- Suitable for soil with low water table.
- Hygienic to use.
- Minimal odour.
- Less water required (1.5 litres for micro-flush).
- Does not require large land area hence suitable for densely populated areas.

Disadvantages

- Final effluent may need secondary treatment to ensure total elimination of faecal coliforms.
- High initial capital cost.
- In water logged areas, effluent has to be treated before final discharge.
- After long periods (more than five (5) years), sludge may accumulate in the digester.

Toilet location, proper use and hygiene

- This toilet can be located in, attached to or close by the house.
- Once a week, sweep and clean the toilet floor (preferably using a disinfectant), and clean the toilet surrounding area.
- Once a month, clean the walls, door and ceiling.
- Once every six months check the fly-screen on top of the vent-pipe and check that the pipe is not obstructed.
- Repairs should be carried out immediately.
- The pit must not be used for garbage disposal.
- Once every three to four months, check to ensure that vermin (worms) are alive and functioning. If not re-seed your digester with worms.
- Regular inspection to check population of vermin is important.

Biogas Digester

What is a Biogas Digester?

In a biogas digester is an airtight tank situated underground that breaks down (decompose) waste through anaerobic digestion, resulting in the production of biogas and digested sludge. The digested sludge collects in a separate tank and can be used as a soil fertilizer.

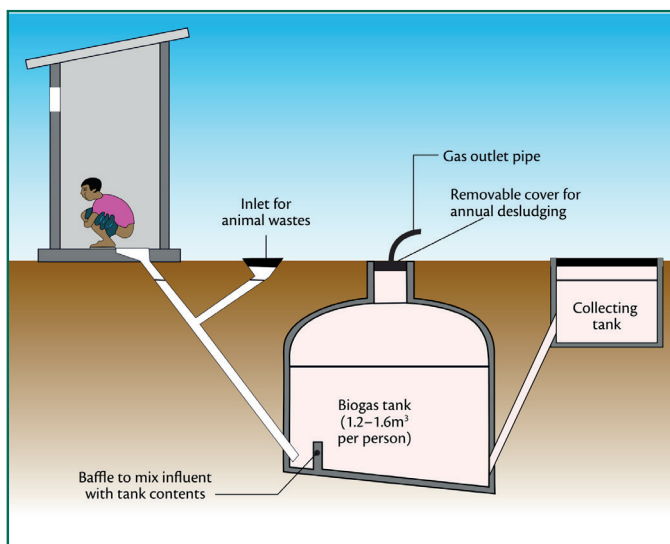


Figure 27 Two-dimensional view of a Biogas system

Principles of operation

A biogas reactor consists of airtight reservoirs in which biomass is caused to ferment under natural anaerobic conditions by living organisms. Anaerobic means without oxygen and the bacteria that produce the biogas can only survive if they are not exposed to oxygen in the air. A biogas reactor can efficiently treat different types of wastewater. It facilitates anaerobic degradation of blackwater, sludge, and/or biodegradable waste. It is an anaerobic treatment technology that produces a digested sludge (digestate) that can be used as a fertilizer, and biogas that can be used for energy.

Biogas is a mix of methane, carbon dioxide and other trace gases which can be converted to heat, electricity or light. Treatment of wastewater takes place as it enters the digester. Inputs are biologically degraded in an active sludge layer within the digester. The digested sludge is discharged from the overflow point at ground level. The chamber also facilitates the collection of biogas produced in the fermentation processes in the reactor. The digestate is rich in organics and nutrients, and is relatively easy to dewater and manage.

The anaerobic bacteria generally thrive at two (2) temperature zones from 95-105°F and from 125-135°F. Lower temperatures are generally not efficient at producing biogas. Anaerobic is a natural, biological process similar to composting that breaks down liquid sewage or other organic wastes and, in the process, biogas is produced.

Biogas Reactors can be built as fixed dome or floating dome digesters. In the fixed dome, the volume of the reactor is constant. As gas is generated, it exerts a pressure and displaces the slurry upward into an expansion chamber. When the gas is removed, the slurry flows back into the reactor. The pressure can be used to transport the biogas through the pipes. In a floating dome reactor, the dome rises and falls with the production and withdrawal of gas. Alternatively, the dome can expand (like a balloon).

Design Considerations

- The hydraulic retention time (HRT) in the reactor should be at least 15 days in hot climates and 25 days in temperate climates.
- For highly pathogenic inputs, a HRT of 60 days should be considered.
- The size of the biogas reactor can vary from 1,000 L for a single family up to 100,000 L for institutional or public toilet applications.
- Because the digestate production is continuous, there must be provisions made for its storage, use and/or transport away from the site.

■ Applicability

- Suitable if the household is interested in using the decomposed faeces as plant fertilizers and methane gas generated from the faeces as fuel for cooking or electricity generation.
- The system requires water and is therefore not suitable for locations where there is scarcity of water, or where the water supply is not regular.
- This technology is not suitable for hard-rock areas and high water-table areas because the whole structure is below ground-level. If properly designed however, there is no risk of ground-water contamination.

■ Social Considerations

- Social acceptance may be a challenge for households that are not familiar with using biogas or digestate.
- Social cohesion can be created through shared management and shared benefits (gas and fertilizer) from biogas reactors. However, there is also a risk that benefits are unevenly distributed among users and this can lead to conflict.

■ Advantages and Disadvantages

Advantages

- Odour is significantly reduced in an anaerobic digestion system.
- It is a renewable energy source.
- Harmful pathogens in waste are reduced.
- Capturing and burning methane with anaerobic digestion systems reduces agricultural sources of greenhouse gases.

Disadvantages

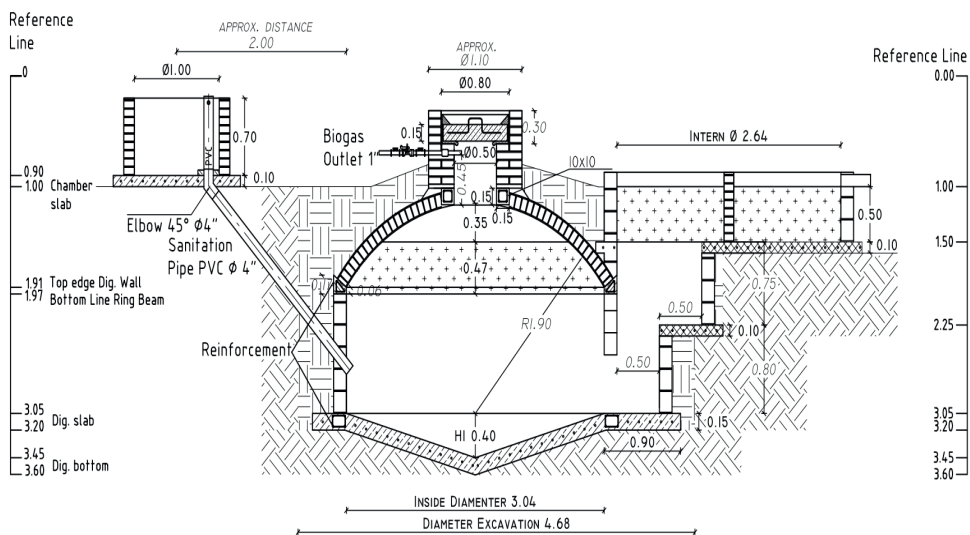
- High initial setup costs.
- Risk from toxicity of its hydrogen sulphide fraction.
- Can be explosive when mixed in the ratio of one part of biogas to 8-20 parts of air.
- Biogas leaks smell like rotten egg.
- Special safety precautions have to be taken for entering an empty biogas digester for maintenance works.

Toilet location, proper use and hygiene

- This toilet can be located in, attached to, or close by the house.
- The decomposed faecal matter is collected in a suitable container and subsequently used as manure.
- Once a week, sweep and clean the toilet floor (preferably using a disinfectant), and clean the toilet surrounding area. Do not use excess water.
- Once a month, clean the walls, door and ceiling.
- Repairs should be carried out immediately.
- The pit must not be used for garbage disposal.

Engineering Drawing of the Biogas Digester

FIXED DOME BIOGAS PLANT VOLUME 12 M³
CROSS SECTION A-A



FIXED DOME BIOGAS PLANT VOLUME 12 M³
TOP VIEW

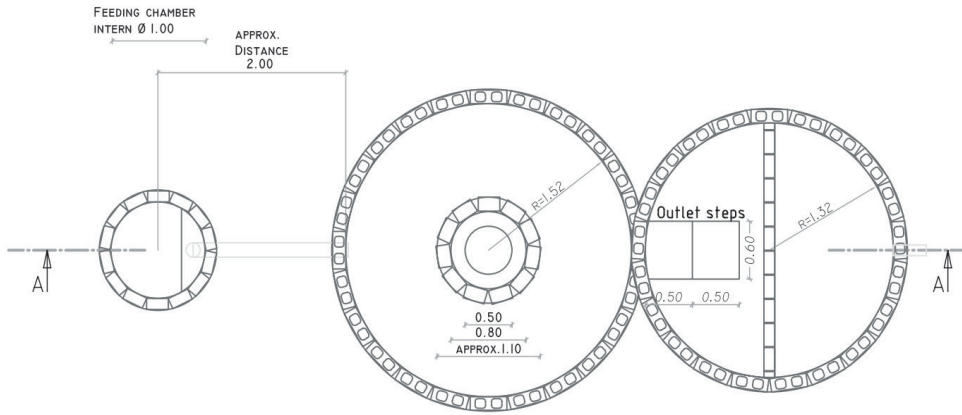


Figure 28 Engineering drawings of the Biogas digester

PART 3 INSTRUCTIONS FOR TOILET TECHNOLOGIES CONSTRUCTION

General guidelines for toilet site selection

- The toilet technology should be constructed close to the house for easy access by all members.
- The toilet should be sited away from trees to prevent obstruction of vent pipes.
- The toilet facility should be constructed with enough space for vehicle access and movement during desludging.
- In the selection of soil conditions on which to construct the toilet, avoid (if possible) rocky terrain, unstable ground conditions and depressions with shallow water table.
- Horizontal distance between the toilet pit and the groundwater source such as a well, should be minimum 30 meters.
- The minimum vertical distance (safety gap) between the bottom of the pit and the groundwater table should be 2 meters.

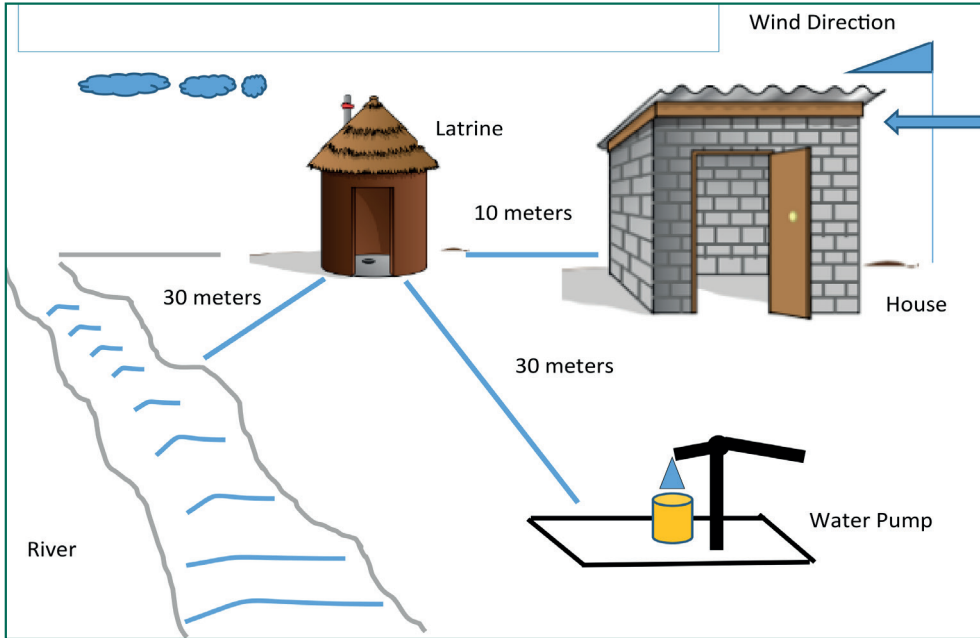


Figure 29 Horizontal distance between toilet and water source

General construction processes

- Site preparation
- Setting out / marking out
- Digging of pit
- Steel reinforcement
- Erecting the walls
- Roofing

Construction Techniques for the Different Toilet Technologies

The Kumasi Ventilated Improved Pit

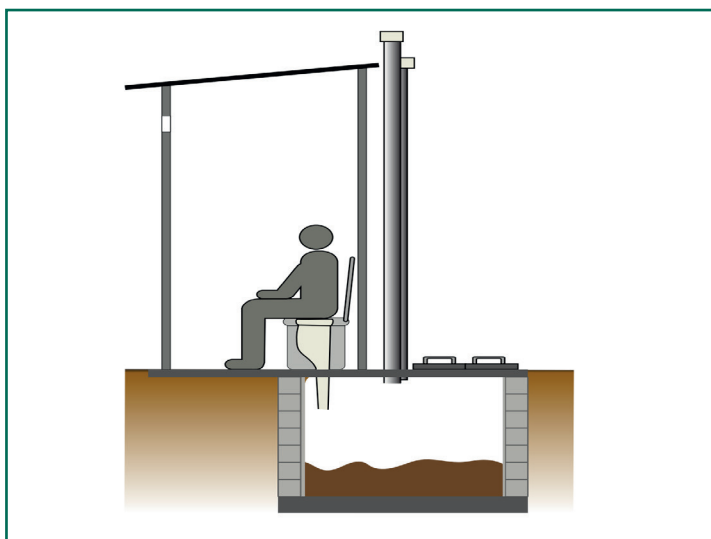


Figure 30 A KVIP Toilet

Site Selection

- Choose a convenient location accessible to all users.
- Well drained land where the groundwater level is more than 2 metres deep (otherwise a raised pit may be needed).
- At least 30 metres from any existing water source e.g. a well or stream used for drinking or cooking.
- If possible, the door should face the wind direction and the vent pipe should face the sun.

Tools Required

Table 1:Tools required for KVIP construction

Tools List	Construction Use
Hammers	Nailing wood & using chisel
Handsaws	Cutting wood
Trowels & wooden floats	Working concrete

Tools List	Construction Use
Shovels	Preparing site, mixing concrete
Spirit Level	Levelling blocks and concrete
Plumb Bob and String Line	Levelling blocks and concrete
String Line	Marking out dimensions
Measuring Tape	Measuring dimensions
Large bucket or wheelbarrow	Mixing concrete
Carpenter's square	Accurate measurements

Steps to Construct KVIP

1. Mark Layout and dig the pit to a depth of between one and two metres. These are internal dimensions. It is therefore necessary to dig a slightly bigger pit. The actual size will be determined by the materials to be used for the sub foundation.
2. Cast three slabs (2 cover slabs and one seat slab). The seat slab has 2 seat holes and each of the two cover slabs has a vent-pipe hole.
3. Line the pit walls from top to bottom.
4. The dividing wall of the pit and the pit lining should be constructed at the same time so that they could bond properly.
5. The dividing wall must be well sealed with cement plaster to ensure that it is watertight. Allow the pit lining to project at least 20 cm above ground level. The pit's dividing wall should be 15 to 23 cm thick.
6. Install the cover slabs and construct foundation for the superstructure.
7. Place a lintel across edge of the slabs and start constructing superstructure.
8. Install seat slab when superstructure wall reaches height of about 35 cm.
9. Complete superstructure construction.
10. Tie fly-screen on vent-pipe and install in one of the vent-pipe holes after checking that the hole is done. Ensure that the vent-pipe is straight and then fasten securely with wire to the rear rafter at the back of the roof.
11. Seal vent-pipe edges with mortar.
12. Place covers on the other vent-pipe hole and corresponding seat hole.



Figure 31 Digging and lining of pit



Figure 32 A rectangular pit lined with blocks



Figure 33 Preparing framework for reinforced cover slab



Figure 34 Casting the cover slabs



Figure 35 Casted slabs



Figure 36 *Placing the slabs on pit*



Figure 37 *Slabs secured on pit*



Figure 38 *Building the superstructure*

The Compost Toilet

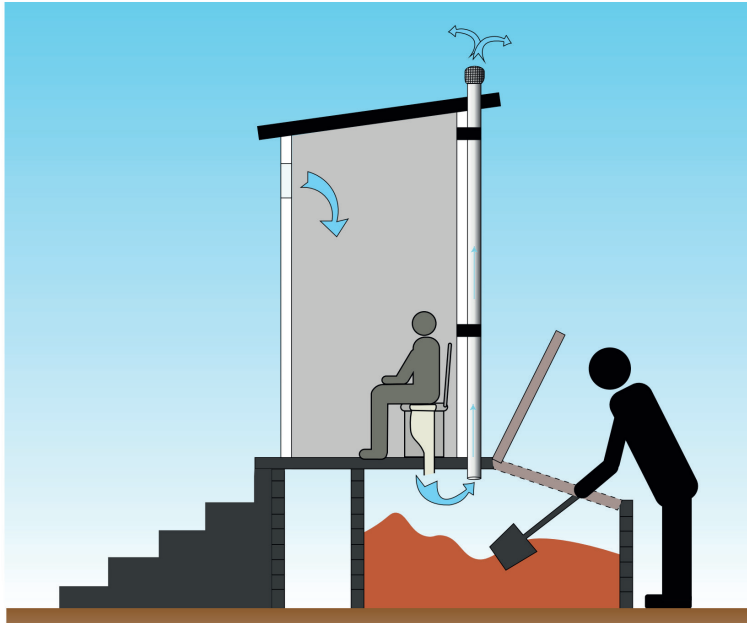


Figure 39 *Compost toilet*

Site Selection for a Compost toilet

A significant advantage of compost toilets is that their location is not dependent on the location of an existing water source, and they do not require a level land or land with good drainage. They can be established in a confined space close to a house. Therefore, in selecting the site for its constructions,

- Select a suitable location where the family will be comfortable using the toilet.
- It needs about 1 metre of space at the back or the sides to construct the soak pit or evapotranspiration beds for treating the urine/liquid.
- Level ground is good, but sloping ground is better as it allows the chamber to be recessed into the hill with level access to the top floor, avoiding the need for steps.
- The compost toilet can be built connected to a house, provided that the vent pipes extend 500 mm above the roof of the dwelling and toilet house.
- Remove grass and topsoil and if the ground slopes, dig a level space for the chamber construction.

Tools required

Table 2: Tools required for compost toilet construction

Tools List	Construction Use
Hammers	Nailing wood & using chisel
Handsaws	Cutting wood
Trowels & wooden floats	Working concrete
Shovels	Preparing site, mixing concrete
Spirit Level	Levelling blocks and concrete
Plumb Bob and String Line	Levelling blocks and concrete
String Line	Marking out CT dimensions
Measuring Tape	Measuring CT dimensions
Cold Chisel	Breaking concrete blocks
Fly Screen	Separating sand from coral
Chicken Wire w/ 25mm holes	Separating small coral from large
Large bucket or wheelbarrow	Mixing concrete
No. 10 & 15 block mould	Making blocks for substructure
Bolt cutters or hacksaw	Cutting rebar to size
Pliers	Cutting and fastening tie wire
Carpenter's square	Accurate measurements
Drill	Drilling holes in wood for bolts

Construction steps

- Construct footings and base slabs.
- Construct chamber walls.
- Prepare the inside of chamber.
- Cast the chamber roof (which is the toilet room floor).
- Prepare the false chamber.
- Prepare the rear door and baffle boards.
- Construct riser.
- Construct the superstructure;

Constructing footings and base slabs

- Lay out and level the base sides using pegs and string lines.
- Use the 150 x 25 rough sawn timber to build formwork for the concrete base slab. The formwork should be sized to match the size of the chamber.
- Dig a 200mm deep footing under the position of each block wall
- Square and level the formwork.
- Use 12mm mesh reinforcing steel in the floor and set vertical 10mm reinforcing bars at correct spacing for concrete block walls.
- Prepare concrete, pour and trowel the base slab and footings smooth.

Constructing Chamber walls

- Lay four (4) courses of sandcrete blocks (or five (5) for larger chamber) to form the two (2) compost chambers.
- Fill the hollow cores in the sandcrete blocks with mortar.

Preparing the inside of chamber

- Cast a 100mm high and 100mm wide concrete step along the floor against the back wall and cast a 50mm high by 150mm wide step across the front of the step
- Use mortar to plaster and seal the inside of the walls and floor.

Casting the Chamber Roof (Toilet room floor)

- Using plywood or local materials prepare formwork to cast the top floor 75mm thick.
- Use polythene to prevent concrete from sticking to the formwork.
- Make round formwork for an opening to match the toilet pedestal.
- Place 100mm/150mm PVC insert for vent at the back edge of the floor over each chamber
- Use 12mm mesh reinforcing steel in the floor and set vertical 10mm reinforcing bars at correct spacing for concrete block walls.
- Prepare concrete, pour and trowel the chamber roof smooth.

Preparing the false chamber floor

- Make a 50mm x 50mm hardwood slat floor using galvanized nails. The floor will sit inside the chamber to support solid waste and allow urine drain. An alternate to hardwood is using bamboo. This will reduce the cost but the bamboo will need a replacing each time a chamber is emptied. Make this floor in two pieces for ease of installation

Preparing the rear door and baffle boards

- Fix 100mm x 50mm hardwood or treated pine around the door opening with masonry nails to support a rear door cover and baffle boards.
- Fit 50mm x 25mm hardwood to make a guide for the super flex plank baffle boards.
- Cut marine ply to match the door opening, place against the frame and drill four holes for the rear door bolts.
- Install the bolts from the inside to the marine ply door can be fixed from the outside

Constructing the seat riser

- Use either a fiberglass or PVC seat riser or construct your own cement seat riser
- Inside the toilet house, provide a place to store biodegradable material that is added each time the toilet is used

The superstructure

- Concrete blocks, sawn timber framing, iron wall cladding or other local materials can be used for the superstructure
- Gutters can be made from PVC pipe or locally available bamboo.

Note: If adding a seat insert bolts into the floor before the cement set to attach the seat riser and wall base plate

Mixing the Concrete

- Make a concrete mixture of ratio 1:2:3 which means: 1-part cement to 2 parts sand to 3 parts gravel.
- Prepare about 240 litres wet mortar. In order to get this, put the quantities on a hard-even surface and mix them very well (first mix the sand and the gravel than add cement)
 - Tree head pans of cement (one and half bags of cement)
 - Six head pans of sand
 - Nine head pans of gravel
- Add as much clean water as necessary to get a uniform and workable mix

Note: Water should not be saline or contain organic materials. Don't add too much water, because it will be leaking out of your slab into the soil before the mortar is hardened and it will take with it a part of the expensive cement

The Urine Diversion Dry/Dehydration Toilet

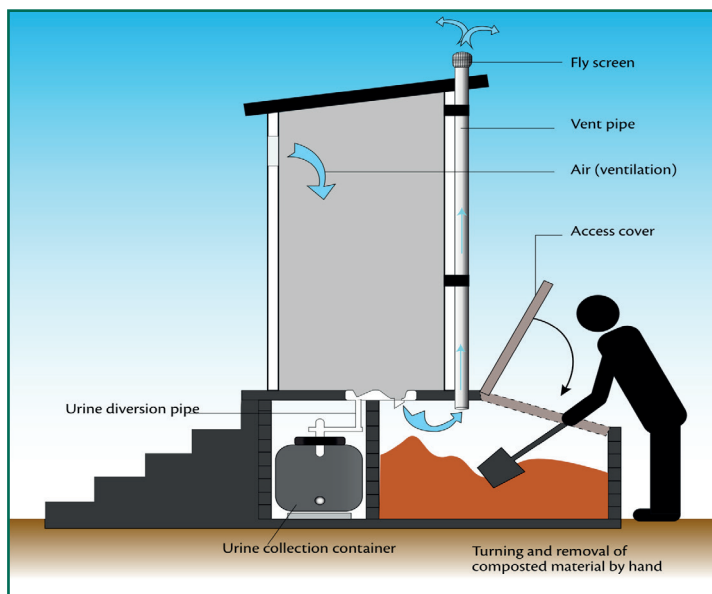


Figure 40 UDDT toilet

Site selection

- Select a suitable location where the family will be comfortable using the toilet.
- It needs about 1 metre of space at the back or sides to construct the soak pit or evapotranspiration beds for treating the urine/liquid.
- Level ground is good, but sloping ground is better as it allows the chamber to be recessed into the hill with level access to the top floor, avoiding the need for steps.
- The compost toilet can be built connected to a house, provided that the vent pipes extend 500 mm above the roof of the dwelling and toilet house.
- Remove grass and topsoil and if the ground slopes, dig a level space for the chamber construction

Tools Required

Table 3: Tools required for UDDT construction

Tools List	Construction Use
Hammers	Nailing wood & using chisel
Handsaws	Cutting wood

Tools List	Construction Use
Trowels & wooden floats	Working concrete
Shovels	Preparing site, mixing concrete
Spirit Level	Levelling blocks and concrete
Plumb Bob and String Line	Levelling blocks and concrete
String Line	Marking out dimensions
Measuring Tape	Measuring dimensions
Cold Chisel	Breaking concrete blocks
Fly Screen	Separating sand from coral
Chicken Wire w/ 25mm holes	Separating small coral from large
Large bucket or wheelbarrow	Mixing concrete
No. 10 & 15 block mould	Making blocks for substructure
Bolt cutters or hacksaw	Cutting rebar to size
Pliers	Cutting and fastening tie wire
Carpenter's square	Accurate measurements
Drill	Drilling holes in wood for bolts

Construction steps

- Construct the foundation slab
- Construct the vaults taking into consideration the position of the urine container
- Construct the superstructure
- Complete the plumbing works

The Substructure

Construction of foundation slab

- Set the profiles at the four corners of the toilet.
- Use a string set at a parallel line to an existing facility or fence (making sure you leave >1.5m between vault door and obstruction), and mark on the profiles with a nail.
- Set the other dimensions with the above profiles as the baseline.
- Check the diagonals and make sure the structure is perfectly square.

- Transfer the dimensions to the ground using a plumb bob.
- Construct a wooden shuttering box with inner design dimensions (refer to specific drawings attached) with a depth of 10cm for casting the foundation slab.
- Mark the foundation area for excavation. The marks are excavated at 15 mm deep and 25 mm wide.
- Excavate 600mm wide foundation trench within the marks until hard surface is reached. This may vary from place to place depending on the type of soils.
- Place a blinding layer of concrete mix (1:3:6) at the bottom of the excavated trench.
- Build the foundation using quarry stones/concrete blocks and a 1:3 mortar to the dimensions in the specific drawing.
- Backfill the slab formation.
- Hand compact the foundation area.
- Place the dump proof membrane (DPM).
- Place concrete mix of 1:2:4 and an 8mm reinforcement steel bar or BRC A98 mesh where necessary (e.g. black cotton soil).
- Backfill the area around the foundation with excavated soil.



Figure 41 *Preparing the UDDT foundation*



Figure 42 *Dressing the foundation*

Construction of vaults

- The foundation slab should dry and cure for at least 2 days.
- Build the vault using bricks/concrete blocks/stones/concrete panel. For other prefabricated options see the specific manufacturer's user instructions.
- Build the vault walls using a mortar of mix 1:3 (cement: sand).
- Use the specifications in the design/drawing to set the height, length and width of the vault.
- Plaster the inside of the vault with a thin coat (2-3mm) mortar of mix 1:1.

- Cast the top slab and fix the squatting pan and anal cleansing pan where necessary.

Note: The top slab should dry and cure for at least 3 days.



Figure 43 Constructing the vault



Figure 44 Preparing for decking of the vault



Figure 45 Decking of the vault



Figure 46 A fully decked UDDT vault

The Superstructure

- Select the preferred material for the superstructure (concrete panels/bricks/concrete blocks/stones/prefabricated panels).
- Select the appropriate tools to construct the superstructure.
- For in-situ options, build the walls with 1:3 mortar, reinforcing alternate layers with hoop iron.
- For prefabricated options assemble as per the manufacturer's manual.
- Build the roof as per specifications in the technical drawings.
- Fix the main doors and vault doors per the technical drawings provided. Make sure the vault doors are watertight; the door should also be level, etc.
- Fix the ventilation pipe(s), PVC/steel/concrete of minimum diameter 100mm, class B.
- The pipe should rise 50cm above the roof, avoiding bends. Cover the end with a cap to prevent rainwater from entering. Make sure that the joints of the pipe and the toilet construction are watertight, to avoid water from entering the vault.
- Fix the urine diverting channel with pipes of at least 50mm diameter. Use rigid piping or semi-rigid hoses (plasticized PE/ polypropylene PP/PVC/uPVC). Do NOT use metal pipes due to the corrosive properties of urine. Use appropriate glue to join the pipes.
- Construct the urine soak pit where necessary, or collect, store/sanitize urine for use as fertilizer in agriculture. For detailed connection to soak pits, see the provided technical drawings.
- Beautify where necessary (e.g. internal plastering, painting and external keying).
- Test and adjust all fixtures and fittings for ease of operation and use.



Figure 47 *Constructing the superstructure*

Plumbing work

- Plumbing is the final construction work undertaken in the construction of this toilet technology; i.e. this is where the urine container, vent pipe, black water pipe, etc, as well as other fitting works are carried out. The plumber must be careful to control leakage.



Figure 48 Installing the urine storage tank

Pour-flush Toilet Connected to Twin-Leach Pits

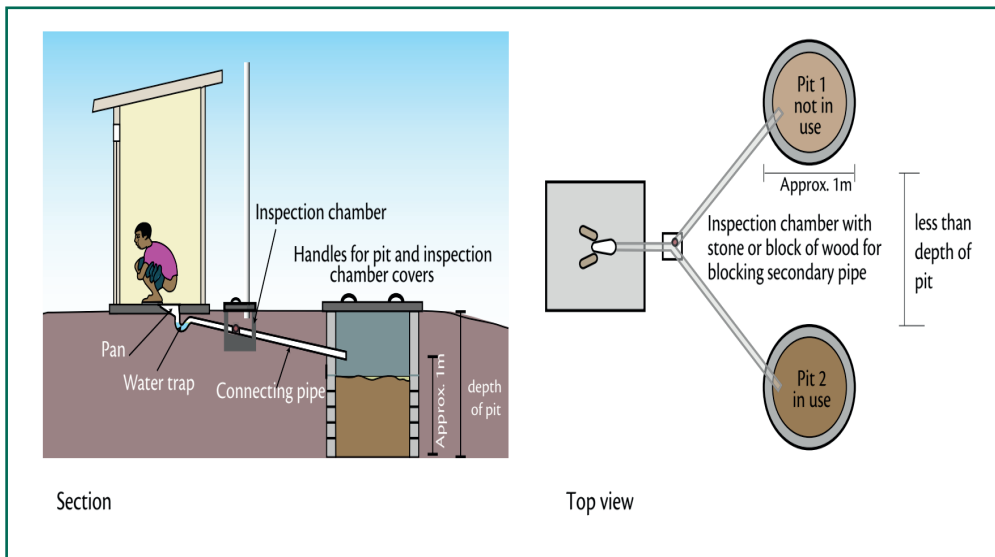


Figure 49 Pour-flush toilet

Site selection

- The location of the toilet should be close to the house and accessible to all users.
- Well drained land where the groundwater level is more than 2 metres deep (otherwise a raised pit may be needed).

- The site should be at least 30 metres away from any existing source of water such as a well or stream used for drinking or cooking.
- The location should be chosen bearing in mind wind and sunlight direction.

The Substructure

Construction of foundation slab

- In case built separately, excavate the foundation area, 15 cm deep and 25 cm.
- Place concrete mix of 1:2:4 and 8mm reinforcement steel bar or BRC A98 mesh where necessary (e.g. black cotton soil).
- Fit the necessary piping, low level pans or leave holes.

Construction of cistern and toilet pans

Note: The foundation slab should dry and cure for at least 3 days to be strong enough for the installation of either sitting or squatting pan.

- Fix the low-level squatting pan before plastering the floor, and the sitting pan after plastering.
- Use a mortar of mix 1:3 (cement: sand).
- Fix the sitting pan after plastering the floor according to the type and specification of the supplier. This has to be done by a qualified plumber. Fix the pan tightly with screws on the floor.
- Plaster the walls with a thin coat (2-3mm) mortar of mix 1:1 before fixing the cisterns/relevant pipes.

Note: Ensure that the plaster works do not hinder the plumbing/fitting works



Figure 50 Pit Excavation



Figure 51 Pit being lined with ring concrete



Figure 52 *Placing the pipe*

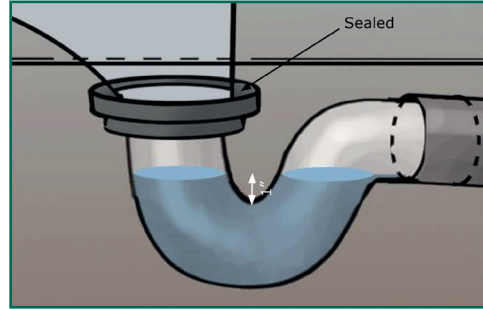


Figure 53 *Water-seal trap*

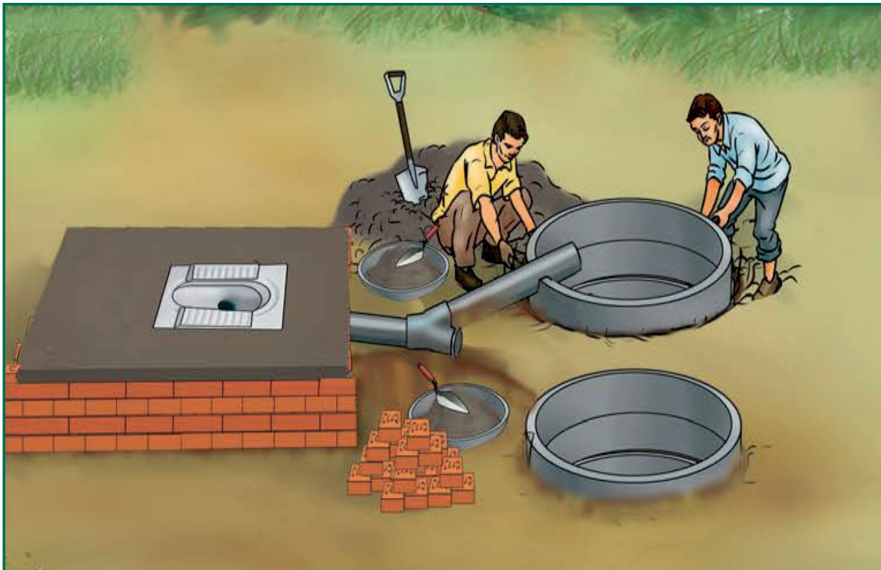


Figure 54 *Connecting the pipes to the pits*

The Superstructure

- Select the preferred material for the superstructure (concrete panels/bricks/concrete blocks/stones/prefabricated panels).
- Select the appropriate tools to construct the superstructure.
- Build the walls and beautify where necessary (e.g. keying).
- Build the roof according to the provided technical drawings.
- Fix the main doors: First, fix the door frames and then the door shutters. The door should be level and should open freely.
- Fix the ventilation pipes, PVC/steel/concrete of minimum diameter 100mm, class B

- The pipe should rise 50cm above the roof, avoiding bends. Cover the end with a cap to prevent rainwater from entering. Make sure that the connection of the pipe and the toilet construction is watertight, to avoid water from entering.
- Fix the necessary sewage pipes/fittings leading to manhole chambers.

Water Closet (WC) with Septic Tank

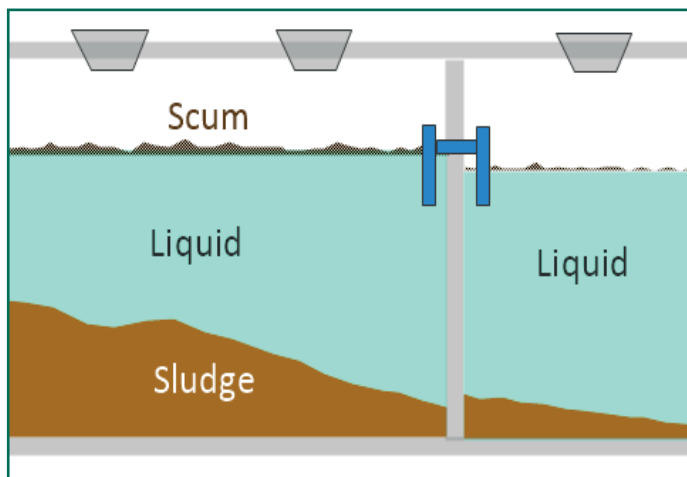


Figure 55 Schematic diagram of a septic tank

Site Selection

- Septic tanks are not suitable for all locations and soil types.
- The soil should have a good soakage ability (i.e. the soil should not be clayey). Problems often occur when trenches are too short and there is not enough room for liquid to soak away quickly enough.
- The ground should not get flooded or waterlogged.
- Level ground is good, but sloping ground is better as it allows the soak away to be recessed.
- Remove grass and topsoil, and if the ground slopes, dig a level space for the chamber construction.

The Substructure

Construction of Foundation Slab and Wall

- The foundation slab should be made from concrete that is 150 mm thick.
- The walls should be constructed from materials like concrete, bricks and mortar/ durable substances which are not subject to excessive corrosion.

- The interior of the brick tanks should be plastered with waterproof mortar.
- Use a mortar of mix 1:3 (cement: sand).
- Ensure that the plaster works do not hinder the plumbing/fitting works.
- Fix the T-pieces for inlets and outlets, and seal properly with mortar.



Figure 56 Constructing the tanks/chambers



Figure 57 Tanks/chambers lined with T-pipes connected

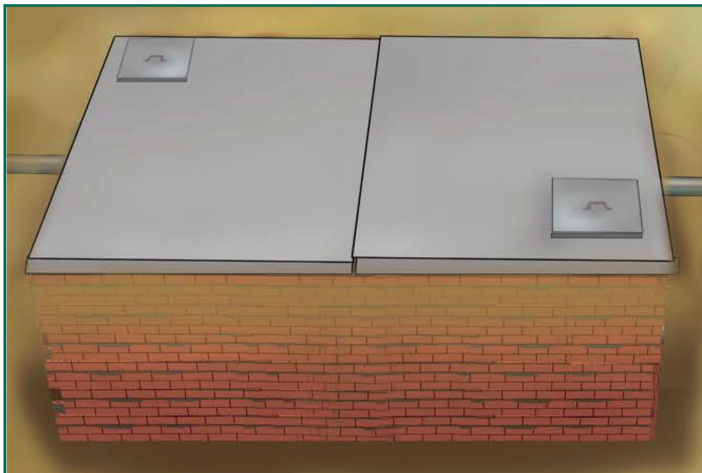


Figure 58 Tanks completely covered with slabs with access covers

Construction of the top slab

- Prepare the formwork for the top slab with the necessary steel reinforcement.
- Cast the concrete slab with the frames for the manholes.
- Use a concrete mix of 1:2:4.
- Cure for at least 3 days.
- Fix the manhole covers.

Anaerobic Baffled Reactor (ABR)

Refer to the steps for constructing septic tank

The Bio-digester Toilet

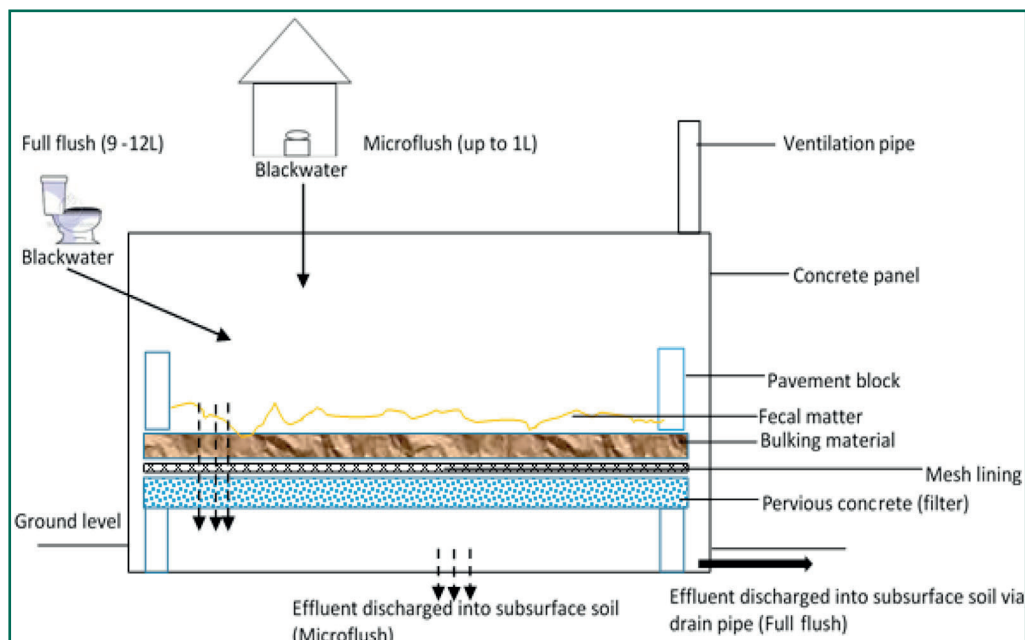


Figure 59 Schematic diagram of a typical bio-digester toilet

Construction Steps

Construction of a standard digester involves two (2) main processes:

- The construction of pre-fabricated parts such as wall slabs, cover slab and porous concrete, and
- The installation of all components.

Table 4: Tools required for bio-digester construction

Tools List	Use
Rubbing Board	Working mortar
Hand Trowel	Working concrete
Large bucket/ wheelbarrow	Mixing concrete
Headpan	Used for batching materials for concrete/ mortar

Tools List	Use
Bolt/Rod cutters or hacksaw	Cutting rebar to size
Hacksaw blade	Cutting rebar to size
Wire Scissors	Cutting wire
Shovel	Preparing site, mixing concrete
Pickaxe	Trenching
String Line	Marking out dimensions
Scissors	Cutting of net lining
Pincers	Tightening wire
Chisel	Making cuts in concrete slabs
Spirit Level	Levelling
Carpenters Saw	Cutting wood
7.5m Measuring Tape	Measuring dimensions
Level Square	Setting corners at 90o
Masonry square	Accurate measurements
Hammers	Nailing wood & using chisel

Constructing Prefabricated Parts

Table 5: Walls, cover slabs, porous filter

Item	Qty	Unit Process
1800 x 600mm wall slab	2	1800 x 600mm wood formwork is formed with the base made of $\frac{3}{4}$ plywood and the wall of 2" x 2" hard wood. 4No. 1750mm long $\frac{1}{4}$ iron rod is then laid on the wire mesh horizontally and another 4No. 580mm long $\frac{1}{4}$ iron rod is laid across them, each with 100mm intervals. 1750 x 580mm wire mesh is then laid on top of the iron rods.

Item	Qty	Unit Process
600 x 600mm wall slab	2	600 x 600mm wood formwork is formed with the base made of $\frac{3}{4}$ plywood and the wall of 2" x 2" hard wood 4No. 580mm long $\frac{1}{4}$ iron rod is then laid on the wire mesh horizontally and another 4No. 580mm long $\frac{1}{4}$ iron rod is laid across them, each with 100mm intervals 580 x 580mm wire
600 x 600mm cover slab	2	600 x 600mm wood formwork is formed with the base made of $\frac{3}{4}$ plywood and the wall of 2" x 2" hard wood 4No. 580mm long $\frac{1}{4}$ iron rod is then laid on the wire mesh horizontally and another 4No. 580mm long $\frac{1}{4}$ iron rod is laid across them, each with 100mm intervals 580 x 580mm wire mesh is then laid on top of the iron rods.
580 x 580 x 50mm porous concrete slab	2	*A 580 x 580mm wood formwork is formed with 2" x 2" hard wood *A 530 x 530mm wire mesh is then placed in the formwork.
290 x 580 x 50mm porous slab	1	A 290 x 580mm wood formwork is formed with 2" x 2" hard wood *A 240 x 530mm wire mesh is then placed in the formwork.
100 x 580 x 75mm porous beam	8	A 100 x 580mm wood formwork is formed with 2" x 2" hard wood *A 70 x 530mm wire mesh is then placed in the formwork.
100 x 580 x 75mm concrete beam	4	A 100 x 580mm wood formwork is formed with the base made of $\frac{3}{4}$ plywood and the wall of 1" x 4" hard wood



Figure 60 *Formwork for pre-cast parts*



Figure 61 *Mixing of concrete and mortar*



Figure 62 *Spreading of mortar on formwork*



Figure 63 *Finishing the pre-cast slab*



Figure 64 *Pre-cast porous concrete*

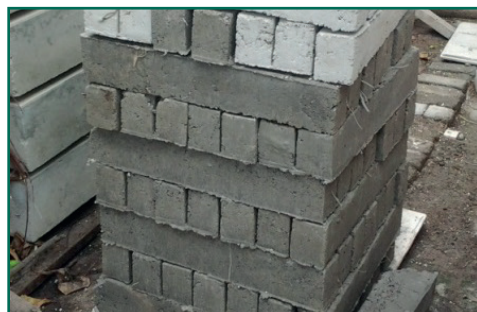


Figure 65 *Pre-cast beams*

Installation of Precast Bio-Digester

- Perforate the pipe making sure to provide openings for drainage at various points.
- Prepare the mortar for spreading in the digester base.
- Insert and position the concrete beams in the digester hole. Ensure there is a slope to allow for easy drainage.
- Connect the concrete beams with the wires at the edge of each concrete beam.
- Use cement mixture to connect the beams to form the digester box.
- Drill the concrete block adjacent to the drainage tunnel.
- Connect the one-way pipe which connects to the rest of the piping system. Cover the pipes with soil.
- Spread ballast in the piping tunnel already dug up. This prevents clogging of the pipes.
- Make the digester water-tight by covering the corners with mortar.
- Insert the concrete suspense beams. Insert the porous concrete slab.
- Suspend a net on top of the porous beam.

- Add coconut fibre on top of the net.
- Cover the top with the concrete slab. Seal completely.

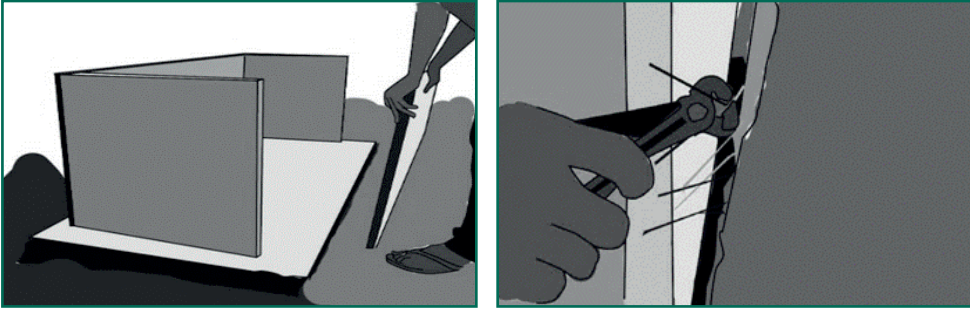


Figure 66 Pre-cast slabs connected together to form the digester box

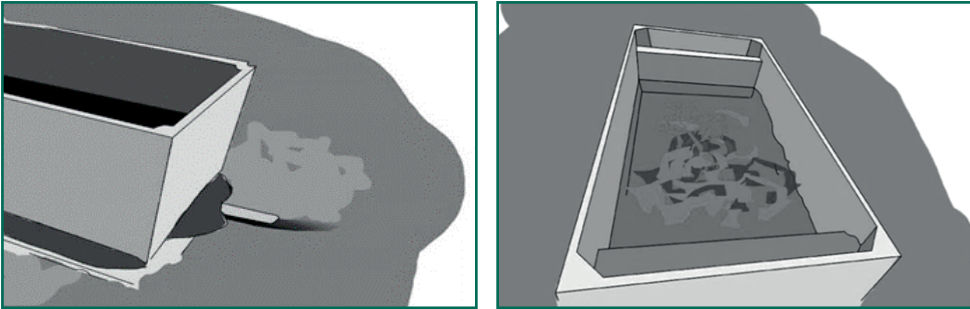


Figure 67 Digester box connected with bulking material connected with drain pipe

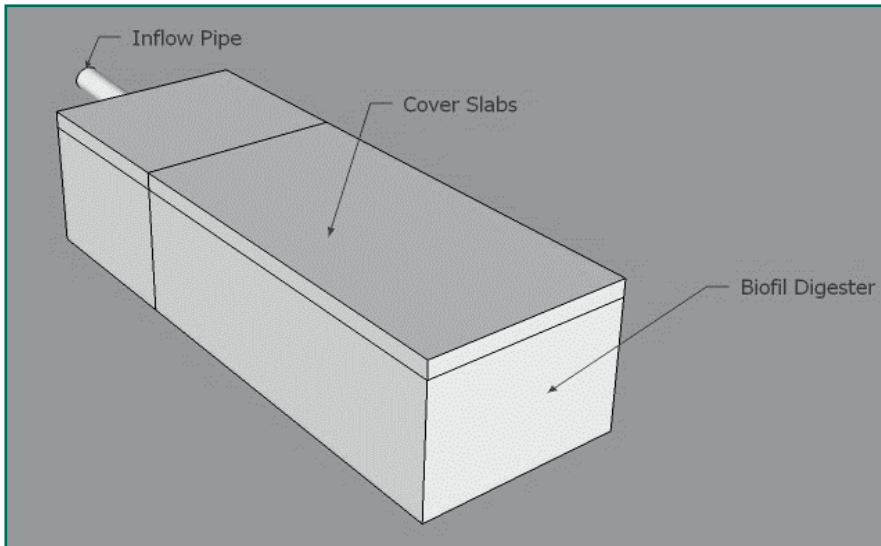


Figure 68 Complete digester covered with slab

Seeding of the Bio-Digester

At this point the system is ready for use.

- Microorganisms, mostly earthworms, are introduced into the system about 2 weeks after the first use. These organisms feed on the faecal matter and decompose it.

Biogas Digester

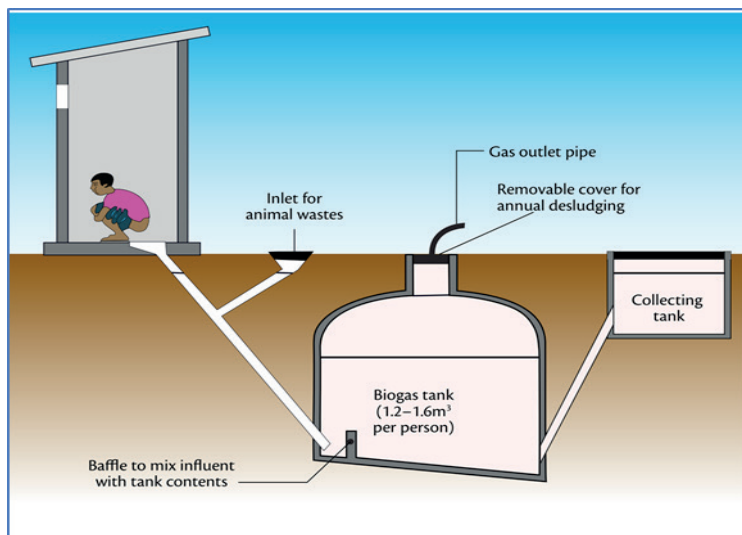


Figure 69 Biogas Digester

Site Layout

- After selection of the plant size and site location, the site layout is marked on the ground surface with wooden stakes, rocks, chalk or other materials.
- To mark the plant, a small peg is stuck in the ground at the planned centre of the digester.
- A cord with the radius of the digester is attached to the peg and a circumference is marked by rotating the end of the cord in a circular motion.
- A suitable arrangement must then be marked for the inlet tank, inlet-pipe, outlet-chamber, compost-pits and gas piping.

Excavation

- Excavation works should only be started after deciding the location of the manhole and the outlet tank.

- For safety precautions, the pit walls should be vertical and stepped away from the ground surface by one meter from the centre of the excavation for each meter in depth excavate.
- Excavated soil should be placed at least one meter away from the edge of the pit so it does not fall inside the pit during construction .
- The pit bottom must be levelled and the earth must be untouched.
- If the required design depth cannot be achieved because of a rock or high-water table, the design will need to be modified to a smaller plant, or a wider digester, or a combination of both.

Construction of the Digester Main Chamber

- The digester foundation is placed using gravels as aggregate and then filled with concrete. This foundation should be 15cm thick.
- At the centre of the pit, a straight rod or pipe must be placed in a perfectly vertical position. This vertical pipe will be used during the construction as a field-expedient guide to ensure symmetry of the biogas plant.
- At the ground level, a rigid pole, pipe or cord is placed horizontally across the diameter of the pit. The vertical pipe is secured to the horizontal pipe, pole or cord.
- After securing, the vertical pipe should be checked to ensure it is still in the plumb/vertical position.
- A string or wire is attached to the vertical pipe. Add one cm length to this length to allow space for plastering.
- After the foundation has cured for at least two days, the round wall is constructed.
- The first two rows of bricks must be positioned side by side so that 23cm wide based is made. It is essential that first row be placed on a firm, untouched and level foundation.
- Subsequent rows of bricks are positioned on their lengths so that the wall thickness is maintained at 23cm wide
- It is not necessary to build in support columns or pillars in the wall. However, the backfilling between the wall and pit-side must be compacted with great care. Backfilling should be done no sooner than 12 hours following the brick course placement to allow mortar to cure. Earth should be well compacted by adding water and gently ramming along the circumference of the digester. Poor compaction will lead to cracks in the round-wall and dome.

- The cement mortar used can be in the range of 1-part cement to 4 parts sand (1:4) up to 1-part cement-6 parts sand (1:6), depending on the quality of the sand.
- The feedstock inlet pipe (and toilet pipe, if installed) must be placed in position when the round-wall is 30-36 cm high. To reduce the risk of blockages, the inlet pipe(s) must be placed as vertically as practically possible.
- Exactly to the opposite of the main feedstock inlet pipe, a 60 cm wide opening must be left in the round-wall that serves as a manhole. The digested slurry will flow to the outlet tank through this opening.
- When the round-wall has reached the correct height, plaster the inside with a smooth layer of cement mortar mix of 1:3 (cement:sand).

Dome Construction

- The dome is constructed using a mould or cast technique.
- This can be accomplished by constructing a timber frame and then placing the earth-cast atop for proper arch design.
- Once the dome is cast, the timber frame and earth will be removed through the outlet chamber manhole.
- Construct a dome arch-guide to be used for ensuring the mould is the correct shape.
- The dome arch-guide can be constructed from an iron rod with a loop at one end attached to the vertical pole of the biogas plant, and the other end bent to seat flush to the top of the digester wall. The arch should be an 80 to 90-degree arc from the Mark "J" on the vertical pipe and interior edge of the completed digester wall. The mould is shaped rotating the guide around the central vertical pipe. The top of the round-wall must be clean when the guide is in use.
- It is important that the earth of the mould is well compacted. If the earth is further compressed after casting the dome, by its own weight and that of the concrete, it can lead to cracks in the dome. When the earth mould has the exact shape of the guide, a thin layer of fine sand is spread on the mould-top by gently patting it on the surface. The sand layer will prevent the earth from adhering to the cast. The earth used for the mould needs to be damp to prevent dry earth from soaking up water from freshly casted concrete.
- During the casting, the concrete has to be protected against strong sunlight by covering it with wetted **burlap**, jute bags or straw mats. This protection has to be left in place for at least one week.
- A day after the casting, the **turret** must be made. The turret is made with brick, 36 cm square and 50 cm tall. The turret is plastered with 1:3 concrete.

NB: Any delays during the dome construction can lead to leakage between the main gas pipe and the dome.

- Following completion of the dome, the structure must be sprinkled with water 3 to 4 times a day during the curing period (of up to one week).
- After the dome has cured for approximately one week, the timbers and earth of the mould can be removed through the manhole.
- On the clean surface of the dome interior, the following plaster coats must be applied to make the dome gas-tight from first to last coats:
 - a) Cement and water wash (1:1)
 - b) 10 mm layer of mortar mix of 1:2 (1-part cement, 2 parts sand)
 - c) 5 mm layer: 1:1
 - d) Cement/acrylic emulsion paint coating: 1.5 parts paint, 20 parts cement
 - e) Cement/acrylic emulsion paint coating: 1-part paint, 2 parts cement
- **NB:** Allow at least one day between plaster coats. When a layer of plaster is applied, the work must be executed with great care and without interruptions. The performance of the biogas plant is dependent on the gas tightness of the dome.

Outlet Chamber Construction

- The walls of the outlet chamber should be vertical and finished with a smooth layer of cement plaster mix: 1 part cement, 3 parts sand.
- Outside of the walls must be supported with sufficient compacted earth up to the overflow level to avoid cracks.
- The walls of the outlet chamber should be of a slight higher elevation than the surrounding ground to reduce chances of surface water entering the outlet during the rainy season.
- The concrete slab of the outlet chamber should be 8cm thick with proper reinforcement bars.
- The outlet cover slabs are essential to protect people and animals from falling inside and to avoid excessive evaporation of the slurry in the dry season.

Construction of Inlet Tank

- The top of the should not be more than one meter above ground level and both inside and outside

The Soakaway Pits

Minimum Standards for Soakaway

The basic design rules for soak pits are as follows:

- Soak away pits are built circular with cement blocks and must be two meters in diameter and to such depth as circumstances dictate. Reinforce slab over the top to contain a 600mm x 450mm inspection cover.
- They should be constructed in such a way not to cause any kind of pollution.
- They should be more than 3m away from any building.
- They should not be constructed where the water table is high.

Site selection for Soak away

- The soil and subsoil must be suitable and the size of the plot adequate.
- A simple percolation test should be done for the soils
- The test should be carried out within 30 minutes.

Construction Technique for circular soak away

- The top slab is made of reinforced concrete with manhole.
- The outer core should be made from 450mm rubble fill .
- The inside of the soak away should be constructed with honeycomb blocks.
- The total depth of the soak away should be 2m.
- The inlet pipe of the soak away should be connected to the 100mm outlet pipe from septic tank.

Fitting Pipes and Appurtenances

Setting and fixing the U-trap and the drain

- The toilet seat and the U-trap should be fixed in place and set in lean concrete 1:3:5 mix, and the floor around the pan carefully screeded and smoothed with 1:3 cement mortar.
- Lay the drain pipe connecting the U-trap to the pit. The gradient on the pipe should be at least 1 in 25.
- Cement the pipe through the pit walls and backfill around the pipe.

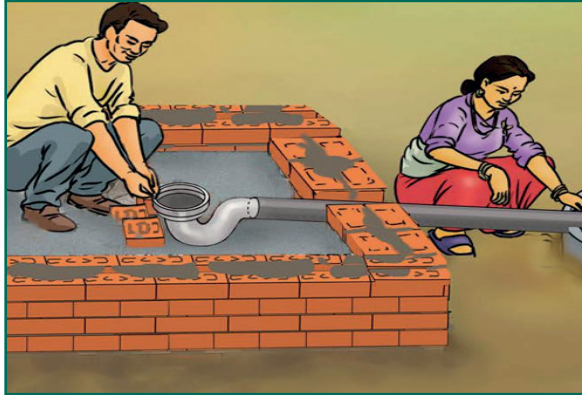


Figure 70 *Fixing the U-trap*

Setting and fixing a Vent pipe

- The vent pipe should be fixed in place vertically and made to go above the roof of the latrine superstructure.
- The lower end of the vent pipe should be fixed directly on top of the pit to allow for the gases to easily escape through the pipe.
- Set the lower end of the vent pipe in the vent slab and fit it in place with lean concrete 1:3:5 mix, and carefully smooth the floor around the pipe with 1:3 cement mortar.

Glossary

Aerobic: Describes biological processes that occur in the presence of oxygen

Anaerobic: Describes biological processes that occur in the absence of oxygen.

Bacteria: are single-celled organisms, some of which cause illness or disease

Biochemical Oxygen Demand (BOD): A measure of the amount of oxygen used by microorganisms to degrade organic matter in water over time (expressed in mg/L and normally measured over five days as BOD5). It is an indirect measure of the amount of biodegradable organic material present in water or wastewater: the more the organic content, the more oxygen is required to degrade it (high BOD).

Biodegradation: Biological transformation of organic material into more basic compounds and elements (e.g., carbon dioxide, water) by bacteria, fungi, and other microorganisms

Blackwater: a mixture of urine, faeces and flush-water along with anal cleansing water (if water is used for cleansing) and/or dry cleansing materials. Blackwater contains the pathogens of faeces and the nutrients of urine that are diluted in the flush-water bodies and, more generally, of the environment.

Chemical Oxygen Demand (COD): A measure of the amount of oxygen required for chemical oxidation of organic material in water by a strong chemical oxidant (expressed in mg/L). COD is always equal to or higher than BOD since it is the total oxygen required for complete oxidation. It is an indirect measure of the amount of organic material present in water or wastewater: the more the organic content, the more oxygen is required to chemically oxidize it (high COD).

Collection and Storage/Treatment: The ways of collecting, storing, and sometimes treating the products generated at the User Interface. The treatment provided by these technologies is often a function of storage and is usually passive (e.g., requiring no energy input).

Composting: The process by which biodegradable components are biologically decomposed by microorganisms (mainly bacteria and fungi) under controlled aerobic conditions.

Contamination/contaminant: Food, water, soil or air, etc that has come into contact with a substance that may be harmful or potentially poisonous.

Defecation/defecate: The discharge of faeces from the body.

Desludging: The process of removing the accumulated sludge from a storage or treatment facility.

Dewatering: The process of reducing the water content of a sludge or slurry.

Dewatered sludge may still have a significant moisture content, but it typically is dry enough to be conveyed as a solid disinfection can be included in the definition of secondary treatment or tertiary treatment, depending on the configuration.

Disinfection: The elimination of (pathogenic) microorganisms by inactivation (using chemical agents, radiation or heat) or by physical separation processes.

Evaporation: The phase change from liquid to gas that takes place below the boiling temperature of, and normally occurs on the surface of a liquid.

Evapotranspiration: The combined loss of water from a surface by evaporation and plant transpiration.

Excreta: Consists of Urine and Faeces that is not mixed with any Flushwater.

Excreta is small in volume, but concentrated in both nutrients and pathogens. Depending on the quality of the faeces, it has a soft or runny consistency.

Faecal Sludge: This comes from on-site sanitation technologies, i.e., it has not been transported through a sewer. It can be raw or partially digested, a slurry or semisolid, and results from the Collection and Storage/Treatment of Excreta or Blackwater, with or without Greywater.

Faeces: (A semi-solid) excrement that is not mixed with Urine or water. Depending on diet, each person produces approximately 50 L of faecal matter per year.

Flush-water: Water discharged into the User Interface to transport the content and/or clean it.

Groundwater Table: The level below the earth's surface which is saturated with water. It corresponds to the level where water is found when a hole is dug or drilled. A groundwater table is not static and can vary by season, year or usage.

Helminth: A parasitic worm, i.e. one that lives in or on its host, causing damage.

Some examples that infect humans are roundworms (e.g., Ascaris and hookworm) and tapeworms. The infective eggs of helminths can be found in excreta, wastewater and sludge. They are very resistant to inactivation and may remain viable in faeces and sludge for several years.

Hygiene: Conditions and practices that help to maintain health and prevent the spread of diseases.

Improved Sanitation: Facilities that ensure hygienic separation of human excreta from human contact.

Influent: The general name for the liquid that enters into a system or process (e.g., wastewater)

Microorganism: Any cellular or non-cellular microbiological entity capable of replication or of transferring genetic material (e.g., bacteria, viruses, protozoa, algae or fungi).

Off-site Sanitation: A sanitation system in which excreta and wastewater are collected and conveyed away from the plot where they are generated. An offsite sanitation system relies on a sewer technology.

On-site Sanitation: A sanitation system in which excreta and wastewater are collected and stored or treated on the plot where they are generated.

Operation and Maintenance (O&M): Routine or periodic tasks required to keep a process or system functioning according to performance requirements and to prevent delays, repairs

or downtime.

Pathogen: A disease-causing organism such as bacteria, virus or fungi.

pH: The measure of acidity or alkalinity of a substance. A pH value below 7 indicates acidity, and a pH value above 7 indicates alkalinity of a substance.

Primary Treatment: The first major stage in wastewater treatment that removes solids and organic matter mostly by the process of sedimentation or flotation.

Sanitation: The means of safely collecting and hygienically disposing of excreta and liquid wastes for the protection of public health and the preservation of the quality of public water.

Secondary Treatment: Follows primary treatment to achieve the removal of biodegradable organic matter and suspended solids from effluent.

Septage: A historical term to define sludge removed from septic tanks.

Septic: Describes the conditions under which putrefaction and anaerobic digestion take place.

Sludge: A mixture of solids and liquids, containing mostly excreta and water, in combination with sand, grit, metals, trash and/or various chemical compounds.

Stabilization: The degradation of organic matter with the goal of reducing readily biodegradable compounds to lessen environmental impacts (e.g., oxygen depletion, nutrient leaching)

Toilet pan/bowl: The part of the toilet that receives the human excreta (urine and faeces).

Urine: The liquid produced by the body to rid itself of urea and other waste products.

Wastewater: Used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff/ stormwater, and any sewer inflow/ infiltration.

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