ABSTRACT

An estimated 37% of the population in South Africa are currently without basic sanitation facilities. Poor sanitation may lead to the spread of disease and increased contamination of ground and surface water resources. The demand for basic services continues to exceed supply and limited progress has been made in elimination of backlogs. As a result, various low-cost sanitation alternatives, are being investigated, including urine diversion toilets and Ventilated Improved Pit (VIP) latrines. Research is also being conducted for the use of anaerobic baffled reactors to treat water from peri-urban communities and industrial wastewater, with positive results.

The Anaerobic Baffled Reactor (ABR) is a high rate anaerobic reactor, which has a series of hanging and standing baffles that form several equal volume compartments to force the wastewater up and down through each compartment as it flows from the inlet to the outlet of the reactor. The ABR has been found to treat high strength organic loads, and has consistently high Chemical Oxygen Demand (COD) removal. It does not require external power and meets the other requirements for a sanitation alternative.

This study forms part of a larger Water Research Commission (WRC) Project, conducted by the Pollution Research Group at the University of KwaZulu-Natal, which investigated the feasibility of "the anaerobic baffled reactor for sanitation in dense peri-urban areas". The objective of this study is to monitor the performance of the ABR in a peri-urban area.

The pilot reactor used for this study was constructed at the University of KwaZulu-Natal, and was set up at the Kingsburgh Wastewater Treatment Works. A submersible pump was used to pump wastewater from the influent channel into the feed box of the ABR. The flow rate of the influent was regulated by a programmable logic controller, which allowed for a relatively constant flow of 1.6 l/min to the ABR, where the unused feed overflowed back into the channel.

Over an operational period of 6 months, samples from the influent and effluent of the ABR were collected and analysed on a regular basis. The influent and effluent results were compared in order to monitor the performance of the ABR. The following parameters were investigated:

- Chemical Oxygen Demand
- Solids
- pH
- Alkalinity
- Phosphates
- Total Kjeldahl Nitrogen
- Faecal coliforms

There were no major stoppages during the study period, and only a few minor flow incidents, as a result sufficient data was obtained to monitor the performance of the reactor. The hydraulic retention time was approximately 42 hours.

The percentage removal of COD by the ABR shows that the average reduction in COD is 83%, and removal rates were consistently between 78% and 90%. Solids were consistently low in the effluent, showing a removal efficiency of 40% - 70%.

On site measurements for pH presented an average of 7.2 for the influent, and an average of 6.5 for the effluent samples. Alkalinity concentrations of were averaged to 256 $mgCaCO_3/l$ for the influent samples and 246 $mgCaCO_3/l$ for the effluent samples. The alkalinity results for this study were low when compared to typical anaerobic treatment systems, suggesting that the ABR was poorly buffered, however this did not appear to influence the treatment performance of the ABR.

There was a slight decrease in Phosphates; however this was not considered a significant decrease. Anaerobic digestion has no mechanism to remove Phosphates or Phosphorous, as a result this decrease is attributed to the relatively few number of samples. A slight reduction on TKN was observed due to treatment by the ABR; however no significant trends were noted.

There was a significant reduction in *E. coli* by an average of 76%. The average removal of 86% of coliforms was significant. Although a significant reduction of *E. coli* and coliforms was found, the concentration of faecal coliforms found in the effluent are substantially higher than the DWA guideline for irrigation, which is 1 cfu/100m*l*, or approximately 10 000 *E. coli* cells.

Significant concentrations of nutrients were still present in the effluent, and as a result, in terms of the Department of Water Affairs (DWA) water quality guidelines, ABR effluent is unsuitable for discharge to surface or groundwater, and may not be used for any activity that may contaminate such water resources.

The ABR achieved significant removal of faecal coliforms, however, there were still high concentrations of indicator organisms in the effluent, and when compared to the DWA guidelines for discharge to natural water resources, and for irrigation and domestic uses, these exceeded the guideline concentrations and are considered a risk to human health. Therefore, the effluent may not be discharged or used without further treatment.

Overall, the ABR proved to be a sturdy treatment system with many biological and hydraulic advantages over the conventional treatment systems (Foxon et al., 2005). Further the ABR would have lower installation, operation and maintenance costs in comparison with conventional treatment systems, and it provides a viable alternative for communities with dry sanitation that aspire to waterborne sanitation (Foxon et al., 2005).

However, the ABR was not found to treat wastewater to suitable chemical and microbiological standards as a stand alone treatment alternative for any end use, including irrigation. For the ABR to become a possible treatment alternative, suitable post-treatment and appropriate uses and/or discharge practises would have to be investigated. The ABR has no means for prevention of the build-up of or for removal of solids, and an ABR treatment system would therefore require a pre-treatment step or maintenance plan for screening and removal of grit and other undesirable material.