

Desludging systems & products – design parameters

System type	Activity	Product or category	Safety	Affordability Product Costs	Affordability Lifecycle Costs	Ability of local manufacturing	Speed	Volume in case of tank	Limited Physical exertion	Limited Labour intensity	Limited Knowledge intensity	Accessibility & Manoeuvrability	Sludge Robustness	Limited use of resources	Sludge transportability	Total Score
Weighting factor →			3.	2.	2.	1.	2.	1.	1.	2.	2.	3.	3.	2.	3.	
MANUAL DRIVEN SYSTEMS	Emptying	Manual desludging	--	++	0	++	--	N.A.	--	-	++	++	+	++	--	3
		Gravitational emptying	0	++	+	++	+	N.A.	+	+	++	+	++	+	--	22
	Filling (bag)	Pee poo bag	+	++	0	0	N.A.	N.A.	++	++	++	++	++	+	-	29
MANUAL DRIVEN MECHANICAL SYSTEMS (semi mechanised)	Compressing	Vacuum tank & hand pump	+	0	+	+	-	-	0	-	0	0	-	+	0	0
		Pumping	MDHP / LSHTM gulper	0	+	+	+	-	N.A.	-	0	+	+	0	+	--
	Diaphragm hand pump		0	+	+	--	0	N.A.	-	0	+	+	0	+	--	
	Screwing	Pit screw auger (PSA)	0	+	+	+	-	N.A.	-	0	+	+	+	+	--	6
	Scooping	Continuous chain device (nibbler)	0	+	+	+	-	N.A.	-	0	+	+	+	+	--	6
Gobbler		0	-	+	+	-	N.A.	0	0	+	+	++	+	--	7	
MECHANICAL SYSTEMS	Compressing	Vacuum truck	++	--	--	--	++	++	++	++	0	--	0	--	++	4
		Micravac	++	-	-	--	+	+	++	++	0	-	0	--	++	9
		Dung beetle	++	-	-	--	++	+	++	++	0	-	0	--	++	10
		Vacutug	+	-	-	--	+	+	+	+	0	-	0	-	0	-2
		eVAC	+	-	-	--	+	+	+	+	0	-	0	-	0	-2
	Pumping	Submersible pump	0	+	+	--	0	N.A.	+	+	+	+	-	0	-	4
		Diaphragm pump	0	+	+	--	0	N.A.	+	-	+	+	-	0	-	0
	Screwing	Power-operated pit screw	0	0	0	--	0	N.A.	+	+	+	+	+	0	-	6

Table explanation

Values:

-- very low - low 0 medium + high ++ very high

Weighting factors:

3. High priority 2. Medium priority 1. Low priority

Design parameters:

- Safety: how safe is the operation, regarding exposure to sludge?
- Affordability Product Costs: are initial costs of the product affordable for executive parties?
- Affordability Lifecycle Costs: are costs due to operation and maintenance affordable for executive parties?
- Ability of local manufacturing: what is the ability to locally manufacture the product?
- Speed: what is the speed of desludging?
- Volume in case of tank: what is the volume capacity, in case of a connected volume for sludge containment?
- Limited physical exertion: does applying the product require a limited amount of physical exertion?

- Limited Labour intensity: does applying the product require a limited amount of labour/operators?
- Limited Knowledge intensity: does the product require a limited amount of specific knowledge or certification?
- Accessibility & Manoeuvrability: the product is accessible for, and manoeuvrable in different types of surroundings?
- Sludge robustness: what is the ability of the product to process different types of sludge (liquid, solid or semi-solid)?
- Limited use of resources: does the product require a limited amount of resources (materials, fuel or electricity)?
- Sludge transportability: what is the ability for long distance transportation of sludge (to disposal)?

Goal

- Identify weaknesses for improvement of the product
- Identify possibilities for product combinations

Overview: description, advantages & disadvantages

Manual Driven Systems: emptying

The action of emptying refers to the emptying of a pit by a person standing in the pit using a bucket or by the use of gravity.

Manual desludging



In many urban areas of the world manual emptying methods dominate the sector. Manual emptying occurs most frequently where large vacuum tankers are not available, too expensive, or unable to access sanitation facilities. It is also generally the cheapest way of removing enough waste to keep a pit operational, although it is usually the most expensive per unit volume

There are numerous types of manual emptying. Often it entails two workers use rope and bucket (figure 2), if the waste becomes too solidified at the bottom of the pit a worker will have to climb in to remove the waste by hand. Sometimes pits will be emptied using gravitational emptying, whereby a hole is made in the side of the pit and excreta flow out under gravity (either into a nearby stream or an adjacent hole).

Often manual emptying is dangerous for the workers involved and causes environmental pollution because there is no control or safe place created (such as a transfer station) for workers to dispose of waste. In some areas (such as Nairobi, Kenya) workers suffer from a significant stigma that forces them to operate at night. This not only increases the likelihood of worker injury, but also increases spillage. The stigma originates from a community dislike of the odour and spillage resulting from the work.

Workers health could be affected by direct contact with faeces containing dangerous pathogens and gas build up in latrines.

If there is no other realistic option than to empty manually it is important to remember that fresh excreta will contain pathogens that could cause worms or diarrhoea. Furthermore, flies attracted to this may spread such diseases to local communities. It is important that no one should enter the pit without a safety rope and colleagues on the surface with the ability to pull the worker out. The risk of fumes and pit collapse are the two primary drivers for this. Workers should be provided with safety clothes and nearby washing facilities.

Advantages

- Services accessible to community
- Relatively cheap to keep latrine operational (especially if slab is connected loose to the pit)
- Low equipment capital cost

Disadvantages

- High unit cost of desludging
- Significant health risks to workers
- Rarely acceptable to municipalities and so not regulated
- Associated with indiscriminate dumping
- Lack of appropriate equipment means spillage regularly occurs
- Will often require the slab of the latrine to be demolished to facilitate access, subsequently increasing householder cost

Gravitational emptying

Gravitational emptying is generally only possible when the pit is next to a river or a drain as the contents flow directly into the water.

Advantages

- Making use of freely available gravitational force

Disadvantages

- Associated with direct dumping in surface waters

Interpretations

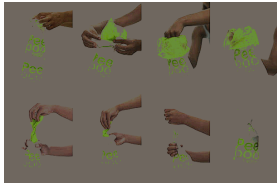
Manual emptying using buckets can be discarded because of health issues, ineffectiveness, and the relationship with direct dumping. Discussing manual gravitational emptying, this technique is more effective and safer than bucket emptying, however the gravitational emptying can only be applied on raised latrines and with the combination of a connected tank. Currently most latrines with gravitational emptying are in the proximity to surface waters to dispose the content.

Manual Driven Systems: filling

The activity of filling refers to the filling of a bag with excreta by the toilet user. Although this activity differs very much from the conventional desludging (applying pump and vacuum tanks) it is still useful to include this system, because of its positive features.

Pee poo bag

Peepoo bag system is a biodegradable toilet bag system for use in places where there are no toilets available. A single-use, self-sanitizing, biodegradable system that turns into fertilizer after use.



Advantages

- good for temporary / emergency situations
- initial target group is used to conventional "Flying Toilets 1.0"
- may be used at home & at nights
- is mobile
- alternative to dirty (public) latrines
- allows for a sanitization within a relatively short time and prevents (stronger) odours

- relatively low costs
- does not require water (= there are no sustainable water options available + this is a dry toilet system)
- no permanent infrastructure like septic tanks or even sewerage required = no maintenance costs
- use as fertilizer in urban farming projects (like this one in Kibera, Nairobi, Kenya)

Disadvantages

- no permanent solution
- not 100% sustainable
- not free (costs vs. convenience, but also future value from fertilizer which could be set off against the price of these bags?)
- bags may be too thin and too small for some users
- higher risk of users getting in touch with their faeces (=> hygiene standards)
- difficulties in using the bag when defecation is accompanied by urination (for women)
- ammonia gas may leak from torn bags & will become an immediate public health problem // odour problems when many filled Peepoo bags are stored together during collection and transport
- the bags should be more durable, stay intact and gas tight long enough for the ammonia to have time to kill off all the possible pathogens (thx, Håkan!)
- the composting part could still be improved, e.g. store them in tight containers for maximum ammonia retention & then plow them down into the soil before the cropping season (thx, Håkan!)

- may degrade too slowly (bioplastic bags used in many modern households today for compost are often removed on compost plants because their plastic requires a temperature of about 60°C or higher which may not always be achieved within the given time frame)
- bag system is patented => how do you prevent fake (= non biodegradable) bags from being sold on the market?
- requires a shielded space / privacy => question of dignity (where do you defecate? and where have the Flying Toilets 1.0 users previously defecated?)
- requires a handling & reuse concept, preferably in the vicinity, but this actually applies to almost all waste stream
- risk of losing political responsibility for a better sanitation concept
- needs strong education component not all people involved might want to use the bag

Interpretations

- The overall score of pee poo bag is really high, desludging actually takes place per individual who eventually takes care of disposal. The method could be improved in combination with a permanent volume and logistical system (transport to disposal).

Manual driven mechanical systems: compressing

The activity of compressing refers to the compression of air so a vacuum is created in a connected tank. The vacuum sucks out the sludge from the pit. In this paragraph the manual driven mechanical systems are discussed.

Vacuum tank & hand pump



This MAPET system comprises a hand-pump connected to a vacuum tank mounted on a pushcart. A hose connected to the tank is used to suck sludge from a pit or a septic tank. When the hand pump is turned, air is sucked out of the vacuum tank and sludge is sucked up into the tank. Depending on sludge consistency, this product can pump the sludge from a maximal depth of 3 m.

On-site disposal in a dug hole on the customers' compound, by tipping the tank. A team of emptiers consists of three men. The emptying job starts with contacting the customer, negotiating over the price, picking up the equipment from its parking place and taking it to the customer's house. This preparation entails mixing the sludge with water (to make it more fluid) and (possibly) paraffin (to reduce the smell). After the hose-pipes have been connected the sludge pumping can start. Depending on the sludge's viscosity and the pumping head, it can take five to twenty minutes to fill up one 200 litre tank with sludge. When a tank is full, the hose-pipes are disconnected and the tank is manoeuvred next to the dug hole, and topped over in discharge position. A pressure relieve valve is opened and the sludge flows to where it is supposed to be discharged. After putting the tank back in its original position, pumping can start anew and the vacuum tank is filled again. This routine is repeated until the required amount of sludge has been taken out. The equipment is then cleaned and returned to its parking place. Care should be taken to find a solution where the sludge can be disposed of safely and sustainably.

Advantages

- Low operation costs.
- Can be constructed, operated and maintained using local materials and skills.
- Capital cost are affordable by entrepreneurs who can develop micro-enterprises
- Does not require any fuel or electricity

Disadvantages

- Labour intensive: method requires 3 men for operation
- Low speed (10-40L per minute) when compared with for example Vacatug
- Solids are often not removed from pits or tanks
- Volume of the vacuum tank (200 ltr.) is relatively small compared to other vacuum tanks used for desludging
- The technology is not suitable if the haul distance exceeds 0.5 km.
- Minimising operation costs may lead to uncontrolled disposal of sludge or urine.

Interpretations

- The vacuum tank with hand pump could be improved by increase of speed and volume, increase its ability to handle different kind of slush and decreasing labour intensity. Overall the technology is not so attractive for larger pits (because its speed, volume and transportability)

Manual driven mechanical systems: pumping

The activity of pumping refers to the transport of sludge from a pit by to an exit point. In this chapter the manual driven mechanical systems are discussed.

MDHP / LSHTM gulper



A relatively new technology type in the Manual Pit Emptying Technology (MAPET) category, is the London School of Hygiene and Tropical Medicine (LSHTM) Sludge Gulper. This is a hand pump that can be lowered into a pit or tank and used to lift the contents out into a bucket. The system is currently still being trialled on varying types of sludge. Whether it performs successfully in all locations is yet to be seen.

There are two critical features of the sludge gulper which make it advantageous. Firstly it has been constructed entirely from local materials that can be found in most countries. Secondly the cost of the system is very low, costing only US\$40 to build in Indonesia.

The two biggest potential problems are the non-odourless nature of the technology and the requirement for the further containerisation of the sludge. For public toilets fitted with septic tanks, the Gulper system is suitable for semi-liquid sludge. The system avoids the need for one person to go into the pit and allows for pumping out the sludge at a flow of 30 L per minute (Pollution Research Group, Durban). While the system is effective, its activation requires a lot of strength.

Basic operation: The device is based on a simple direct action type hand pump. The pump is operated by either one or two pit emptying operators. The handle is raised and lowered which lifts the contents of the pit up through the riser pipe. This is then discharged through the angle 'T' outlet pipe at the top of the Gulper. This is directed into a container positioned directly below the outlet of the pump.

Advantages

- Very simple
- Possible to produce locally in many areas
- Facilitates access into even very densely populated areas (can work in confined spaces)
- Low operation and maintenance costs
- Low cost when compared to other technologies, so suitable for small scale independent providers (SSIPs)
- pumps semi-solid sludge

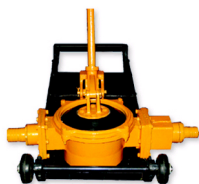
Disadvantages

- Requirement for further containerisation and safe disposal of waste
- Could still produce unpleasant odours
- May be difficult to operate on thick sludge (or rubbish thrown in the latrine) or low volume installation
- Not getting down to the lowest part of the pit (improvement: adding short sections)
- Foot rest is short and not very stable
- Pump does not generate enough pressure to push sludge upwards, so a bucket or drum needs to be placed at the latrine under the outflow side of the pump.
- Accessing some latrines might be more difficult compared to the diaphragm pump because of its larger size.
- Hard work and very slow; highly labour intensive

Interpretations

Like most other manual driven mechanical systems, the gulper is not a fully safe method, while there can be still contact with sludge when pumping it into a storage medium. However most of the manual driven mechanical systems, like the gulper, are affordable. Safety could be increased by creating a closed transport route from pit to storage medium. Also the desludging speed is low and the physical exertion is high. The combination with transport for disposal is required.

Diaphragm hand pump



The diaphragm pump is manually operated for emptying the wet pit latrines. The sludge is pumped into a bucket or small drums. The pump cannot be produced locally. Like the gulper a grid or mesh is placed at the intake of the pump to prevent large items to enter the pump. The pump can only empty wet latrines (sludge that is liquid). The cost for pump and hoses is estimated to be around 300 USD.

Basic operation: The device is a hand pump. The pump is operated by either one or two pit emptying operators. The handle is moved backwards and forwards. The pump can be operated outside the latrine and can pump the sludge over a small distance (maximum 6 meters). For example, the pump can pump sludge into a drum placed on a hand cart outside the compound

Flow rates: Flow rate is up to 130 litres a minute. So a pit of 1m diameter and 1.5m deep can be emptied in just over 10 minutes.

Advantages

- Low capital costs (about \$150 each pump fob India, total \$300)
- Simple equipment: easy to repair
- Low operation costs in terms of fuel and maintenance

Disadvantages

- Maintenance costs might be high due to imported technology (replacement diaphragms not easy to find)
- Pump cannot be produced locally.
- The pump is expected to work less well with more solid sludge compared to the gulper.
- Available only in India – problem of spares support and ordering extra equipment
- Low capacity and low efficiency (slow pumping rate over short distances) May not effectively pump out sludge unless a lot of water is added which then has to be transported away from the site, adding to the operation costs
- Need for 2 or 3 operators (one for each pump plus stirring) – this adds to costs, but makes the operation difficult as toilets are very small and there is usually room for only one person.

Manual driven mechanical systems: screwing

The activity of screwing refers to the rotating of a cylindrical rod incised with one or more helical or advancing spiral threads, to transport sludge.

In this paragraph the manual driven mechanical driven systems are discussed.

Manual pit screw auger



The Pit screw auger is designed for solid sludge, such as the sludge found in open pits. It uses an auger and its flow ranges from 7 L to 20 L per minute.

The Pit Screw Auger is essentially a modified fence post drill.

Advantages

- simple to use.
- Might deal with solid waste and rubbish in the pit better than some other technologies

Disadvantages

- it needs quite precise positioning
- Not getting down to the lowest part of the pit (improvement: adding short sections)

- is heavy and not easy to transport by hand
- PSA is hard to clean.
- Very slow speed, compared to other manual driven mechanical systems
- Hardly used in the field and little real field experience exists
- Pump does not generate enough pressure to push sludge upwards, so a bucket or drum needs to be placed at the latrine under the outflow side of the pump.

Interpretations

Like most other manual driven mechanical systems, the manual pit screw auger is not a fully safe method, while there can be still contact with sludge when pumping it into a storage medium. However most of the manual driven mechanical systems, like the pit screw auger, are affordable in product and lifecycle costs. Safety could be increased by creating a closed transport route from pit to storage medium. Also the desludging speed is low and the combination with transport for disposal is required.

Manual driven mechanical systems: scooping

The activity of scooping refers to the use of a device with utensils (scoops) for the dispensing and transportation of sludge. In this paragraph the manual driven mechanical driven systems are discussed.

Continuous chain device (nibbler)

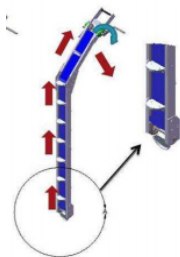


A non vacuum-based technology is the continuous chain device, called nibbler, recently developed by professor Sugden of LSHTM. It is manufactured out of local components and based on scooping action rather than vacuum action. The device uses a chain and “scoops” to draw waste up and out of the pit. A prototype design which uses steel disks welded onto a bicycle chain is shown below. Testing to date has only been completed on farm slurry but first results seem positive. Sugden was, however, of the view that the fairly dry pit sludge encountered in South Africa would be difficult to move using the Gulper or the Nibbler, particularly given the high domestic refuse content.

Questions
No field experience exist
What are advantages and disadvantages?

Is it only used for solid sludge?

Gobbler



The design of the Nibbler was based on the kind of parts and technology that are cheap and easy to source in Tanzania. However, in South Africa there is a well-developed market for a wide range of agricultural machinery, so it was decided to try to develop an extra robust ‘Nibbler’ which was given the name ‘Gobbler’. As a starting point for the design off the shelf chains and links were researched with a focus on a link that could be easily connected to a scoop or claw. It was found that agricultural machines often use chains with links and brackets integrated into the chains and they were found to be locally available at low cost. The basic concept which is similar in principle to the Nibbler would produce a system that would draw the waste up out of a latrine pit discharging into a container.

Construction of the prototype started in March 2009. The approach was to produce a rig that could be used to test different scoop designs, and be as strong, robust and reliable as possible. This has resulted in a slight over engineering of the Gobbler and use of machining processes that would not be necessary in a final optimized production design.

Advantages

The prototype construction is progressing well and if it proves successful, which will only be seen after the testing of the prototype, there will be an opportunity for further design work and production of a more optimized solution.

Disadvantages

The gobbler is still in test phase; Initial suggestions for optimization on the design are:

- Cost reduction through selection of lower cost materials, plastics replaced with plywood or bent metal sections, elimination of expensive fixtures and fittings, and cheaper chain and brackets
 - Part count reduction to aid cost reduction, complexity of manufacture and failure modes
- Weight reduction through the use of thinner sheet steels and a lighter weight chain.

Interpretations

The scooping devices are very similar to other manual driven mechanical systems; they are slow in speed and have no direct combination with sludge transportation for disposal. To obtain a complete view of this technology, evaluation data is required. It is expected that the gobbler has a higher speed compared to nibbler and little physical exertion.

Mechanical systems: compressing

The activity of compressing refers to the compression of air so a vacuum is created in a connected tank. The vacuum sucks out the sludge from the pit. In this paragraph the mechanical driven systems are discussed.

Vacuum truck



The conventional method for pit emptying is the vacuum tanker. This is a truck-mounted tank between 1 to 10 m³ in with a vacuum pump connected to the tank to suck out the sludge commonly used in industrialised countries. However, there are technical limitations to the use of the vacuum tanker in areas with inadequate road access, shortage of spare parts and fuel.

Advantages

- pit will be empty after only one or two tanker visits
- The vacuum is strong enough to lift sludge from a depth of 2 to 3 metres
- Relatively fast travelling speeds has better possibility of economical disposal of waste
- It is a low odour technology
- Removes waste safely for both workers and public health
- Fastest means with which excreta can be exhausted

Disadvantages

- Large vehicles cannot negotiate narrow, twisting roads and alleys.
- Vehicles with powerful pumps are very expensive, and it is often very difficult to get spares
- Despite being 'high technology' it does not overcome the lack of a disposal site
- Maintenance costs are also high due to imported technology
- Haulage distances are likely to be key in overall expenditure
- Access problems in many areas
- Costs too much for many SSIPs

Micravac



The Micravac is a micro vacuum tanker developed for use on uneven roads and areas with poor access.

Advantages

Disadvantages

Dung beetle



The Dung Beetle is a machine developed by a Dutch company J.Hvidtved Larsen and deployed in Ghana. This machine uses a two wheel tractor based drive, with the driver sitting on the tank and steering using the long handles on the machine. These machines have been successfully used for many years in Ghana. Useful specifications of the machine are:

Max. speed: 12 km per hour.

Turning radius: 3.05 metres within kerbs, 3.3 metres within walls

Total weight empty: ~675 kg, fully loaded including driver ~1550 kg.

Vacuum pump capacity 4300 litres per minute.

Sludge tank: Net operating volume approx. 800 litres

Advantages

Disadvantages

- Access to latrines occasionally poses a problem to both dung beetles and large vacuum tankers, although this is generally overcome by using longer hoses, or making holes in the perimeter walls of households

Vacutug



Vacutug is a gasoline-powered four-foot-tall vacuum-pump conveyance that sucks human effluent out of holes in the ground with 1,700 litres a minute. The content of the tank is 500 litres. Considerably smaller and slower than a vacuum tanker, it is designed with densely populated areas in mind. It can travel at 5 km/hour, 'driven' by a man walking behind: this means that it should be able to access areas that a vacuum tanker can't, but has the drawback that it takes a long time to get between the pit and an appropriate emptying place.

The opinion of the project managers involved with eVac differs much from the people who operate the machine:

Opinion of Project Managers

Spare parts are easily available and machine is locally manufacturable

Only two operators are required to operate the machine

The Vacutug is highly maneuverable and optimized for movement on settlement roads.

Opinion of Vacutug users

Spare parts are NOT locally available the machine has stood out of action for almost a year

4 operators and not 2 are required to operate a Vacutug

Handling is poor and machine often falls over.

Advantages

- Accessibility: In densely populated urban areas where there is a disposal site/point nearby the small exhausters such as the Vacutug are a viable options.
- Income: Operators should aim for 8 loads a day to cover costs.
- It is a low odour technology
- Removes waste safely for both workers and public health
- Faster to empty than either manual or manually driven mechanical systems

- Can process small amounts of rubbish
- Can be air transported??

Disadvantages

- Limited road transportation
- Slow max speed means localized emptying point such as sewer or tank are needed
- Costs too much for many small scale independent providers (SSIPs)
- Is having some access problems in Kibera, Nairobi, despite its small size
- Maintenance cost are potentially high

eVAC



eVAC is a light vacuum reservoir system that is power-operated and designed for pits with liquid sludge. The eVac is a portable system to be used when vacuum tankers can't be, either because of access or cost. The concept is simple: because pit latrine sludge is varied and often contains large objects it would be difficult to create a reliable pump that could have the sludge travelling through it. Therefore a small vacuum pump is used to generate a vacuum in one of several small containers, and this vacuum causes the sludge to be pulled up from the pit and gather in the container. Once the container is full the lid (which has the hoses attached) is moved to the next container whilst the previous container is emptied.

Using small containers means that a 'plug and gulp' system can be used: if the waste cannot be pulled up in a continuous stream the hose can be lifted in and out of the waste, which makes it easier for the waste to flow.

Advantages

- the technology requires small containers which can be applied on locations where vacuum tankers are unsuitable

Disadvantages

- using a plug and gulp system, waste cannot flow in a continuous stream
- speed: it takes a long time to suck up sludge
- It gets blocked quite easily

Interpretations

Compressing is the most appealing technology when it comes to safety, speed, tank volume, limited labour intensity. However in most cases there is no ability to locally manufacture the product and because their size they are not easy manoeuvrable. In addition, the products are very costly and have difficulties with the processing of solid sludge. Spare parts of the products are in most cases not easy to obtain either.

Mechanical systems: pumping

The activity of pumping refers to the transport of sludge by increasing its speed. In this paragraph mechanical systems are discussed using a power driven ventilator.

Submersible pump



It is generally accepted that vacuum pumps (whereby a vacuum is created in a tank which results in the waste being sucked into it) are the most appropriate systems for emptying pits. An alternative is a pump that is submersed within the pit and allows fluid to pass through it before pumping it upwards. The problem with such pumps is the ease with which solids can damage them. Despite this, in some areas the pumps have proven reasonably successful, however they should not be used where solid anal cleansing materials are used. Furthermore, the process requires containerisation and separate transportation.

Advantages

- Submersible pumps are efficient, high in capacity,
- requires very little maintenance
- generally very economical for wells that are 80 feet or more in depth.

Disadvantages

- The tolerances between the impellers and diffusers are relatively small; therefore, submersible pumps are unsuitable for solid sludge (improvement: http://www.goodwinindia.in/submersible_slurry_pumps_industry.php)
- You might need to break the latrine slab to enter a pump like this

Diaphragm pump



Advantages

- have good suction lift characteristics, some are low pressure pumps with low flow rates; others are capable of higher flows rates, dependent on the effective working diameter of the diaphragm and its stroke length. They can handle sludges and slurries with a relatively high amount of grit and solid content.
 - suitable for discharge pressure up to 1,200 bar
 - have good dry running characteristics.
 - are low-shear pumps.
 - can be used to make artificial hearts.
- are used to make air pumps for the filters on small fish tanks.
 - can be up to 97% efficient.
 - have good self priming capabilities.
 - can handle highly viscous liquids.
 - are available for industrial, chemical and hygienic applications
 - cause a pulsating flow that may cause water hammer

Interpretations

Electronically pumping combines full mechanicalization with the advantages of good accessibility and manoeuvrability while using less fuel (resources) than other mechanical (compressing) systems. In addition the production and lifecycle cost are lower. Still it is an imported technology that in most cases can not be manufactured locally. Another very important aspect is the ability to process different types of sludge, of which not every pump is capable of; an improvement should be introduced to process thicker sludge.

Mechanical systems: screwing

The activity of screwing refers to the rotating of a cylindrical rod incised with one or more helical or advancing spiral threads, so the sludge is transported. In this paragraph the mechanical driven systems are discussed.

Power-operated pit screw



Advantages

Disadvantages

Interpretations

Evaluation data is required!

Overall conclusion

To be discussed