The Clear water recirculation toilet system

The safe collection, transportation, treatment and disposal of human excreta is necessary for the control of infectious and communicable diseases. The quality of available sanitation system is linked to the quality of available drinking water. Communities where open defecation is still being practiced are more susceptible to communicable disease outbreaks. The advent of waterborne sanitation can be traced to the cholera outbreaks of the 19th century and the conveyance of human excreta away from homes and separate from drinking water has become the acceptable way of ensuring and maintaining the barrier against communicable diseases.

The modern flushing toilet is commonly attributed to Thomas Crapper, who installed one for Queen Elizabeth I in 1880. The design was an improvement on an original design by Sir John Harrington in 1596. In South Africa the first waterborne sanitation system, with sewers, was used in the Great Karoo town of Matjiesfontein, founded in 1884 (S J van Vuuren and M van Dijk, 2011). Waterborne sanitation has since been accepted as the gold standard and engrained in the consciousness of modern society as the most appropriate sanitation method. However, due to modern day challenges such as climate change, erratic weather patterns causing droughts and exacerbating water stress, there is more focus on the conservancy of our natural resources. While dry sanitation offers a less resource intense alternative to conventional water borne sanitation solutions, it suffers from user acceptance issues and only finds use in remote areas where there are limited water resources. A closed loop, full recycle toilet therefore offers a suitable and acceptable choice as it conserves water use through the recovery, recycle and reuse of flush water.

A full recycle toilet system is a unit that collects waste stream (including excreta, urine and flushing water) from a flushing toilet, treats the waste stream, recovers the water, disinfects the recovered water, stores it and uses it for flushing.

Benefits of Close-loop full recycle toilet

1. Helps with water conservancy. Water content from the waste stream is recovered and reused for flushing
2. Allows for off-grid set-up. Can be used for household, community scale and sanitation micro grids.
3. Provides a sustainable waterborne sanitation solution.
4. Can be connected to renewable energy source i.e. PV solar panels to offset energy requirements.
5. No need for expensive civil construction and infrastructure i.e. reticulation systems, pipelines, pump stations etc.
6. Allows for the connection of other water sources such as grey water and rainwater harvesting. This could augment water needs during system instability.

A close-loop full recycle toilet is a valuable solution to include in the South African sanitation toolbox especially in areas with little water supply. With the right revenue and operations and maintenance model. This category of technology is able to replace the pit latrine, increase access to improved sanitation, and provide other health and environmental benefits that come with a well-designed system. As it is an off-grid solution, the system can fit in easily in peri-urban locations where poor spatial planning limits the construction of underground sewer reticulation systems or in rural areas where bulk infrastructure is not practical due to the low population density.

The Clear water recirculation toilet system is part of the Reinvented toilet technologies suite. It was developed through a grant provided by the Bill and Melinda Gates Foundation. It is a modular and

containerized system designed as a multi-seat unit. It comes in several models. The latest two models will be demonstrated on the SASTEP platform.

- Model TT-5B
- Model TT-6

Model TT-5B

Figure 1: Model TT-5B

The unit is a 4-seater front-end toilet with the back-end treatment unit. It is designed to accommodate an average of 600 uses a day. It is a containerized and modular unit that easy to transport, install and commission. It requires no connection to an existing sewer system and can be energy self-sufficient if connected to solar panels. It offers an off-grid solution and will work in areas will little water supply.

The front-end is a conventional flushing toilet system and the backend is essentially an aerobic treatment unit with a proprietary membrane biological reactor (MBR) and an ultraviolet (UV) system to disinfect the recovered water stream before it is recycled for flushing.

Model TT-6

Figure 2: Model TT-6

The model TT-6 is a modular and containerized unit that houses the backend only with no front-end provided. The unit can be coupled to existing toilet blocks, which makes it more versatile than the model TT-5B. It is designed to accommodate an average of 6000 uses a day. As with the model TT-5B it is a containerized and modular unit that is easy to transport, install and commission. It requires no connection to an existing sewer system and can be energy self-sufficient if connected to solar panels. It offers an off-grid solution and will work in areas will little water supply. Up to 20 frontend units can be connected to the model TT-6. The model TT-6 is equivalent to the backend of the model TT-5B but with more processing capacity.

General process description of the backend process

The waste stream from the toilet is initially stored in a black water collection tank. The tank provides residence time for the wastewater to equalize. The tank inventory is then pumped to the treatment

section of the system where it is first treated to remove suspended solids and then it undergoes aerobic and anoxic biological treatment to remove organic and nitrogen respectively. A special aerobic media is placed in the aerobic reactor and proprietary bacteria, specifically developed for treating wastewater is attached on the media as a biofilm. This biofilm is able to effectively biodegrade the organic pollutants and reduce its concentration. The treated stream is then passed through the membrane biological reactor (MBR). The MBR membranes serve as microbial barriers that can capture most of the biomass for recirculation inside the bioreactor. The MBR has very good solids/liquid separation effects and produces water that can either be reused for toilet flushing or discharged into downstream sewer directly or be reused as irrigation water.