The NoWaste Toilet™ – Function and Nutrient Recovery In-Situ Sanitation System
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ABSTRACT
Globally, it is estimated that 64% of people are discharging human excreta and waste water into the environment without any prior treatment (Baum et al., 2013). Untreated excreta that enters the environment not only threatens people’s health but also leads to eutrophication and degradation of aquatic ecosystems due to the nutrients in human excrement being the same essential nutrients for plant growth: nitrogen, phosphate and potassium (N-P-K) (Jönsson et al., 2004). The main objective of the NoWaste Toilet™ was to conceptualize an in-situ sanitation system that would contain, treat and concentrate excreta and output a dry, commercial, fertilizer (from urine) and a hygienic, low volume, organic soil amendment (from faeces).

The toilet would be located inside with the heating unit for the dehydration module outside and could replace exciting toilets (Figure 1). The urine-diverting seat would channel the urine into the alkaline treatment module which would rapidly increase the pH of the urine to above 10 by ion exchange to limit the enzymatic-hydrolysis of urea. Next, the urine would flow to the dehydration module which would contain ash (5% w/w) to insure high pH (>10) and act as an adsorbance medium during dehydration by ventilation (16 m³ hr⁻¹). The dehydration module would be solar heated to reach average temperature of 35°C (maximum peak temperature 40°C). The faeces, upon excretion, would drop directly into a vented vermicomposting module, designed for volume reduction of more than 85%. The objective is to prolong the retention time to minimize risk of handling and maximize natural decay rates (Lalander et al., 2013).

The alkaline and dehydration modules would achieve 90% mass reduction of the urine within 24 hrs, while preserving 85% of nitrogen as urea. Odours would be limited by minimizing ammonia emissions and having negative pressure in the vermicomposting module. The final output from the urine would be a dry powdered fertilizer with an N-P-K mass percent of 9-3-11. The vermicomposting unit would produce an organic fertilizer with an N-P-K mass per-cent of 0.5-1.5-5. The study by Lalander, et al. (2013) demonstrated that...
the accumulation of solid material in the vermicomposting module would be kept to a minimum, as the worms effectively reduced the material volume.

The implementation and maintenance of the toilet would be serviced by a local social entrepreneur. The output of the NoWaste Toilet™ would produce two concentrated, stable, storable and bag-able fertilizers, with a potential commercial value of 290$ per metric ton (USDA, 2013). This correspond to a value of 52 $ UDS for a family of five if all the nutrients would be collected (this value is based on world market price and local prices can be higher due to transport and retail addition or lower due to governmental subsidies). The installation costs of the toilet are estimated to be more than a VIP latrine and less than twin-pit or pour-flush system. Annual material costs are estimated at 30$ USD a year (only material costs were considered, as labour costs vary greatly).

On a weekly base, the alkaline module would be replaced with a fresh module. The dehydration module would be replaced with fresh alkaline material every two months. The vermicomposting module would be changed once every two years. The containers would be taken to the central station for regeneration (alkaline module), for bagging as fertilizer (dehydration module) or for further treatment (vermicomposting module).

Further treatment of vermicomposting would be required as the remaining degraded faecal matter can still poses a health risk (Lalander, et al. 2013). Therefore, the matter would be matured (2-6 months), after which the worms would be removed by using an attractant (fresh food) and then be transferred to a new unit. The remaining product would be bagged and be followed by a sanitization treatment of ammonia dosing (sourced from the dehydrated urine/ash mix) (Nordin et al., 2009). Overall, the risk for disease transmission from the system would be minimal due to the elevated pH for the urine and the prolonged retention time of the faecal fraction within the system.

The true innovation of the NoWaste Toilet™ in-situ sanitation system is the production a dry concentrated fertilizer (9-3-11) from the urine that would be equivalent to commercial fertilizers. This new concept would not require highly mechanized treatments or monitoring systems which otherwise can inhibit the use of improved sanitation systems. By dehydrating the urine within 24 hrs and degrading the faeces (prolonged retention time), there would be no liquid disposal. Therefore, there would be no need for vacuum trucks or other complex, potentially, unsanitary manual emptying, making this sanitation system suitable for areas where mechanical emptying by service trucks is not possible.
References


Latrine Design: Go in Peace

Steven Sugden, Water for People

Abstract

It is a truth universally acknowledged that a woman in possession of a good house must be in want of a beautiful toilet. But what exactly is a beautiful toilet? If beauty is in the eye of the beholder, does that mean a toilet which is considered beautiful in Nigeria may be considered ugly or even repulsive in Malawi or West Bengal?

Is your toilet just a place to defecate and get in and out of as quickly as possible, or is it a place where you can relax, read a paper and contemplate the meaning of life. Is your toilet more than a toilet? During some consumer research in India, a woman gave the following insight:

"[In the toilet] We feel comfortable to sit. We get peace. When we go to toilet we should feel peace. If the toilet is dirty then people would like to come out soon. They have to hurry their business. When it stinks we have to force ourselves to be there to complete the business. Peace is not there" Respondent 3 (PSI survey)

In more developed areas of the world we have forgotten the horrors of using a disgusting toilet and we take for granted our ability to ‘go in peace’, yet this is something a large proportion of the world’s population have yet to enjoy - a clean, private, peaceful place to ‘go’.

In the past, latrines have been designed from a purely functional perspective with vague ideas about what poor people want, or what the donor or implementing organization thinks poor people should have. Gradually marketing based organizations are forcing a more people-centered design approach in to the sanitation sector. These new organizations know how vital it is to listen to the consumer. They use professional designers who think about objects in a different way than engineers. A good designer worries a lot about the physical feel of their product and knows materials can make a huge difference to an object’s desirability. Engineers assess materials by their physical properties such as tensile strength, density or roughness, and view latrine design through a functional lens. The paper tries to bring these two perspectives together and to develop a single way of thinking about latrine design.

The focus of this paper is the designers view of latrines, it looks at what we mean by ‘beautiful latrine’ and how to create the “WOW” response when consumers open the door and see a latrine for the first time. It draws on Donald A. Norman’s book ‘Emotional Design: Why We Love (or Hate) Everyday Things’ (2004). It provides a lens through which the visceral, behavioral and reflective design aspects of a latrine can be viewed and through which different latrine attributes are examined. The paper also draws heavily on the author’s twenty years of experience in the sanitation sector in Africa and Asia and the thousands of happy hours he has spent talking to householders and poking his nose into their latrines.
The Evolution of Sanitation Services to the Previously Unserved by eThekwini Water and Sanitation Unit

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Theme: The enabling environment for FSM

Keywords: ventilated improved pit latrines; urine diversion toilets; low-flush toilets

This paper will describe rationale and the path taken by the Water and Sanitation unit of the eThekwini Municipality in the provision of sanitation services to the previously unserved

Context
It is important to appreciate the municipal context which drives decision making. These are:-

- water scarcity - a constant threat to be taken into account when considering any system,
- undulating topography - increases the costs of providing services,
- universal provision of potable water - reduces the risks associated with groundwater contamination,
- density of dwellings – which range from deep rural to dense peri urban,
- influx to the city - estimated to be 100 000 people per year,
- housing backlog - will not be met for many decades,
- high unemployment - 40%,
- high prevalence of HIV / AIDS - the concomitant feature of child or grandparent headed households,
- policy of free basic services - makes South Africa unique from a level of service and cost of delivery perspectives,
- theft of electricity and copper installations – limit the selection of treatment processes.

Trajectory
The current municipal administrative structure was created by amalgamating many smaller structures of different capacity and income bases. It inherited 60 000 ventilated improved pit latrines which were rapidly reaching capacity.

Without a method of emptying or disposing of the faecal sludge the city embarked on the installation of urine diversion toilets in the rural areas (90 000). The house holder was expected to empty the vaults themselves. Within the more dense regions of the municipality community ablution blocks connected to the sewerage system were installed (300). A network of entrepreneurial pit emptying contractors was established to provide faecal sludge which was processed in the newly developed latrine dehydration and pasteurisation machine (LaDePa). The number of VIP had by then decreased to 35 000.

The presence of informal settlements and development nodes outside the sewered area intensified research on the Borda Dewats system (super septic tanks) to be coupled to the community ablution blocks. Research on wetlands and the agricultural reuse of treated wastewater was initiated.

Research commenced on the collection and processing of urine from urine diversion toilets for its agricultural nutrient content. The municipality took over the operation and maintenance of the demonstration DEWATS plant.
Safety concerns associated with the household emptying of urine diversion toilets and the associated policy anomaly whereby all other households had a free municipal sewage disposal system resulted in the municipality to investigate different UD toilet emptying services. The densification of rural areas made in the practice of burial of faecal solids on-site impractical. This provided an additional reason for a municipal emptying service to be considered.

Research on pedestal pour flush toilets had shown success and prototype production of pedestals had progressed to the development of a low-flush variant. The municipality started planning for the piloting of 600 of these systems which would be located inside the dwelling.

Trials started using black soldier flies on the solids from urine diversion toilets. The resulting lava were considered as a commercial product. Investigations were initiated into the privatisation of the collection and treatment of urine diversion vault solids.

Detailed planning into the installation of DEWATS plants with agricultural areas for the rural community ablution blocks is underway and the first plants are planned to be commissioned in late 2014.

Full-scale emptying of VIP toilets and the treatment in three decentralised LaDePa will commence in late 2014.
Minimum-flushing Toilet and Human Waste Processor

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ABSTRACT

The goal of this project is to develop a waste processing system that can be applicable to sunny areas and meet the basic requirements of “Reinvent the Toilet” program. The Sunnybreeze team’s main idea about the innovative toilet systems (1) to limit the total amount of black water from the origin source using minimum flushing toilet; (2) to evaporate raw sewage to produce dry manure powder, (3) to pasteurize solid manure powder to kill pathogens, and (4) to disinfect fecal sludge as organic fertilizer and to recycle and reutilize resources.

Water-saving toilet is the premise of the evaporation technology that this project employs. In the first section, the authors introduce some characteristics of this mini-flushing toilet.

First, the toilet uses a foot pump to provide 50~100 ml high-pressure spray-water each pedal action. The second idea is the grinder+ black-water pump system, crash any fecal matter, which can surely Black-water safely discharge through a soft flexible rubber / plastic’s tube. It provides the possibility of multiple users to share one waste processor (to lower the cost) and, also provide the flexibility to place the toilet in anywhere (indoor / outdoor).

In section 2, we first explains the drier that we invented using the practice of “making the Chinese pancake”. The process of “making the Chinese pancake” can be briefly explained as: pour the batter onto the griddle, use the wooden rake to spread the paste on a large pan, flip the paste from time to time in order to heat the pancake from the inside, get the pancake out of the pan. When the pancake is ready, it is needed manually clear up the thin layer of batter that is bonded on the edge of the wooden rake. All the actions above can be realized using inexpensive and reliable mechanical equipment that doesn’t need manual intervention.

The third innovation is about “how to kill pathogens”. It is also a simple technique: the outputed fecal powder is placed into a Teflon cloth bag. It is then placed inside the vacuum tube that is stored under the sun. The solar energy makes the temperature of the manure powder inside the tube quickly rise to 130 degrees or above (which eliminates the bottleneck that water doesn’t boil under 100 degrees). Sufficient time and temperature reliably ensures pathogens like eggs, bacillus, are killed.

We are planning a “pilot scale” field test and user trail, with the goal to meet the actual needs of a village of about 800 people, this autumn in China. In the fourth section, the authors will demonstrate the detail plan of this field test. The experimental data will be analyzed, and the advantages/problems will be discussed. Some user’s will tell their experience which include whether the human - machine interface is friendly, whether the operation is simple, whether the equipment is durable, and whether the equipment is applicable to a variety of weather and season.

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