Processing of Urine Diversion Toilet Faecal Sludge using Black Soldier Fly Larvae eThekwini Municipality project

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WIN-SA aims to capture the innovative work of people tackling real service delivery challenges. It also aims to stimulate learning and sharing around these challenges to support creative solutions. Most importantly, WIN-SA strengthens peer-to-peer learning within the water sector.

The eThekwini Municipality is considered as one of the leading municipalities in South Africa in the provision of basic sanitation service and has won a Stockholm Industry Water Award in 2015, has selected the urine diversion, ventilated improved double pit (UD/VIDP) toilets as the preferred delivery mechanism for certain communities in their area of responsibility.

According to Teddy Gounden, Manager for eThekwini Water and Sanitation since 2002, the municipality has installed over 80 000 Urine Diversion (UD) double vault toilets at the household level in rural areas. This technology was selected to replace Ventilated Improved Pit Latrines (VIPs) as the municipality's basic onsite sanitation option which was expected to produce a degraded sludge which could be safely removed and buried on site by the residents. This approach eliminated the challenges and costs encountered when servicing VIP systems, which included access to pits, removal of sludge containing solid waste, and transport and disposal of sludge.

Gounden says, "A number of concerns have since arisen over the removal of faecal material from UD toilets. These include health risks to residents who handle the potentially pathogenic sludge and dissatisfaction amongst household owners over the expectation that they will remove the faecal matter from their systems themselves while other recipients of basic sanitation receive a free service from the Municipality".

In order to tackle the problem, the Municipality therefore needed to identify other safe and economically feasible faecal matter removal options which can be provided to the 80 000 homes. The two potential options for disposing of the UD toilet faecal waste were (i) burial on site with tree planting, (ii) transport to a hazardous waste site, or (iii) transport to a central faecal waste processing facility. The initial modelling of these options has shown high costs with both the burial and hazardous waste site disposal option.

Through funding from the Bill & Melinda Gates Foundation (BMGF), the eThekwini Municipality's Water and Sanitation Unit (EWS), together with a professional consulting team comprised of Khanyisa Projects, Partners in Development and the University of KwaZulu-Natal's Pollution Research Group began exploring an alternate central waste processing option to reduce the costs to the Municipality. This involved to identify and eventually implement a processing technology that could convert faecal waste to valuable end products through a business partnership with a local private operator. The planned full-scale operation would need to process 20 tons of faecal waste per day, which represents approximately 20% of the Municipal UD faecal sludge waste removal programme.

Emptying faecal sludge from a Urine Diversion Toilet

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Establishing a New Industry on Toilet Waste

Nick Alcock from Khanyisa Project says,"The re-use of the toilet waste is not new and has been occurring for centuries, especially for agriculture. However, there has been renewed

focus on this aspect with the aim to establish new products and supply chains. This way of thinking aims to move away from traditional linear approach of using a circular economy approach that aims to re-use and profit from products formed through the sanitation value chain".

"In order to implement this programme, the project was divided into two components. The first component involved the rollout of a management contract, which included the appointment of local labour to undertake the removal of faecal waste from the UD toilet vaults, and either bury onsite or transport the contents to the central processing plant", explains Alcock.

Black Soldier Fly Larvae Technology

According to Mr Dave Still who is co-managing the project through Partners in Development (PID), the Black Soldier Fly Technology is an industrial biology technology in which Black Solider Flies (BFSL) , which have limited span of up to 8 days, lay eggs that develop into larvae. The larvae eat waste products – this was mostly confined to food wastes but now has been applied to human faecal waste - to reduce its volume. These larvae gain significant weight in a few days and the flies, unlike household flies, are neither considered a pest nor spread diseases. These larvae can be further processed into protein feeds and oils.

In Durban, the harvested larvae are being collected after composting with a combination of food and faecal-origin waste for further processing into a product called MagOil (some the products that can manufactured from this technology can be viewed here: http://agriprotein.com/our-products/). The pilot aims to not only demonstrate circular economy principles that can be achieved through sanitation provision but also provides a platform to showcase the technology to potential commercial partners who may be interested in new supply chains for their products.

The second component of the project was the establishment and operation of a faecal waste processing plant utilizing the Black Soldier Fly Larvae Technology.

The Project team engaged with the private organization Biocycle which has been piloting the BSFL technology to process faecal waste for several years. The BSFL consumes organic waste in order to grow to adult size. The adult larvae are then processed into products such as chicken feed, pet food and oils. The residue can be used as a soil conditioner or converted into biochar. Business modelling was undertaken and a draft service level agreement (SLA) was drawn up with a view to establishing a form of public private partnership between the Municipality and Bicycle. The Isipingo Waste Water Treatment Works was identified as a suitable site for the establishment of the processing plant.

The construction of the BSFL Processing Plant

During 2016 and 2017, a BSFL plant capable of processing up to 20 tons of faecal sludge per day was constructed. In addition, high-tech processing equipment to separate residue from larvae, press larvae to make oil, then dry, and mix the remains to make a feed mix has been installed, as well as machinery for heating and drying of the residue to make biochar. Since July 2017, the plant has been processing an average of three tons of UDT waste per day or 60 tons per month.

Business Model

A viable business model was agreed within the SLA between eThekwini municipality and the BSFL plant operator for a 5-year period with a 6-month start up. Financial modelling of the options was developed taking into account a number of assumptions on conversion rates, mass of faecal waste processed, end-product output, and municipal gate fees. Table 1 below summarises the estimated costs to the Municipality of the BSFL model and compares these to the cost of transporting the waste to a hazardous waste landfill site and burial on site with tree planting. The table below shows the Comparison of financial model results.

The removal, burial and transport costs are based on actual tendered rates. A capital cost subsidy for the BSFL plant of approximately $24 per ton processed has been provided by the Bill & Melinda Gates Foundation and the eThekwini Municipality and this has been discounted from the BSFL costs. The processing rates and sale costs for products are based on mass balance research and estimated prices respectively.

Challenges experienced

According to the Khanyisa project team members a number of challenges have been experienced during the course of this project, such as delays in the development and agreement of the Service Level Agreement (SLA), design and fabrication of the processing equipment, and institutional delays due to municipal procedures. In addition, the efficiency and cost-effectiveness of the technology can only be determined once the processing plant is fully operational. The operation of the plant over the next 12 - 24 months will enable the accuracy of this business model to be tested. If the BSFL plant is successful, it should make business sense to build more strategically located BSFL plants elsewhere in the city.

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