Optimization of continuous vermifiltration processes for small communities

Summary

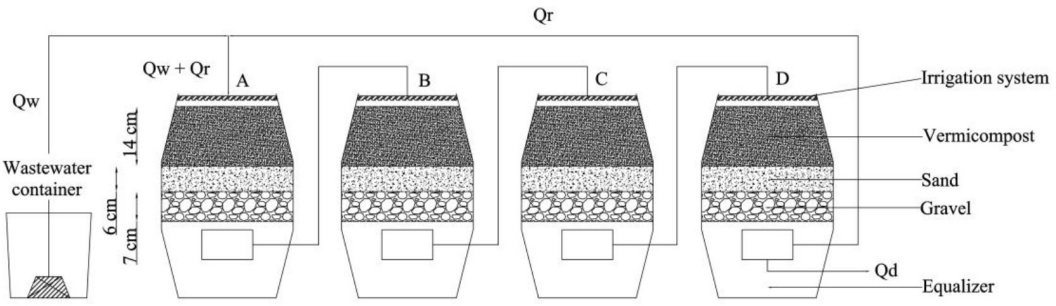
This thesis studies the optimization of decentralized vermifiltration processes to treat urban wastewater. The process included the optimization of small-scale vermifiltration processes, complemented with life cycle assessment studies. Decentralized systems are being progressively considered as more sustainable solutions. Many do not require electricity supply, expensive or sophisticated operation, and are easy to adapt in different geographic contexts.

Dry controlled systems are suited for arid regions and for disperse dwellings without centralized sanitation. Since several dry and wet decentralized technologies may be important sources of contamination, many opportunities are still open for research, including, not only the conversion of rudimentary systems into controlled systems in dry technologies, but also the inclusion of secondary treatment systems in a complement to primary treatment systems in wet technologies. The optimization of the vermifiltration system evolved finding the best set of hydraulic variables, earthworm stocking density, and system configuration, when evaluating a single-stage reactor and a four-stage reactor. In all treatments, efficiencies were still short to attain the EU regulation for wastewater discharges discharges in sensitive water bodies (TN and TP) and USEPA and WHO guidelines for irrigation (faecal coliforms). Even so, all treatments fully eliminated helminth eggs.

A full life cycle assessment study was made to benchmark vermifiltration systems against other technical alternatives. More material resources were used during construction than in any other phase. Given the small served population used, the material intensity per user was higher than that found in other larger facilities. Electricity was the resource more used during operation, which was an expectable result. Vermifiltration would be a better environmental solution than constructed wetlands and activated sludge, as shown by better results in most impact categories. In all treatment solutions the impacts during construction outweigh those of the other phases, due to the small number of served inhabitants, not attaining economies of scale.

Keywords

Vermifiltration, wastewater, optimization, life cycle assessment.



Sequential vermifilter design.

PhD student
Nelson Miguel Guerreiro Lourenço

PhD program
Science and Environmental Technologies (University of Algarve)

Supervisor
Luis Fernandes Nunes (University of Algarve; CERIS, IST, University of Lisbon)

Co-supervisor
-

Period
2012-2021

Funding
-