Report for 2002CA1B: Fate of viruses, endocrine disrupters, and nitrogen in non-conventional onsite wastewater treatment processes: a technical and economic analysis

- unclassified:
  - Leverenz H., G. Tchobanoglous, and J. Darby (2002) Review of Technologies for the Onsite Treatment of Wastewater in California, Center for Water Resources Engineering, University of California Davis, No. 2002-2. Leverenz H., L. Ruppe, G. Tchobanoglous, and J. Darby (2001) Evaluation of High Porosity Media for the Treatment of Onsite Treatment of Wastewater, (peer reviewed) Small Flows Journal, Vol. 2, No. 2.

Report Follows:

Project Summary

Onsite wastewater treatment systems have been constructed and are currently in operation at the UC Davis wastewater treatment facility for investigation of the fate of indigenous coliphage, nitrogen, and endocrine disruptors in these systems. The treatment systems that have been selected for evaluation are unique because of their high efficiency and role in the future of onsite wastewater treatment. The treatment systems that are in operation encompass several state-of-the-art technologies, including (a) three high porosity, high surface area multi-pass biofilm reactors (see Fig. 1), (b) two submerged aerated biofilm reactors; one to be inoculated with specific bacteria (i.e., bioaugmentation) for enhanced performance (see Fig. 2), and (c) a traditional septic tank followed by single-pass sand filters. In addition, soil lysimeters (see Fig. 3) have been assembled to further evaluate the effect of upstream processing on the performance of soil adsorption systems (i.e., standard leach field).

The treatment systems described above are typically used for the treatment (or pre-treatment) of wastewater from individual or clustered buildings or small communities before discharge to the soil environment. After discharge to the soil, the partially treated wastewater undergoes additional treatment by soil microorganisms, followed by evaporation or infiltration to the local groundwater. Constituents that are typically present in wastewater include dissolved and particulate organic materials, nutrients, pathogenic and non-pathogenic microorganisms, and chemicals resulting from human activities (e.g., hormones, pharmaceuticals). These constituents are removed to varying degrees depending on the nature of the treatment process used. The purpose of the present research is to determine the fate of these constituents when treated in conventional and non-conventional treatment systems and after discharge to the soil.

Due to the nature of the treatment systems, it will be possible to evaluate the removal and transformation of wastewater constituents under a range of conditions. For example, based on preliminary research, the biofilm reactors are able to provide nearly complete BOD and TSS removal, complete nitrification, and 30 to 70 percent total nitrogen removal (through anoxic denitrification) depending on the mode of operation. In contrast, the submerged aeration systems function similar to conventional nitrifying activated sludge systems when operated without bioaugmentation. However, when bioaugmentation is initiated before nitrification develops, BOD is removed and the nitrification reaction is inhibited, thus producing an effluent low in biodegradable organic substrate yet high in ammonia. Alternately, if a nitrifying culture is established before bioaugmentation, there is evidence that aerobic denitrification processes will occur, resulting in an effluent low in BOD and inorganic nitrogen. Similar transformation and removal dynamics are expected for other wastewater constituents.

The application of these effluents to soil lysimeters will improve our understanding of the fate of wastewater constituents under different treatment scenarios and in the soil. The results will be useful for decision makers contemplating the appropriate use of onsite wastewater treatment systems for protection of public and environmental health.

Professional Presentations

Leverenz, H.L. The use of pretreatment technologies for the removal of wastewater constituents, National Symposium on Individual and Small Community Sewage Systems (ASAE), Sacramento, CA, March 21-24, 2004.

Student Training

Gina Choi, undergraduate; Civil and Environmental Engineering, UC Davis

Ian Maki, undergraduate; Civil and Environmental Engineering, UC Davis

Erin Onieda, undergraduate; Civil and Environmental Engineering, UC Davis

Olivia Virgadamo, graduate, M.S.; Civil and Environmental Engineering, UC Davis

HsinYing Liu, graduate, Ph.D.; Civil and Environmental Engineering, UC Davis

Harold Leverenz, graduate, Ph.D.; Civil and Environmental Engineering, UC Davis

Additional Funding

The following equipment has been donated (values estimated) for the purpose of conducting the research:

- → Four septic tanks, $5,000 (Delta Precast & Jensen Precast)
- → Three biofilm reactors, $6,000 (Orenco Systems Inc.)
- → Two aeration systems, $4,000 (Pirana Inc.)
- → Six soil lysimeters basins, $3,000 (Orenco Systems Inc.)
- → Miscellaneous pumps, basins, control systems, supplies $10,000 (Infiltrator Systems Inc., Orenco Systems Inc., & Pirana Inc.)

Collaborative Efforts

Bioaugmentation processes will be monitored and characterized through interdepartmental collaboration with Dr. Stefan Wuertz. The collaborative work will include sequencing of bacterial DNA needed to construct molecular probes to be used for identification of relevant treatment organisms.

Images

The following images have been included

Figure 1 Diagram of high efficiency biofilm reactor used for wastewater treatment, currently under evaluation at UC Davis.

Figure 2 Diagram of submerged aerated biofilm reactor used to facilitate bioaugmentation processes in wastewater treatment, currently under evaluation at UC Davis.

Figure 3 Diagram of soil lysimeter used for assessing performance of onsite wastewater treatment processes.

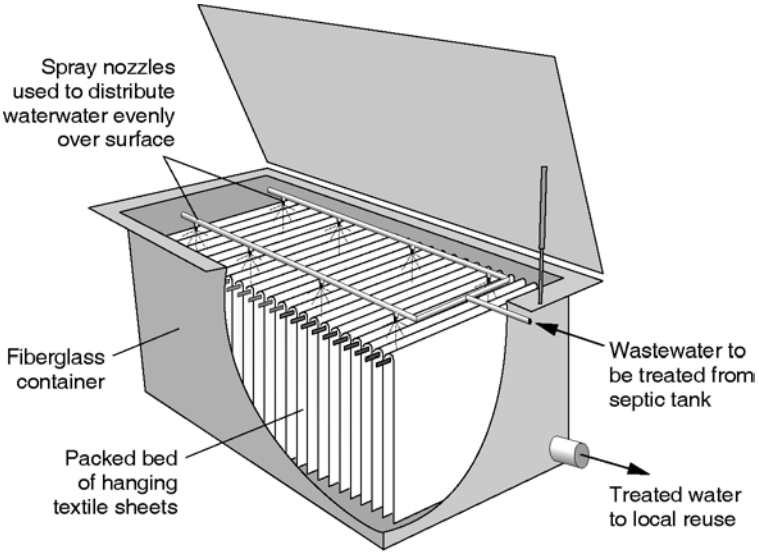

Figure 1
Diagram of high efficiency biofilm reactor used for wastewater treatment, currently under evaluation at UC Davis.

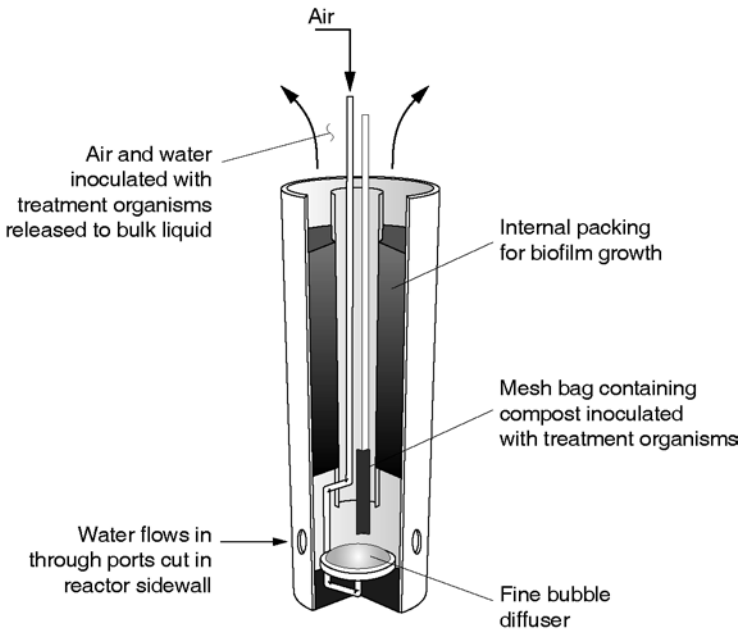

Figure 2
Diagram of submerged aerated biofilm reactor used to facilitate bioaugmentation processes in wastewater treatment, currently under evaluation at UC Davis.

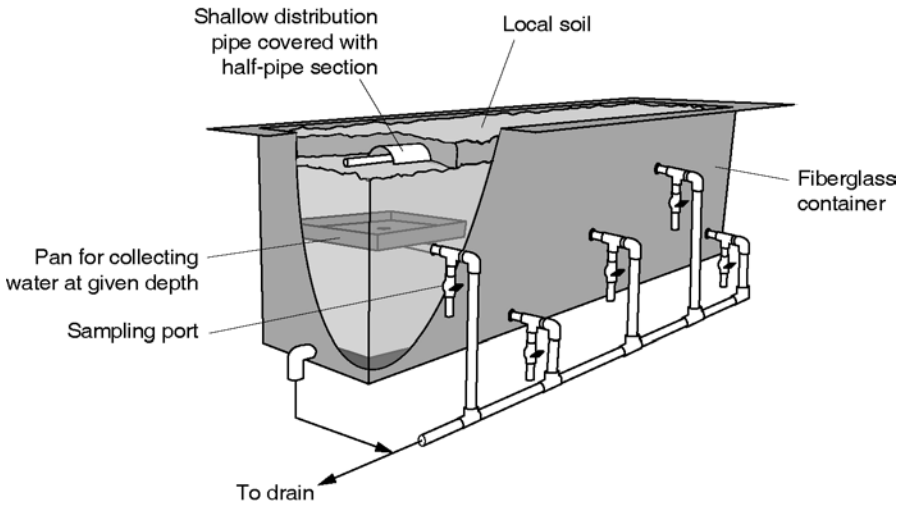

Figure 3
Diagram of soil lysimeter used for assessing performance of onsite wastewater treatment processes.