

Integration of horizontal and vertical flow wetlands in a modular compact system for individual sanitation in Galicia

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Abstract

Due to the great dispersion Galicia's population, there is a high percentage of households without access to adequate conventional wastewater sanitation system. Due to this fact, there is great need to examine the possible use of certain types systems that have a low cost of construction and operation, as an alternative to reduce the problem. Wetlands systems have this characteristics. A pilot plant has been constructed to treat the effluent coming from a household. The treatment system is composed by a septic tank of 500 dm³ and three subsurface vertical flow constructed wetlands of 3,3 m² each, working in parallel. One of them has on its surface a compact modular system that allows the combination of a horizontal and vertical flow system in a minimum surface equivalent per capita. It also provides mobility to these systems, which improved the replacement of substrate in case of clogging problems. Preliminary results during the start up period indicate an average removal efficiencies of 54 %, 46 % and 43 % in total suspended solids; 62 %, 60 % and 64 % in chemical oxygen demand and 64 %, 62 % and 65 % in biological oxygen demand for the first, second and third reactor respectively. Subsurface vertical flow constructed wetlands are therefore considered a good alternative for individual sanitation in Galicia. The unit with the modular compact system has higher removal rates for total suspended solids.

Keywords: individual sanitation; modular compact system; raw wastewater household; subsurface horizontal flow constructed wetland; subsurface vertical flow constructed wetland.

Introduction

Galicia is characterized by a highly dispersed population. About 21% of the population lacks sanitation system, or it consists only in a septic tank with deficiencies in results and yields. Domestic and agricultural wastewater is usually discharged into surrounding streams and rivers causing water pollution (Galicia's Sanitation Plan, 2000–2015).

Constructed wetlands have proved to be highly efficient wastewater treatment systems. They are a low cost technology, require low maintenance, have null energetic cost, generate a minimum amount of sludge and are good for the ecosystem, since the plants can be a habitat for different kinds of animals and birds. These characteristics make them a good alternative to conventional systems for the sanitation of small communities (García and Corzo, 2006).

Although research on constructed wetlands is ongoing at many sites around the world, a few studies of this system have been carried out in Galicia (Puigagut, 2007). There are three main basic types of wetland treatment systems based on their hydrology; natural wetlands, surface flow and subsurface-flow constructed wetlands. Wastewater flows by gravity, vertically or horizontally, through the bed matrix.

Methods

The experimental plant is located in a household in Teo (A Coruña, Spain). The plant was constructed in march 2009. Data presented range from August09–October10. The septic tank with a volume of 500 dm³ was fed with raw domestic wastewater of the house, the effluent goes into the constructed wetlands system, constituted by three wetlands (Polyester tanks of 2 m³ and 3.3 m²) working in parallel with intermittent loading (four loadings a day in average). The first one of them is equipped on its surface with a compact modular system that allows the combination of horizontal and vertical flow systems. The experimental plant was operated automatically.

The composition of substrates for all tanks is: 10 cm layer of sand main (\varnothing 2 mm), 35 cm layer of gravel (\varnothing 4–8 mm), 15 cm layer of gravel (\varnothing 12–16 mm) and 15 cm drainage layer gravel (30–60 mm). The distribution system consisted of three pipes with holes of 20 mm spread over the surface of the wetland. Each system has 26 emitters.

The species of emergent macrophytes selected for the system are mixed *Typha sp.* and *Iris pseudacorus* (VFCW 1), *Typha sp.* (VFCW 2) and *Iris pseudacorus* (VFCW 3).

The organic load applied to the three beds was 24 gDBO₅/m²/d, which corresponds to a specific area demand of 2.5 m² per person (when considering a specific pollutant load for 60 gDBO₅/d per person).

Results and Discussion

The inflow is taken after septic tank, and the outflow individually in each reactor. Figure 1 shows evolution of the efficiency of treatment in each VFCW during the start up. The operating characteristics during this period was one day to application and two days dry period with a hydraulic load of 8,3 mm/d. In these conditions, the average percentage of removal was over 43 % and 63 % in TSS and organic matter, respectively. These variations in efficiency could be due to a bad distribution of the influent; to the temperature of the system; the high concentration of the influent and mainly because the system is in start up. This aspect should be revised in the near future. Currently, no significant differences between the unit with the modular system and the rest of constructed wetlands have been observed.

Conclusions

Despite the fact that the wetland system used was still in start up, the treatment system based in septic tank and constructed wetlands is capable of improving the quality of the effluent significantly. The average removal efficiencies were of 48 % total suspended solids (TSS), 62 % chemical oxygen demand, 64 % biological oxygen demand (BOD₅), 31 % total nitrogen and 42 % total phosphorus for the overall system.

This treatment system can be used particularly in small communities or households, because of its simplicity and economy compared to conventional systems.

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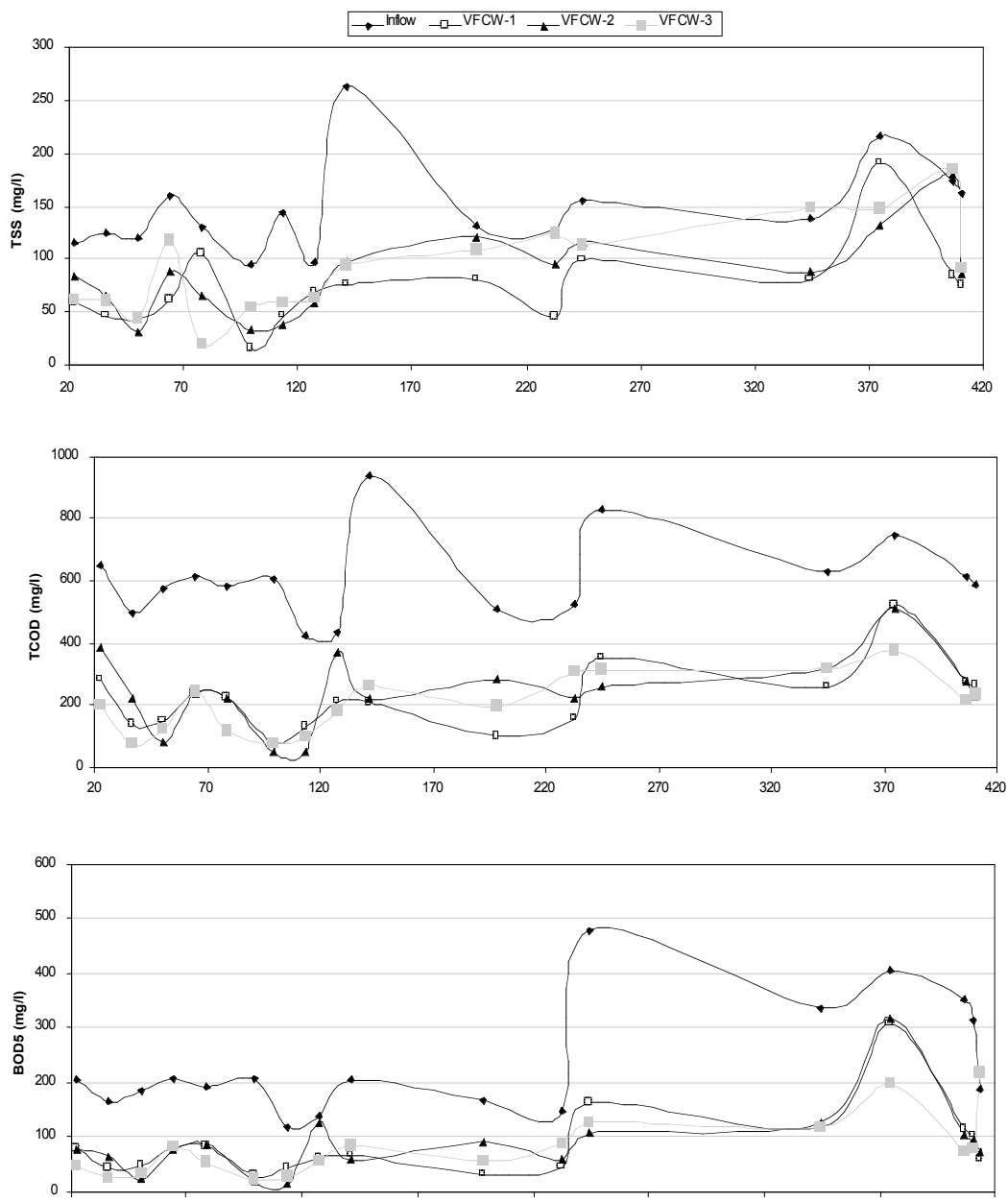


Figure 1. Evolution of the treatment in the VFCW-1 (a), VFCW-2 (b) and VFCW-3 (c).