BIO-LATRINES

PRACTICAL ACTION
Technology challenging poverty

This brief looks at the option of using bio-latrines, an on-site dry toilet technology which generates fertilising materials and fuel from the human excreta.

What is a bio-latrine?

A Bio-latrine is low maintenance system comprising a combination of a toilet and a bio-digester unit.

It can be constructed using local materials and requires no machinery or fuel input other than human waste.

In developing countries bio-latrines can vary dramatically in size, from household level to a system which serves a small community.

The biogas generated can be used for cooking, lighting, refrigeration, heating and electricity production purposes or even as a substitute to petrol and diesel in engines.

Figure 1: Household Bio-latrine showing toilet attached to a bio-digester
Photo credit: Practical Action.

Figure 2: Large-scale bio-latrine system showing the Biogas and toilet structures.
Photo credit: Practical Action Kenya.

How does the system work?

Many different types of the bio-latrines components exist but all are built to minimise the risk of gas leakage. This is most likely to occur on corners and joints; therefore a cylindrical or half-sphere shape tends to be favoured. The three most common designs of plant are fixed dome, floating drum and flexible bag digesters which are often further adapted to suit local situations and requirements. See the Technical Brief *Biogas* for an introduction to biogas technologies.

Regardless of the bio-latrine unit design, the human waste from the toilet or toilet block is fed via a pipe into the bio-digester chamber of the biogas unit which should be at least 0.3 m below the floor of the toilet to prevent flooding.

Figure 3: Woman cooking with biogas
Photo credit: Practical Action Bangladesh.

Once the waste material has entered the bio-digester chamber a number of biological processes take place, resulting in the formation of fatty acids such as acetic acid, which will be broken down further via anaerobic fermentation. This encourages the waste to decompose into a mixture of slurry and biogas, primarily comprised of methane. The fermentation process requires the presence of a dark and air-free environment with temperatures of 30 - 40°C or 45 - 60°C so is therefore most easily achieved in tropical or sub-tropical countries.

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technical brief

Biogas collects in the upper part of the bio-digester chamber and passes through an outlet pipe at the top of the dome either to a storage facility or through pipes directly to the stoves and other appliances where it is required, whilst the slurry can be accessed by an outlet either directly or via one or more chambers.

Figure 4: Young boy doing his homework using light from a biogas lamp.
Photo credit: Practical Action Sri Lanka.

Important factors
For the bio-latrine system to work, a tested and proven design must be built by professionally trained and skilled individuals who must also ensure that the construction details are followed carefully. For example, the bio-digester chamber of a fixed dome digester is often lined with bricks and must contain high pressures of gas, so if the chamber is not constructed properly the gas will escape and the whole system will not work properly.

Particular care should also be taken to prevent non-biological materials other than human waste and toilet paper entering the system, otherwise blockages can occur.

Siting
Bio-latrines should be located in areas of firm but sloping ground to allow the slurry generated to flow through the biogas plant by gravity. Furthermore, pipe work on the chosen site should not interfere with the movement of people or school children.

Why choose bio-latrines?

Figure 5: Construction of the Bio-digester chamber (in a fixed dome biogas unit). Photo: Practical

- They require no water in contrast to sewerage systems and flush toilets, which often rely upon large quantities of water for their operation. Bio-latrines can therefore be suitable for use in places where water is expensive and/or scarce (i.e. urban slums and informal settlements).
- They are a good alternative to traditional pit latrines in flood prone areas or where a high water table makes the construction of pit latrines difficult or impractical
- Many of the biogas designs require little maintenance as there are no moving parts, therefore they are simple to operate and maintain.
- Unlike traditional pit latrines and VIP toilets, bio-latrines do not fill up and have to be abandoned so are sustainable and suitable for areas where space is limited
- As the methane gas produced can be used as an alternative cooking fuel to wood, their use can help to reduce the rate of deforestation. This would also reduce women's workload as they are largely responsible for collecting firewood
- The slurry/biodegraded waste has a high nutrient content, making it an ideal organic fertiliser
- The fertiliser and biogas generated can provide an extra source of income
- This is a form of decentralised energy production that compliments unreliable 'grid' energy in urban areas and may be the only form of energy in rural areas.
- Although the retention time for human excreta is 100 days, the fixed dome digester can be built to include an additional safety factor of an average of 120 days. This ensures that the waste is well treated and harmless by the time it leaves the system.

Limitations or problems

- They are more expensive than pit latrines and ventilation improved pit latrines.
- If available land is scarce, increased costs are likely, particularly in urban areas.
- Often bio-latrines units fall into disrepair due to lack of maintenance.
- Sufficient and constant volumes of human waste must be available to ensure a reliable production of the fertilising product (slurry) and biogas. The Bio-latrines should therefore be built taking into account factors such as population size and density.
- The presence of antibiotics and disinfectants will inhibit the bacteria responsible for the anaerobic digestion and production of biogas
- In cooler climates it may be necessary to heat or insulate the bio-digester chamber in order to achieve the optimum temperatures for fermentation and biogas production.
- The units must be well constructed to contain the highly pressurised gas and prevent leakage into the surrounding environment.
- A market for the fertiliser must exist.
- Initial high capital costs may require a large amount of subsidisation which is not sustainable, particularly in low income areas.
- Using fertiliser from human waste (and even biogas) may not be culturally acceptable.
- Each design of bio-latrine unit has its own drawbacks detailed further in the Practical Action Technical Brief – *Biogas*.

Example of a bio-latrine system

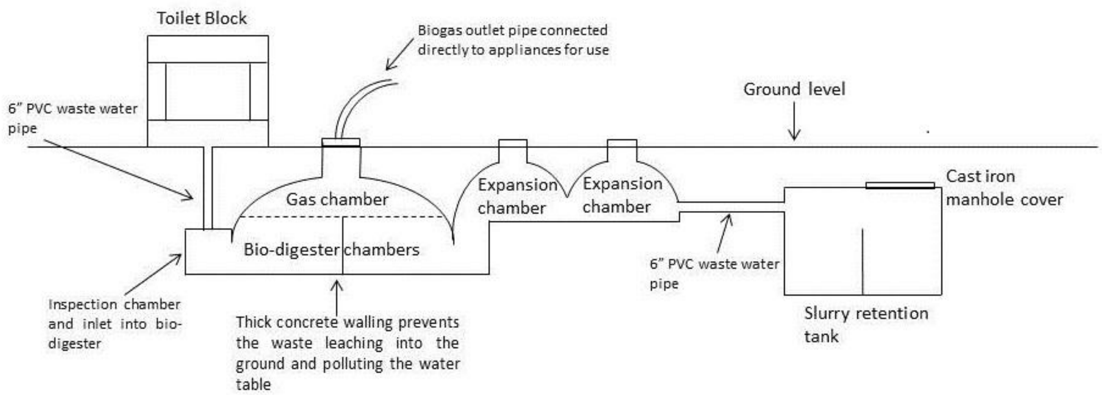

Figure 2: Bio-latrine installation constructed by Practical Action in Kitale, Kenya.
Illustration: Practical Action.

Practical Action has designed and built bio-latrine systems in a number of schools in Kitale, Kenya using a fixed dome digester design. In this design the pipe which links the toilet to the biogas plant is made of PVC. Waste initially flows through this pipe to an inspection chamber and an inlet, then into the bio-digester chamber. As the biogas is generated in the bio-digester chamber, the waste slurry is displaced into two expansion chambers. This slurry then flows through hydraulic movement and a PVC pipe to the Slurry retention tank, where it can be emptied via a manhole located in the top of the tank.

The biogas collects in the gas chamber above the bio-digester chamber, from which it is piped through underground pipes directly to appliances such as stoves, located in premises or households.

Practical Action Case Study –Kitale, Kenya

Kitale is a small town in western Kenya, with a rapidly growing population (12%pa). Almost two thirds of town's residents live in slums or informal settlements. There are no water and sanitation services in these areas and water sourced from the river is contaminated with sewage, oils and solid waste. Sanitation in these informal settlements is terrible, exacerbated by the lack of affordable sanitation options, a low awareness of health issues and insecure land tenure, resulting in a number of outcomes which include alarming levels of waterborne disease, ill health, social exclusion and crime.

Bio-latrines have been installed in 4 primary schools in the area, providing safe and hygienic sanitation facilities for 2780 children and are especially effective in these areas which are water logged or have no sewers. The bio-latrines also provide energy for the school kitchens and lighting for the classrooms to enable pupils from crowded single room informal settlements to study in the evenings. Furthermore they generate valuable organic fertiliser to use in the school farm which supports the school meals programme. Local manufacturers have quickly realised the potential of the technology and become involved in the construction of bio-latrine plants.

Other Practical Action work in Kenya

Another Bio-latrine design undertaken in Kenya incorporated a range of sanitation features. Biogas generated from the human waste was fed to a gas-fired water heating system to produce hot water for the showers. The waste water from the showers was then purified by a reed bed system and filtered into a fishpond. The fish enable the biological health of the water to be monitored before solar-powered pumps send it back into a storage tank for re-use.

Lukhana Primary School, Kitale. Provision of bio-latrines replaced traditional inadequate pit latrines for 908 children who attend the school.
Photo: Practical Action / Justine Williams.

Use of bio-latrines in hospitals

In the past public hospitals in Nepal were not able to offer patients or facilities access to food as they had no kitchens or cookers so families would have to either have to go hungry or pay large sums of money for food from local restaurants or hotels.

Practical Action has installed bio-latrine plants in 5 hospitals which provide natural power to newly-built common kitchens. Each hospital now has two stoves which are powered for three hours morning and evening and can provide food for hospital patients and relatives. The hospital staff have been trained in the maintenance and running of the bio-latrine units, giving them full control of the technology and ensuring the long-term benefits.

Cost of the bio-latrine

The cost of a bio-latrine depends on its size. A 10-door toilet block with a urinal, gas system (e.g. similar to the bio-latrines and system constructed by Practical Action at Lukhuna Primary School for approximately 980 pupils, the total cost was £4,600. (Ksh 600,000). Hence a single unit could cost approximately £50.00. Smaller units of about 6 toilets would cost £3,000 (costs are quoted from Practical Action 2007).

The approximate cost of one block of 8-10 door bio-latrine was £5,000 when constructed in 2007. This figure does not include any overheads such as staff costs, and local travel. The block can cater for 500 children.

Conclusions

Whilst Bio-latrines place more emphasis on the provision of a solution to sanitation problems rather than the generation of energy, they are not a perfect answer to either of these issues. Furthermore their use as an appropriate technology depends on a number of factors but the value of Bio-latrines has already been proven in the locations where they have been introduced with sensitivity to the local population and surrounding environment.

References

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- Musungu, W. N. (2009), *Review and evaluation of eight constructed biogas system connected to toilets.* Report For Practical Action Kenya

Further information

- *Biogas Use in Reconstruction* http://practicalaction.org/biogas-use-in-reconstruction
- *Biogas Digest - Volume 1 Biogas Basics* http://practicalaction.org/biogas-digest
- http://www.youtube.com/watch?v=_m1nr2v5S8o

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